Southwestern Region

Final Environmental Impact Statement for
Carlota Copper Project

Tonto National Forest

July 1997

Volume II

Equal Employment Opportunity Statement

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3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.0 Affected Environment and Environmental Consequences

This chapter describes the environment that would be affected by the development of the proposed Carlota Copper Project or the project alternatives. The environmental baseline information summarized in this chapter was obtained from field and laboratory studies of the project area, published sources, unpublished materials, and communication with relevant government agencies and private individuals with knowledge of the site. The affected environment for individual resources was based on the area of potential direct and indirect environmental impacts. For some resources, such as geology, soils, and vegetation, the affected area was determined to be the physical location and immediate vicinity of the areas to be disturbed by the project. For other resources, such as water quantity and quality, air quality, and social and economic values, the affected environment comprised a larger area, i.e., watershed, airshed, local counties, etc.

Chapter 3 also describes the anticipated direct, indirect, and cumulative impacts of the proposed action and the project alternatives, including the no action alternative. Recommended monitoring and mitigation measures developed in response to the impacts are also identified for individual resources. These measures are recommended by the Forest Service and are not part of Carlota's Plan of Operations for the proposed project. These measures could be required by the Forest Service or other regulatory agencies as conditions or stipulations of approval and authorization of the Plan of Operations.

This chapter is organized by environmental resource to provide the reader with a clear understanding of the existing conditions and potential environmental impacts associated with each resource. The monitoring and mitigation measures recommended by the Forest Service for all resources are summarized in Section 3.15. Unavoidable adverse impacts are identified in Section 3.16; short-term uses compared to long-term productivity are discussed in Section 3.17; and irreversible or irretrievable commitments of resources are presented in Section 3.18.

3.1 Air Resources

3.1.1 Affected Environment

3.1.1.1 Climatology

Regional Characterization and Influences

The climate of the Carlota Copper Project area is marked by low to moderate precipitation, dry winds, and warm temperatures. A mountainous region, oriented southeast to northwest, separates the state into a higher elevation plateau in the northeast and a lower, desert-like region in the southwest. The project area (elevation 3,700 ft-amsl) is located within the mountainous region, resulting in highly localized climatic conditions. A giant escarpment, the Mogollon Rim, is located to the north of the project area and represents a boundary for restricted air movement.

The area experiences a high percentage of sunshine and low humidity. From late fall through early spring, storm systems from the Pacific Ocean cross the state. During these months, the area generally has moderate daytime temperatures and cool nights. In contrast, moisture-bearing winds from the southeast (Gulf of Mexico) prevail during the hot summer months through mid-September. Thunderstorms occasionally develop, preceded by strong winds that produce dust storms. The generally arid conditions, in combination with these summer thunderstorms and high winds, may contribute to airborne particulates in the region. Typical annual precipitation of approximately 19 to 20 inches is evenly distributed throughout most of the year, except in the dry months of April, May, and June.

The project area is located on the border of Gila and Pinal Counties, with the closest town being Miami (6 miles to the east). Meteorological data (1951 to 1980) from the National Oceanic and Atmospheric Administration (NOAA) summarizing climatic conditions for the Miami weather station are presented in *Table 3-1*.

Project Meteorological Conditions

A meteorological monitoring program was initiated by Carlota in July 1992. The monitoring site is located approximately 5,000 feet west of the Cottonwood tailings pond in Pinto Valley (elevation 3,800 ft-amsl; Universal Transverse Mercator (UTM) coordinates 501,583 E, 3,693,714 N). At this station, temperature, wind speed, wind direction, and sigma theta (standard deviations of horizontal wind direction fluctuations) are measured. Information on these parameters is subsequently provided in this section. Information on precipitation and evaporation is presented in Section 3.3, Water Resources. *Figure 3-1* indicates the locations of the meteorological and air quality monitoring stations.

Temperature. The temperature data used in this analysis (measured at the project site from July 1992 to June 1993) are presented in *Table 3-2*. The average annual temperature during the sampling period is 62°F. The maximum daily average for the Carlota site is 88°F (June 1993), while the minimum

Table 3-1. Selected Miami, Arizona, Meteorological Data

Parameter	Miami
Elevation (ft-amsl)	3,560
Mean Annual Temperature (°F)	62.9
July Normal Daily Maximum Temperature (°F)	96.9
January Normal Daily Minimum Temperature (°F)	32.5
Mean Days Per Year >89°F	1.2
Mean Days Per Year <32°F	48
Mean Annual Rainfall (inches)	19.0
Mean Days Per Year >0.1 inch rain	37

Source: NOAA (1985)

daily average at the site is 33°F (December 1992). Temperature fluctuations on an hourly basis also are recorded at the site. The highest maximum hourly temperature during the data collection period was 103°F (June 26, 1993); the minimum hourly temperature was 24°F (December 20, 1992).

Table 3-2. Mean Monthly Temperature Data (°F) for the Project Site (July 1992 to June 1993)

Month	Monthly	Maximum Daily	Minimum Daily
July	79	86	68
August	77	85	62
September	79	79	63
October	66	73	57
November	46	57	37
December	42	53	33
January	47	53	37
February	46	52	41
March	53	61	39
April	61	72	52
May	71	78	60
June	78	88	60

Source: Applied Environmental Consultants, Inc. (AEC) (1992-1993)

The 1 year of on-site temperature data were compared to long-term temperature data available for the nearby Miami station (Ruffner 1985). The annual average temperature measured at the Carlota site during the 1992-1993 monitoring program is approximately 1 degree less than the annual average measured at the Miami station from 1951 through 1980. The major difference occurred in the summer months of July and August. During these 2 months, average temperatures were 4 to 5 degrees less at Carlota. This difference is likely caused by the altitude of the on-site monitoring station (3,800 ft-amsl), as compared to the Miami station (3,560 ft-amsl).

The Carlota project area is located in a semi-arid region with limited vegetative cover. Based on 30-year (1951 to 1980) climatological data from Miami (Ruffner 1985), temperatures occasionally drop below the freezing point (32°F) from October through April, potentially limiting the growing season. The number of average annual heating degree days (below base 65°F) for this 30-year period is 2,846, and the number of average annual cooling degree days (above base 65°F) is 2,104.

Winds. The wind information used in this analysis was recorded at the project area from July 1992 to June 1993 and is considered to be representative of the long-term local wind patterns on the project site. However, since the monitoring station is located within Pinto Valley, the winds recorded at this station likely represent the local drainage patterns of the valley, rather than regional wind characteristics. Winds measured at the site during this period are summarized in *Tables 3-3* and *3-4*. *Table 3-3* lists frequency distributions of winds as a function of speed and direction; *Table 3-4* shows frequency distributions of winds as a function of stability class and direction.

The wind speed and direction data in *Table 3-3* are presented graphically in *Figure 3-2* as a wind rose. The mean wind speed is 2.6 meters per second (m/s), with the winds predominating from the upstream (south-southeast and southeast) directions. The predominating winds from these two sectors account for 48 percent of the wind direction measurements. A secondary wind peak from the downstream directions of northwest and north-northwest accounts for 12 percent of the winds. Seasonal wind data and wind roses are not presented since there is minimal seasonal variance in wind conditions (i.e., the annual wind data are considered to be representative of conditions throughout the year). The wind rose exhibits wind conditions that are characteristic of valley drainage winds, (i.e., winds blow predominately down the Pinto Creek valley, with a secondary wind frequency peak in the up-valley direction).

Table 3-4 presents the distribution of winds by direction and stability. Stability is a measure of air turbulence and the dispersive potential of the atmosphere. It is related to radiative energy flux at the surface, wind speed, and surface roughness. The six stability classes range from A (the most unstable) to F (the most stable). Stable air mixes the least, and it is the most stratified. Stability class D is neutral, which is normally associated with strong winds and moderate turbulence.

Figure 3-1
Air Quality Map

Table 3-3. Frequency of Winds by Direction and Speed (July 1992 to June 1993)

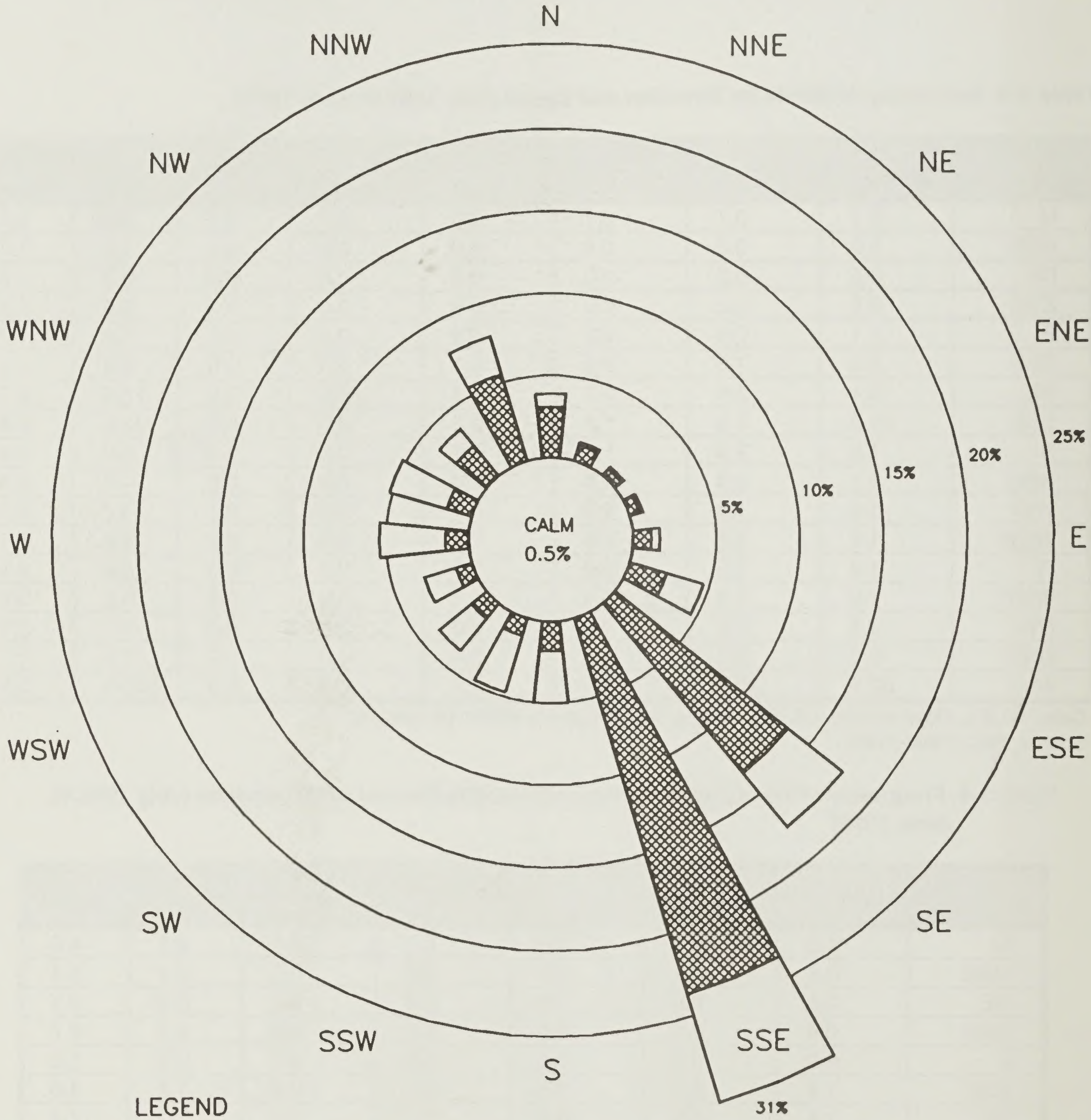
Direction	Speed Class Intervals (m/s)							Mean Speed
	0.45-2.5	2.6-4.5	4.6-6.5	6.6-8.5	8.6-11.5	>11.6	All	
N	3.1	0.7	0.1	0.0	0.0	0.0	3.9	2.9
NNE	1.0	0.2	0.0	0.0	0.0	0.0	1.2	1.7
NE	0.5	0.2	0.0	0.0	0.0	0.0	0.7	1.8
ENE	0.6	0.2	0.0	0.0	0.0	0.0	0.8	1.8
E	1.1	0.4	0.0	0.0	0.0	0.0	1.6	1.8
ESE	2.3	1.5	0.5	0.3	0.0	0.0	4.6	2.9
SE	13.4	2.6	0.7	0.6	0.3	0.0	17.6	2.9
SSE	23.8	5.5	1.0	0.3	0.0	0.0	30.6	2.9
S	1.8	2.2	1.0	0.1	0.0	0.0	5.0	3.3
SSW	1.1	2.3	1.0	0.2	0.1	0.0	4.7	3.8
WS	1.2	1.9	0.5	0.1	0.0	0.0	3.7	3.2
WSW	1.0	1.9	0.3	0.0	0.0	0.0	3.0	3.1
W	1.4	3.2	0.8	0.1	0.0	0.0	5.4	3.3
WNW	1.6	2.9	0.5	0.0	0.0	0.0	5.2	3.2
NW	2.4	0.9	0.3	0.0	0.0	0.0	3.7	2.5
NNW	5.5	2.2	0.2	0.0	0.0	0.0	7.9	2.1
All	62.3	28.5	7.0	1.7	0.4	0.0	100.0	2.6

Calm = 0.5%, Observations = 8,756, Missing data = 4, m/s = Meters per second
Source: AEC (1992-1993)

Table 3-4. Frequency of Winds by Direction and Stability Percent of Occurrence (July 1992 to June 1993)

Direction	Stability Class						
	A	B	C	D	E	F	All
N	1.5	0.4	0.9	0.4	0.1	0.7	4.0
NNE	0.6	0.1	0.0	0.0	0.0	0.4	1.1
NE	0.3	0.0	0.0	0.0	0.1	0.3	0.7
ENE	0.4	0.1	0.0	0.0	0.0	0.2	0.7
E	0.9	0.1	0.0	0.0	0.0	0.5	1.5
ESE	1.4	0.7	0.5	0.6	0.2	1.2	4.6
SE	1.4	0.5	0.8	6.3	3.4	5.2	17.6
SSE	1.2	0.6	1.0	9.0	15.4	3.5	30.7
S	0.8	0.8	0.8	1.3	0.3	1.1	5.1
SSW	0.7	0.9	1.1	1.0	0.3	0.7	4.7
SW	0.8	0.9	0.6	0.5	0.1	0.7	3.6
WSW	0.7	0.7	0.5	0.2	0.3	0.6	3.0
W	0.8	1.6	1.2	0.5	0.4	0.9	5.4
WNW	0.6	1.2	1.3	0.8	0.4	0.9	5.2
NW	1.4	0.4	0.4	0.6	0.2	0.8	3.8
NNW	2.6	1.4	1.9	0.9	0.2	0.9	7.9
All	16.1	10.4	11.0	22.1	21.3	18.6	99.6

Source: AEC (1992-1993)



LEGEND

< 2.6 M/S

≥ 2.6 M/S

AVERAGE WIND SPEED = 2.6 M/S

CALMS ARE WINDS WITH SPEEDS LESS THAN 0.5 M/S

Riverside Technology, inc.

CARLOTA COPPER PROJECT

Figure 3-2

Wind Frequency Distribution

Carlota Copper Project
Pinto Valley, Arizona
June 1992 - June 1993

Table 3-4 characterizes wind stability by the following frequency of occurrences: 40 percent are stable winds (classes E and F), 38 percent are unstable winds (classes A, B, and C), and 22 percent have neutral stability. The stable winds are almost exclusively from the southeast and south-southeast, blowing in the down-valley direction. The unstable winds are distributed over all directions, with north-northeast to east being the least frequent. The unstable winds (classes A, B, and C) occur during daytime hours, while stable winds (classes E and F) occur at night. Class D can occur either in the day-time or nighttime. Given this information, nearly all nighttime winds come from the southeast to south-southeast; daytime winds are multi-directional.

Dispersion Conditions. The wind speed, direction, and stability frequency information indicate how pollutants would disperse in the air basin. Wind direction determines where the pollutants would go. Speed and stability determine the degree of dilution that would take place with downwind distance.

Dispersion is directly related to wind speed. Doubling the speed doubles dispersion potential (and halves the pollutant concentration). Wind directions of north-northwest through east usually exhibit velocities that are well below mean speeds. Although winds from these directions only occur approximately 16 percent of the time, and 70 percent of these winds are classified as unstable, the low-speed winds from these directions would contribute to poor conditions for the dispersion of pollutants.

The atmospheric stability classification also affects dispersion potential. With increasing wind stability, dispersion characteristics are reduced. The wind direction during stable conditions significantly influences the locations of highest pollutant impacts, especially from surface-level sources such as those associated with a heap-leach operation like the proposed Carlota Copper Project. As shown in *Table 3-4*, the highest frequency of stable conditions is from the southeast to south-southeast. In addition, winds from these directions have a mean speed of 2.3 m/s (below the mean speed of all winds) and occur nearly 50 percent of the time. This combination of stable, low-speed, persistent winds spanning a narrow direction range of 45 degrees indicates a strong possibility that long-term, high pollutant impacts would be modeled to occur northwest to north-northwest of a surface-level source on the project site.

It is likely that the on-site meteorological data reflect micro-scale wind conditions (i.e., wind conditions of the Pinto Creek drainage patterns only), and that emissions leaving the project site would actually be affected by winds that are not so characteristically homogeneous. Actual dispersion conditions beyond the project site are likely to be more favorable to dispersion than the conditions indicated by the data collected on the site.

3.1.1.2 Air Quality

<u>Regional Characterization and Influences</u>

In general, the complex terrain of the project area should minimize air pollution impacts at or near the project site caused by nearby sources of air pollution. Mining is the major local industry and may contribute to ambient concentrations of particulate matter, sulfuric acid mist, and airborne metals. BHP Copper's Pinto Valley Mine, which is located adjacent to the proposed Carlota Copper Project, is the emission source most likely to contribute to ambient concentrations of these pollutants proximate to the project site. Other significant sources are at least several miles away and would have a relatively minor contribution to Carlota's baseline levels of particulate matter and hazardous air pollutants.

The town of Hayden, containing a smelter plant (ASARCO) as a major industrial pollution source, lies approximately 30 miles south of the project site and may contribute a minor amount to ambient levels of particulates and sulfur dioxide on the site. The town of Miami is also the site of a smelter facility (Cyprus). Phoenix (approximately 65 miles to the west) is the closest major metropolitan area to the project site. Phoenix is a potential source of significant quantities of process and non-process (mobile source) emissions, including carbon monoxide (CO), ozone (O_3), and particulate matter. Because of the mountainous region and distance separating Phoenix and the project site, emission sources in Phoenix are not expected to contribute significantly to ambient pollution levels near the project site, although the regional transport of emissions from the Phoenix area may influence visibility conditions and background levels of ozone in the vicinity of the project.

Air quality is frequently evaluated in terms of concentrations of the six federally defined criteria pollutants. These criteria pollutants are respirable particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), CO, O_3, and lead (Pb). Health-based ambient concentrations of these pollutants (National Ambient Air Quality Standards, or NAAQS) have been defined by the U.S. Environmental Protection Agency (EPA) and adopted by the State of Arizona. These standards are presented in *Table 3-5*.

Table 3-5. National and State Ambient Air Quality Standards

Pollutant	Averaging Period	National and State Standards
PM_{10}	24-hour annual	150 $\mu g/m^{3(1)}$ 50 $\mu g/m^{3(1)}$
SO_2	3-hour 24-hour annual	1,300 $\mu g/m^{3(2)}$ 365 $\mu g/m^{3(2)}$ 80 $\mu g/m^3$
NO_2	annual	100 $\mu g/m^3$
CO	1-hour 8-hour	40,000 $\mu g/m^{3(2)}$ 10,000 $\mu g/m^{3(2)}$
O_3	1-hour	0.12 ppm or 235 $\mu g/m^{3(2)}$
Pb	quarterly	1.5 $\mu g/m^3$

[1]Not to exceed an average of once per year over 3 or more representative years of data.
[2]Not to be exceeded more than once per year.
Source: 40 CFR 50.4-12

Project Monitoring Station

Baseline conditions for particulates at the project site were monitored using two volumetric, high-volume PM_{10} samplers. Samples were collected for a 24-hour period, with average ambient concentrations (in $\mu g/m^3$) of PM_{10} derived based on the quantity of particulate collected and the volume of air drawn through the sampler. PM_{10} samples were collected every 3 days by alternating samplers (i.e., each sampler collects a sample every 6 days).

Carlota's PM_{10} monitoring program began on September 29, 1992, and was completed on December 31, 1993. The samplers were installed at a site located northwest of the Cottonwood tailings pond (BHP Copper's Pinto Valley Mine) in the Pinto Creek drainage, just outside the Carlota property boundary (elevation 3,700 ft-amsl; see *Figure 3-1*). Because of a change in land use that has made the samplers susceptible to localized road and windblown fugitive dust emissions, monitoring was suspended on March 20, 1993. The station was relocated southeast of the original site (elevation 3,825 ft-amsl), restarted on May 7, 1993, and ran on an every-third-day schedule until the study's completion. Air quality instruments were audited quarterly by AEC. The locations of both the original and current PM_{10} monitoring sites, approved by the ADEQ, are presented in *Figure 3-1*.

Air Quality Standards and Air Basin Attainment Status

The NAAQS for PM_{10}, SO_2, NO_2, CO, O_3, and Pb are shown in *Table 3-5*. The State of Arizona has adopted the NAAQS as the state standards.

Particulate and SO_2 levels in the Hayden/Miami area have been determined to exceed the federal (and state) standards, likely because of SO_2 emissions from the Miami smelters and particulate emissions from all smelting operations in these areas. Therefore, the EPA has designated this as a non-attainment area for both particulates and SO_2. The ambient air quality of the Hayden/Miami area is considered to be within the federal and state ambient air quality standards for all other criteria pollutants. Furthermore, no exceedances of the PM_{10} or SO_2 NAAQS were recorded in this area from 1990 through 1995.

The State of Arizona is mandated by EPA to develop plans to bring ambient air quality in non-attainment areas in the state to levels that are lower than the NAAQS. Sources within the Hayden/Miami non-attainment area are subject to the air pollution reduction measures of these plans (also called State Implementation Plans, or SIPs). At the time of this writing, the PM_{10} SIP for the Hayden/Miami non-attainment area has not been approved by EPA.

Prevention of Significant Deterioration Classification

The EPA has established a classification system for the prevention of significant deterioration (PSD) of air quality. This system applies to areas in attainment of the NAAQS. Areas are categorized as Class I, Class II, or Class III. Class I areas are typically areas with pristine air quality, such as national parks, national monuments, or wilderness areas. No areas in the United States have been designated as Class III. All other areas in the country are designated as Class II areas, including the project area. Major stationary sources are not permitted to cause expected exceedance of the incremental ambient air quality standards specified for Class I and Class II areas. The proposed Carlota Copper Project would not be considered a major stationary source, and therefore PSD incremental standards would not need to be addressed in terms of regulatory compliance. However, expected impacts at nearby Class I areas are compared to the PSD allowable increments as a way to measure the significance of expected impacts in these areas. The nearest PSD Class I areas are the Superstition and Sierra Ancha wildernesses, 2 to 3 miles to the west and 25 miles to the north-northeast, respectively. The Salt River Canyon and Salome wildernesses, 12 miles to the northeast and 25 miles to the north-northwest, respectively, are not designated Class I areas.

Measured Particulate Concentrations

The on-site particulate data used in this analysis (both quarterly averages and maximum concentrations) were collected during the last quarter of 1992 and all four quarters of 1993 and are presented in *Table 3-6*. The highest 24-hour PM_{10} concentration (48.8 $\mu g/m^3$) occurred on October 18, 1992. Generally, the data indicate that exceedances of the 24-hour NAAQS (150 $\mu g/m^3$) are unlikely. Other PM_{10} monitoring programs in Miami confirm this conclusion (ADEQ 1990-1995). The average PM_{10} concentration of 17.2 $\mu g/m^3$ for the period from October 1992 to December 1993 indicates that the baseline annual average concentration would be well below the annual NAAQS (50 $\mu g/m^3$). The background concentration of PM_{10} for the project site is assumed to be the average PM_{10} concentration for the monitoring period (17.2 $\mu g/m^3$).

In the environmental consequences section, this background concentration is added to maximum 24-hour modeled PM_{10} impacts and average annual modeled PM_{10} impacts to estimate ambient levels of PM_{10} (background plus impact). Maximum 24-hour PM_{10} impacts from the project are expected to occur under a consistent set of meteorological conditions (many hours of low speed winds [1 to 2 m/s] in a consistent direction [from the south-southeast] under stable conditions [Stability Classes E-F]). Background PM_{10} concentrations are not dependent upon such specific meteorological conditions. A review of meteorological data suggests that days during which average background PM_{10} concentrations occur, meteorologic conditions are more similar to the meteorology of the maximum PM_{10} impact day than to the meteorology of the maximum background day.

Other NAAQS Pollutant Concentrations

The ADEQ has monitored particulate matter and SO_2 levels in the region of the Carlota project because of the abundance of mining sources in the area. However, no monitoring for the other NAAQS pollutants (NO_2, CO, O_3, and Pb) has been conducted in the area because of the lack of significant local sources of these pollutants. As a result, no site-specific background data are available for the project site for these pollutants.

SO_2 monitoring has been conducted and is currently being performed at several locations near the town of Miami. Results for the period from 1991 through 1995 indicate that there were no exceedances of the annual, 24-hour, and 3-hour SO_2 NAAQS (*Table 3-7*).

Ozone monitoring data are not available for the project site. Background ozone levels are estimated to be 0.040 ppm (40 ppb) for the project area. This estimate represents the median of the range of daily 1-hour maximum background ozone concentrations during the summertime in the United States (EPA 1996a). In addition, EPA's PLUVUE II visibility model (used in the visibility analysis for the Carlota project) uses 0.040 ppm as its default background ozone concentration for portraying clean areas in the western United States. Consequently, the value of 0.040 ppm was chosen as representative for the Carlota project area.

Background levels of NO_x and NO_2 are estimated to be 0.003 ppm each. Since no background NO_2 monitoring has been conducted in the vicinity of the proposed project site, these concentrations are based on data reported for a similar rural site in Springerville, Arizona, The reported value represents the mean of maximum annual averages

Table 3-6. PM_{10} Monitoring Summary for the Project Site

Quarter, Year	Number of Samples	Quarter Average (μg/m³)	First Maximum Concentration (μg/m³)	First Maximum Concentration Date	Second Maximum Concentration (μg/m³)	Second Maximum Concentration Date	Number of Measured Exceedances
4th, 1992	29	21.7	48.8	10/18	41.9	11/17	0
1st, 1993	22	14.4	36.6	02/06	27.5	03/11	0
2nd, 1993	18	19.0	29.2	06/24	25.6	06/12	0
3rd, 1993	29	18.3	26.7	08/11	24.8	09/10	0
4th, 1993	25	12.7	28.8	10/04	26.3	10/01	0

Average for Monitoring Period = 17.2 μg/m³
Source: AEC (1992-1993)

Table 3-7. SO_2 Monitoring Summary for Miami, Arizona

Site	SO_2 Concentration (μg/m³) NAAQS	1991	1992	1993	1994	1995
Nolan Ranch (Jones Ranch 1995)						
3-hour	1,300	875	875	721	566	433
24-hour	365	144	128	123	121	122
annual	80	10	8	10	16	8
Wheatfield/Burch Pump Station						
3-hour	1,300	53	23	40	57	63
24-hour	365	10	8	5	11	21
annual	80	0	0	<1	0	1
Town Site						
3-hour	1,300	453	383	237	273	280
24-hour	365	64	52	58	42	56
annual	80	5	4	4	4	6

Source: ADEQ (1991 - 1995b)

for six monitoring locations in Springerville for the period from 1990 through 1995 (ADEQ 1990-1995).

Air Toxins

In addition to the standards set for criteria pollutants, the State of Arizona has established Ambient Air Quality Guidelines (AQGs) for a large number of toxins. The AQGs have been established to protect human health. Small quantities of metals (contained in the ore body and mine rock material), in addition to sulfuric acid and octane (gasoline), are the toxic emissions of interest associated with the proposed Carlota Copper Project. A listing of the AQG values for these toxins is presented in *Table 3-8*.

Background concentrations of air toxins are expected to be negligible in the vicinity of the project. However, because the background PM_{10} concentration is assumed to be largely a result of dust emissions from the nearby BHP Copper Pinto Valley Mine, background concentrations of metals can be estimated in the same way as the predicted maximum concentrations. (This method is discussed more fully in Section 3.1.2 - Environmental Consequences.) The background metals concentrations, shown in *Table 3-8*, are calculated as the product of the background PM_{10} concentration (17.2 μg/m³) and the average metals concentrations as measured from soil samples taken at the Carlota project site. The soil sample analyses are discussed in more detail in AEC's report entitled *Demonstration of Protection of Arizona Air*

Table 3-8. Arizona Ambient Air Quality Guidelines

Substance	Background Concentration (µg/m³)	AQG (µg/m³)		
		1-Hour	24-Hour	Annual
Antimony (Sb)	8.60×10^{-5}	15.0	4.0	---
Arsenic (As)	6.35×10^{-5}	3.2×10^{-1}	8.4×10^{-2}	2.3×10^{-4}
Barium (Ba)	1.34×10^{-3}	15.0	4.0	---
Beryllium (Be)	2.03×10^{-5}	6×10^{-2}	1.6×10^{-2}	5.0×10^{-4}
Boron (B)	4.00×10^{-4}	23	7.5	---
Cadmium (Cd)	4.30×10^{-6}	1.7	1.1×10^{-1}	2.9×10^{-4}
Chromium (Cr)	1.91×10^{-4}	11	3.8	---
Hexavalent Chromium (Cr VI)	1.91×10^{-4}	1.1×10^{-1}	2.9×10^{-2}	8.0×10^{-5}
Lead (Pb)	2.28×10^{-4}	---	9.0×10^{-2}	1.5*
Manganese (Mn)	6.81×10^{-3}	25	8.0	---
Mercury (Hg)	---	1.5	4.0×10^{-1}	---
Nickel (Ni)	1.91×10^{-4}	5.7	1.6	4.0×10^{-3}
Octane (C H)	---	11,000	2,900	---
Selenium (Se)	9.68×10^{-5}	6.0	1.6	---
Silver (Ag)	6.54×10^{-6}	3×10^{-1}	7.9×10^{-2}	---
Titanium (Ti)	5.59×10^{-3}	150	40	---
Vanadium (V)	4.15×10^{-4}	1.5	4×10^{-1}	---
Zinc (Zn)	7.16×10^{-4}	150	40	---
Sulfuric acid (H_2SO_4)	---	22.5	7.5	---

*Corresponds to lead NAAQS and is based on an average each calendar quarter.
Sources: ADEQ (1992a), AEC (1995d)

Quality Guideline Concentrations for Metals at the Proposed Carlota Project (AEC 1995d).

Air Quality Related Values

In addition to estimating the impacts of project emissions on air quality, this EIS also evaluates the impacts from air emissions on other resources on and off the site. These air quality related values (AQRVs) include the effects on biological resources (terrestrial and aquatic) and visibility. Impacts of criteria pollutants (NAAQS) and hazardous air pollutants (especially sulfuric acid mist) emitted from the proposed project are examined relative to the baseline conditions of these resources. Baseline conditions for these resources are described in Section 3.5, Biological Resources, as well as the following section on visibility.

Visibility

The federal Clean Air Act's PSD regulations mandate that federal land managers protect visibility resources within Class I areas (areas considered to have pristine air quality). Visibility can be defined as the degree to which ambient air pollutants obscure a person's ability to see a given reference point through the atmosphere. The federal government has chosen to protect visibility in Class I areas because vistas are a highly valued aspect of the experience of visiting pristine and scenic areas, such as national parks, monuments, and wilderness areas. The Forest Service has requested an analysis of baseline visibility conditions and of the project's impacts on visibility in the nearby Class I areas.

Table 3-9 presents standard visual range (SVR) data at the 10, 50, and 90 percent frequency values, based on data collected from camera stations at the Superstition Wilderness and Sierra Ancha Wilderness from 1985 through 1992. The data are presented in kilometers (km), and the frequency values represent the percentage of all valid data points that were analyzed to have an SVR less than or equal to the specified distance. For example, 90 percent of the valid samples collected in the Superstition Wilderness

Table 3-9. Photographic SVR Data for the Superstition Wilderness and the Sierra Ancha Wilderness

	SVR (km)							
	Superstition				Sierra Ancha			
Year	10%	50%	90%	C.I.[1]	10%	50%	90%	C.I.[1]
1985	68	145	293	137-154	113	183	298	179-187
1986	75	145	229	138-153	119	202	333	198-206
1987	86	172	332	166-179	120	206	341	202-210
1988	---	---	---	---	113	194	320	191-198
1989	---	---	---	---	119	202	320	199-205
1990	---	---	---	---	138	214	331	211-217
1991	---	---	---	---	151	232	331	229-235
1992	109[2]	209[2]	352[2]	192-227[2]	135	220	334	216-224

--- Monitoring station inactive
[1]Confidence Interval: 90 percent confidence interval for the 50 percent SVR value
[2]New site location
Source: Air Resource Specialists (1993)

in 1985 showed a visibility of 293 km or less (or 10 percent showed a visibility greater than 293 km).

The results of camera data collected at the Superstition Wilderness for the period 1985 through 1987 (*Table 3-9*) were used to estimate seasonal background visual range values for the Carlota visibility analysis. These values define baseline visibility conditions for the visibility analysis. A Best Estimate Annual 90th Percentile Standard Visual Range was defined as the 80th percentile cumulative frequency of camera data for all months of the year, except December through March. This definition most closely corresponds with SVR data generated by collocated IMPROVE (Interagency Monitoring of PROtected Visual Environments) samplers and camera sites at several eastern and western locations and is consistent with Forest Service precedent and guidance under Forest Service Region 3 PSD application requirements. The seasonal SVR values were calculated based on scaling factors consistent with seasonal SVR patterns at the Tonto and Chiricahua IMPROVE sites. The seasonal background SVR values are 216 km - Spring, 192 km - Summer, 240 km - Fall, and 264 km - Winter. These values were used in the PLUVUE II visibility modeling analysis conducted for the proposed Carlota Copper Project. The results of this modeling are discussed in Section 3.1.2.

3.1.2 Environmental Consequences

This section identifies the air quality impacts associated with the air emissions from the proposed Carlota Copper Project. The issues identified for air quality included (1) impacts to health and safety and visual resources caused by emissions from project construction and operations, and (2) impacts to AQRVs in Mandatory Class I areas from project air emissions. The following evaluation criteria were used in the air quality impact assessment:

- Project emissions and off-site concentrations of all criteria pollutants; and comparison to federal, state, and local ambient air quality standards and guidelines
- Project emissions and off-site concentrations of non-criteria pollutants listed in federal PSD regulations
- Conformity with Hayden Area SIP and required Reasonably Available Control Measures (RACM)/Reasonably Available Control Technologies (RACT)
- Project emissions and off-site concentration of hazardous air pollutants (as listed in Title III of the 1990 Clear Air Act Amendments or the State of

Arizona AQG) and, when applicable, comparison to AQGs 1-hour, 24-hour, and/or annual standards

- Effects of the project emissions on AQRVs in mandatory Class I areas through qualitative and/or quantitative analyses

- On-site concentrations of the project's emissions of criteria pollutants, hazardous pollutants (including those listed in the Arizona AQG), and non-criteria pollutants listed in the federal PSD regulations as necessary for assessing air quality impacts to biological resources and threatened and endangered species

As a result of the findings of the Draft EIS public comment process, several technical portions in this Final EIS have been changed. The emissions inventory used herein has now been fully approved by the Forest Service and ADEQ. As a result, no adjustments are necessary between the inventory used in the Air Installation Permit (AIP) and that used in the Final EIS. Because of the requirement for a formal conformity determination, PM_{10} and SO_2 emissions have been remodeled. Modeling included in this document is based on the approved inventory and is consistent with the results presented in the Conformity Determination (February 1996). Specific changes incorporated in this Final EIS are discussed below and are also detailed in the Conformity Determination

During the visibility analysis process, Carlota agreed to implement additional mitigation measures to reduce the air quality impacts of the proposed project. These additional measures included (1) equipping the large haul trucks with new diesel engines to increase horsepower and efficiency, (2) eliminating the haul route from the secondary crusher to the leach pad by using the overland conveyor after the second year of production, and (3) increasing control of fugitive particulate emissions from all unpaved haul roads other than the plant entrance road and the leach pad road.

Tailpipe emissions of PM_{10}, NO_x, and CO were reduced by recalculating the emission rates using revised emission factors supplied by the manufacturer for the newer diesel engines, as compared to the AP-42 emission factors used in the original emissions inventory. In addition, the revised emission calculations incorporated the fact that the newer engines will be able to meet production requirements while operating at a lower average engine load. This operational efficiency further reduced tailpipe emissions of PM_{10}, NO_x, and CO, and lowered SO_2 emissions, as well. Eliminating the haul route from the secondary crusher to the leach pad would eliminate fugitive particulate and tailpipe emissions associated with haul truck traffic on this route. There would also be a small decrease in process emissions associated with the overland conveyor since Carlota has reconfigured the conveyor to have approximately one-half of the conveyor drops assumed in the original inventory. An increased rate of road watering over the previously planned rate would further reduce PM_{10} emissions caused by trucks hauling ore and waste rock (AEC 1996a). These reduced emission rates were incorporated into the visibility analysis, and additional dispersion modeling was performed to reassess NO_x impacts (AEC 1996b). The results of this revised NO_x dispersion modeling are included in this section; however, no additional dispersion modeling was performed using the reduced PM_{10}, CO, and SO_2 emission rates. Therefore, the PM_{10}, CO, and SO_2 impacts discussed in this Final EIS are actually higher than those that would likely occur with the proposed project.

3.1.2.1 Proposed Action

<u>**Description and Quantification of Emissions**</u>

The primary project emissions would be process dust (e.g., dust from the crushing and conveying systems) and non-process dust (e.g., dust from materials handling, blasting, and the transport of ore and mine rock along unpaved haul roads). Dust is quantified as PM_{10} since this is the current format of the ambient particulate standards. Emissions from the combustion of fossil fuels in vehicles, the hot water heater, and the backup diesel generators include PM_{10}, NO_x, SO_2, CO, and volatile organic compounds (VOCs). Emissions of VOCs from petroleum storage are also quantified.

The proposed Carlota Copper Project would be a source of sulfuric acid (H_2SO_4) mist emissions, an Arizona listed air toxin. Potential sources of H_2SO_4 emissions include the tank house of the SX/EW plant, the ore preconditioning system, and the H_2SO_4/ raffinate solution application on the leach pad. Emissions of H_2SO_4 are based on the emission estimates for the SX/EW plant that are presented in the AIP application for the Carlota Copper Project. The AIP process is a construction permitting process coordinated by the ADEQ. Permits to construct new facilities or modifications to existing facilities are issued based upon ADEQ's determination of a proposed facility's compliance with applicable state and federal air regulations. This emission estimate is based on a confidential empirical monitoring study of emissions from an existing SX/EW plant that represents the best source of information on H_2SO_4 emissions currently available (AEC 1992). ADEQ has reviewed the confidential study upon which the H_2SO_4 emission estimate is based. ADEQ has cited the experimental approach as reasonable and has characterized the emission estimate as conservative.

Given the emission rate and the ventilation rate of the tank house, indoor concentrations of H_2SO_4 are expected to be higher than the Occupational Health and Safety Administration (OSHA) "No Breathing Apparatus" standard (1 mg/m^3) and lower than the OSHA Absolute Maximum standard (15 mg/m^3). ADEQ has commented that conditions related specifically to H_2SO_4 emissions from the tank house will be included in the AIP to ensure the direct application of the emissions study to the Carlota operation. H_2SO_4 emissions from the preconditioning treatment and the leach pad are assumed in the AIP to be negligible based on controls, solution application methods, and on-site meteorology.

A number of metals that are also listed air toxins for the State of Arizona may occur in trace amounts in particulate emissions from both process and non-process sources at the project. These include antimony, arsenic, barium, beryllium, boron, cadmium, chromium, lead, manganese, nickel, selenium, silver, titanium, vanadium, and zinc. A report prepared by AEC (1995d), presents the results of metals analyses conducted on soil samples from the project area and estimates metals concentrations in airborne dust in the vicinity of the project. The findings of this report are summarized later in this section.

Octane is also an Arizona-listed air toxin. Emissions of VOCs resulting from fuel storage, combustion, and evaporation at the raffinate pond are likely to contain small quantities of octane. According to the EPA's *VOC/PM_{10} Speciation Data System (SPECIATE Version 1.5)*, octane typically accounts for less than 0.4 percent of VOCs in these sources. VOC emissions are estimated to be 1,202 tons per year. This total incorporates a mass-balance approach to estimate emissions from the raffinate pond. Based on this estimate, emissions of octane are expected to be less than 5 tons per year.

Maximum emission rates for two scenarios are presented in the AIP application in order to represent the case that results in maximum off-site impacts. The first scenario corresponds to Year 8, the operating year during which maximum hourly and annual emissions would occur. Greater emissions in Year 8 result from slightly greater combined ore and mine rock haul truck distances. However, since emissions are spread over a relatively large area in Year 8, this scenario is less likely to produce maximum off-site impacts.

The second scenario corresponds to Year 5, during which the mining activities would be in closer proximity to each other, and emissions from this orientation would be more likely to result in maximum off-site impacts. Another potential factor for higher off-site emissions under this scenario is that more of the haul road emissions would occur outside of the pits in Year 5. Because emissions from the Year 5 scenario result in the maximum case for off-site impacts, Year 5 emissions were used in this analysis to assess impacts from the proposed action. A listing of Carlota emission sources and associated pollutants is presented in *Table 3-10*. *Table 3-11* shows a list of primary operations and their associated projected activity levels for Year 5. (Note: A proposed temporary crusher to be located at the Eder pits would not become operational until Year 9 of the project. Emissions from this crusher were included in the analysis to determine the maximum emission case but are correctly not included in the impact analysis.)

Maximum hourly and annual emissions have been calculated for all pollutants assuming maximum daily ore and rock mining and processing rates (*Table 3-11*). Hot water heater and backup generator emissions are based on the maximum design fuel rate, and generators have been assumed to run 5

Table 3-10. Air Emission Sources

Source Description	Source Type (point, fugitive, or mobile)	Emission Species
Topsoil Removal in Carlota/Cactus Pit	F	PM_{10}/metals
Topsoil Unloading to Stockpiles	F	PM_{10}/metals
Drill Holes - Ore/Mine Rock	F	PM_{10}/metals
Blasting - Ore/Mine Rock	F	PM_{10}/metals
Load - Ore/Mine Rock	F	PM_{10}/metals
Mine Rock Unloading to Dump	F	PM_{10}/metals
Haul Truck Dumping to ROM Bin	F	PM_{10}/metals
Primary Crusher System	P	PM_{10}/metals
Conveyor Systems	P, F	PM_{10}/metals
Secondary Crusher System	P	PM_{10}/metals
Unloading Ore to Leach Pad	F	PM_{10}/metals
Hauling on Unpaved Haul Roads	F	PM_{10}/metals
SX/EW Plant	P, F	H_2SO_4, VOCs
Stationary Combustion Sources (includes boiler and backup generators)	P	PM_{10}, NO_x, CO, SO_2, VOCs
Diesel/Gas Vehicles	F, M	PM_{10}, NO_x, CO, SO_2 VOCs
Diesel, Diluent, Organic Storage Tanks	F	VOCs

Table 3-11. Maximum Activity Rates (units in tons)

Activity	Rate
Annual Copper Ore	7,500,000
Annual Mine Rock	20,500,000
Daily Ore and Rock Mining	125,000
Daily Ore Haul to Primary Crusher	70,000
Daily Ore Processing Rate	40,000
Daily Mine Rock Haul	100,000
Hourly Facility Process Rate	1,667

percent of the time (438 hours per year). Emission factors used to calculate emissions were based on an EPA document entitled *AP-42, EPA's Estimating Air Toxics from Organic Liquid Storage Tanks and Air Emission Species Manual*, Volume I; the EPA's *VOC/*PM_{10} *Speciation Data System* (SPECIATE Version 1.5); the American Mining Congress report entitled *Report on Fugitive Dust Emission Factors for the Mining Industries* (1983); and an AEC study on sulfuric acid emissions (1992).

Emissions from several sources at the proposed Carlota Copper Project would be controlled by implementing air pollution control measures.

Emissions of process and non-process particulates, sulfuric acid, and VOCs would be controlled from a variety of sources. These controls are presented in *Table 3-12* along with the estimated control efficiency for each measure. Control efficiencies are based on information from AP-42.

Ore processing equipment for the proposed project would include a primary crusher, vibrating screen, secondary crusher, and conveying system. Each of these facilities would be a source of PM_{10} emissions. Water sprays at the primary crusher and conveyor transfer points would control emissions by 85 and 82.5 percent, respectively. In addition, chutes at the conveyor transfer points would also reduce dust emissions. The secondary crusher circuit would be equipped with a baghouse. The filtration efficiency of the baghouse is expected to exceed 99 percent with a typical performance level of 0.01 grains/scf of discharge air for the entire secondary crushing circuit.

Non-process mining activities that would have controlled PM_{10} emissions include ore hauling over unpaved haul roads and drilling in the pit. Dust emissions from haul roads would be controlled with the routine application of water and dust palliatives. It

Table 3-12. Control Technology and Efficiency

Source	Pollutant	Control	Efficiency
Drilling	PM_{10}	Filter/pneumatic flushing	90 percent
Primary Crusher and Conveyor Drop Points Material Handling[1]	PM_{10}	Water sprays Chutes	Crusher = 85 percent drop points = 82.5 percent
Secondary Crusher Circuit	PM_{10}	Baghouse	Control to 0.01 grains/scf
Haul Roads	PM_{10}	Water/chemical application Gravel roads	91 percent (access and leach pad roads) 100 percent (other interior haul roads)
Ore Conditioning	H_2SO_4	Shrouds	unknown
Extraction/Stripping Settlers	VOCs	Roofs	unknown
EW Tank House	H_2SO_4	Dispersion balls/surfactants	unknown

[1]From primary crusher to loadout conveyor

is estimated that routine application of water or biweekly application of chemical dust suppressants (at an application intensity of 0.25 gallons per square yard) would provide approximately 91 percent control of dust emissions. (Carlota has committed to increasing the application rate and volume of water applied to haul roads to reach the equivalent of 0.01 inch of precipitation per day. This increase in watering would further reduce fugitive particulate emissions. This additional mitigation measure was incorporated into the visibility analysis, but no additional dispersion modeling was performed using the reduced particulate emission rates.) Dust emissions from drilling in the pit (in preparation for blasting) would be controlled using a pneumatic flushing and filter system with an estimated control efficiency of 90 percent.

Sulfuric acid would be used to condition the ore in preparation for leaching and would be applied at conveyor transfer points at three to four locations immediately prior to or at the point of heap stacking on the leach pad. Emissions of sulfuric acid from this source would be reduced by conducting the ore conditioning on a fully covered conveyor belt, which should reduce wind effects to negligible levels. In addition, a concentrated acid solution with low pressure sprays would be used to minimize the potential for acid mist escaping the ore conditioning system. Sulfuric acid emissions at the leach pad would be minimized by the use of wobblers or drip lines to apply leaching solution instead of sprays. Emissions of H_2SO_4 from the SX/EW plant would be controlled using dispersion balls and surfactants to reduce losses of acid mist.

Tables 3-13 and *3-14* summarize the maximum hourly and annual emissions from the proposed Carlota Copper Project. These emission rates match those presented in the Conformity Determination (Air Sciences Inc. 1996c) and the AIP (AEC 1995e). As indicated in these tables, PM_{10} and NO_x are the pollutants that would be emitted in the largest quantities. The majority of PM_{10} emissions would originate from non-process particulate sources, and the majority of NO_x emissions would originate from mobile sources. Detailed descriptions of particulate and combustion emission calculations are presented in the Conformity Determination and AIP documents.

As stated previously, Carlota has agreed to implement additional mitigation measures to reduce the potential air quality impacts of the proposed project. *Tables 3-15* and *3-16* summarize the maximum hourly and annual emissions from the Carlota Copper Project based on the implementation of the additional mitigation measures discussed at the beginning of Section 3.1.2, Air Resources - Environmental Consequences. These revised

Table 3-13. Summary of Maximum Hourly Controlled Emissions (in pounds)

Source Category	PM_{10}	NO_x[1]	CO	SO_2	VOCs	H_2SO_4
Process	11	82	18	1	9	--
Mobile	15	233	68	6	12	--
Non-Process	122	--	--	--	260	1
TOTAL	148	315	86	7	281	1

[1]Based on AEC (1996a)

Table 3-14. Summary of Maximum Annual Controlled Emissions (in tons)

Source Category	PM_{10}	NO_x[1]	CO	SO_2	VOCs	H_2SO_4
Process	16	19	4	1	11	--
Mobile	65	1,022	296	25	51	--
Non-Process	322	--	--	--	1140	5
TOTAL	404	1,041	300	26	1202	5

[1]Based on AEC (1996a)

Table 3-15. Summary of Maximum Hourly Controlled Emissions with the Implementation of Additional Mitigation Measures (in pounds)

Source Category	PM_{10}	NO_x	CO	SO_2	VOCs	H_2SO_4
Process	11	82	18	1	9	--
Mobile	3	79	14	2	12	--
Non-Process	16	--	--	--	260	1
TOTAL	30	161	32	3	281	1

Table 3-16. Summary of Maximum Annual Controlled Emissions with the Implementation of Additional Mitigation Measures (in tons)

Source Category	PM_{10}	NO_x	CO	SO_2	VOCs	H_2SO_4
Process	16	19	4	1	11	--
Mobile	13	348	62	9	51	--
Non-Process	49	--	--	--	1140	5
TOTAL	78	367	66	10	1202	5

emission rates were incorporated into the visibility modeling analysis and the NO_x dispersion modeling analysis. However, dispersion modeling for all other pollutants was performed using the emission rates listed in *Tables 3-13* and *3-14*. As a result, the PM_{10}, CO, and SO_2 impacts discussed in this EIS are higher than those that would likely occur with the proposed project given the additional mitigation measures now committed to by Carlota.

Description of Modeling and Quantification of Impacts

Long- and short-term impacts of all pollutants (except PM_{10}) presented in the EIS are based upon the BEEST-X model analyses included in the Revised AIP (AEC 1995e). The PM_{10} impacts are based upon the ISCST3 model analyses presented in a separate document (AEC 1995b) and are included in the Conformity Determination. EPA's ISCST3 model conducts a refined evaluation in both simple and complex terrain and incorporates a dry deposition algorithm that EPA considers to be more accurate for estimating deposition for particles less than 20 micrometers in diameter.

Impacts from criteria pollutants and H_2SO_4 have been modeled using 3-km (1.8-mile) and 10-km (6-mile) receptor grids that include receptors inside and outside the project boundary (including the Superstition Wilderness) and along the project boundary. Additional receptors have been used to estimate pollutant concentrations in the Sierra Ancha Wilderness, Tonto National Monument, and two other distant wilderness areas. Dispersion modeling of project impacts was performed using the 1 full year of on-site meteorological data (collected from July 1992 through June 1993 by AEC) summarized previously. A more detailed discussion of particulate modeling is presented in the Conformity Determination, and a discussion of combustion pollutant modeling is included in the *Revised Technical Submittal Application for a Class II Permit* (AEC 1995f).

Impacts from the project's air emissions are estimated for points outside of the limits of public access. This limit is shown in *Figure 3-1*. The limit of public access is approximately 600 meters distant of locations of mining activity at the Carlota Copper Project. This distance is an appropriate safety buffer to protect the public from the hazards of blasting and other mining activity and equipment. The limit of public access would be demarcated by a combination of natural and man-made barriers to convenient access to the project site and would include the following:

- Existing fence lines associated with Forest Service grazing allotments in the project area
- New fences and/or gates along public access roads
- Natural, steep terrain along the west side of the project that prevents convenient access
- The BHP Copper tailings dam to the northeast of the project
- Signs warning of the danger from blasting and other hazards

Estimated maximum impacts for PM_{10}, NO_x, CO, and SO_2 are presented in *Table 3-17*. This table also includes background concentrations and the listing of federal standards. Based upon the air quality impact analysis, emissions of PM_{10}, CO, NO_x, and SO_2 from the proposed Carlota Copper Project are not expected to exceed the NAAQS at or beyond the limits of the project boundary. Impacts at the Top-of-the-World subdivision are modeled to be less than the values presented in *Table 3-17*, and therefore, below the NAAQS.

The proposed conditions in the AIP for the project include a requirement to monitor PM_{10} impacts in (or near) the area of expected maximum impact (north of the project in the direction of the Superstition Wilderness) for the 5-year permit term. The purpose of the PM_{10} monitoring requirement is to demonstrate ongoing compliance with the PM_{10} NAAQS. The program includes reporting measured levels above 120 $\mu g/m^3$ and allows ADEQ to work with Carlota to reduce the frequency of occurrences of measurements above this level, should they occur.

In addition to estimating impacts immediately surrounding the project area, impacts are also presented for the Superstition Wilderness, the Sierra Ancha Wilderness, and the Class II Tonto National Monument. Estimated impacts at the nearest Class I area (the Superstition Wilderness), located

Table 3-17. Maximum Estimated Impact at or Beyond the Limit of Public Access Plus Background Concentrations (μg/m[3])

Pollutant	Averaging Increment	Maximum Impact[1]	Maximum Background[2]	Total Concentration	NAAQS
PM_{10}	24-hour	94	17.2	111	150
	annual	20	17.2	37	50
NO_x	annual	22	6	28	100
CO	1-hour	468	2,280	2,748	40,000
	8-hour	110	2,280	2,390	10,000
SO_2	3-hour	15	875	890	1,300
	24-hour	5	144	149	365
	annual	1	10	11	80

[1] PM_{10}, CO, and SO_2 impact estimates are based on dispersion modeling that did not incorporate the additional mitigation measures Carlota plans to implement, as described in AEC 1996a. Therefore, these impact estimates can be considered conservative estimates, and the actual impacts would likely be lower.
[2] PM_{10} background concentrations are based on 5 quarters of on-site monitoring data. For both 24-hour and annual background concentrations, the average for the monitoring period is assumed. The NO_x and CO values represent the highest background concentrations at other similar rural locations. The measured background SO_2 concentrations at Miami are influenced by a local smelter. SO_2 concentrations in the vicinity of the project should be much lower.

approximately 2 to 3 miles to the west, are expected to be approximately an order of magnitude less than impacts estimated at the project boundary. Wilderness impacts for criteria pollutants are presented in *Table 3-18.*

Based upon the air quality impact analysis, emissions of CO, NO_x, PM_{10}, and SO_2 from the proposed Carlota Copper Project are not expected to result in exceedances of the NAAQS in the Class I Superstition Wilderness and Sierra Ancha Wilderness or in the Class II Tonto National Monument. In most cases, expected impacts from the proposed project are a fraction of the existing background concentrations.

Although the PSD increments are not strictly applicable to the Carlota Copper Project (the project is not a major source), the PSD increments are presented here as a measurement of the significance of particulate impacts from the project.

Sulfuric acid and nitrogen oxide (NO assumed to be equal to NO_x) would be the two main pollutants emitted from the facility for which there are Arizona AQGs. Emissions of H_2SO_4 from the SX/EW plant have been estimated based on a study conducted by AEC (1992) and modeled to determine the impacts of this Arizona-listed toxin. Estimated impacts from H_2SO_4 emissions were calculated using a 3-km (1.8-mile) grid and an additional 8 discrete receptors located in sensitive vegetation areas. *Table 3-19* shows the maximum impacts on or outside the project area boundary. Impacts of NO from stationary sources (i.e., the diesel hot water boiler and the two backup generators) and AQG concentrations are also presented in *Table 3-19.* Based upon the air quality impact analysis, emissions of H_2SO_4 and NO from the proposed Carlota Copper Project are not expected to exceed the Arizona AQGs at the limits of the project boundary.

H_2SO_4 impacts at the Top-of-the-World subdivision (approximately 4 km south of the tank house) are expected to be below the health-based AQG levels (1-hour: 22.5 μg/m[3], 24-hour: 7.5 μg/m[3]). The highest expected 1-hour H_2SO_4 impact 4 km south of the tank house is between 1.1 and 1.7 μg/m[3]. Twenty-four hour average impacts are not expected to exceed 0.3 μg/m[3].

Although modeling of VOC emissions is impractical because of the high complexity of VOC interactions with other chemical species, ambient impacts of octane are estimated herein using the results of H_2SO_4 modeling. As shown in *Table 3-14*, the facility will emit 5 tons per year of H_2SO_4, resulting in 1-hour and 24-hour maximum ambient concentrations of 21

Table 3-18. Estimated Impacts at Surrounding Class I Wilderness Areas and the Class II Tonto National Monument (units in $\mu g/m^3$)

Pollutant[1]	Averaging Increment	Superstition Wilderness (2-3 miles)	Tonto National Monument (18 miles)	Sierra Ancha Wilderness (27 miles)	PSD Increments Class I Areas[2]
PM_{10}	24-hour	6	1	1	8
	annual	2	negligible	negligible	4
NO_x	annual	3	negligible	negligible	N/A
CO	1-hour	85	84	4	N/A
	8-hour	26	11	1	N/A
SO_2	3-hour	4	2	negligible	25
	24-hour	1	negligible	negligible	5
	annual	negligible	negligible	negligible	2

[1] PM_{10}, CO, and SO_2 impact estimates are based on dispersion modeling that did not incorporate the additional mitigation measures Carlota plans to implement, as described in AEC 1996a. Therefore, these impact estimates can be considered conservative estimates, and the actual impacts would likely be lower.
[2] Although not a PSD source, this increment was used for comparison purposes.

Table 3-19. Maximum Impacts of H_2SO_4 and NO (units in $\mu g/m^3$)

Pollutant	Concentrations 1-Hour	Concentrations 24-Hour
H_2SO_4		
Impact	21	2
AQG	22.5	7.5
NO[1]		
Impact	559	74
AQG	690	230

[1] NO impact estimates are based on dispersion modeling that did not incorporate the additional mitigation measures Carlota plans to implement, as described in AEC 1996a. Therefore, these impact estimates can be considered conservative estimates, and the actual impacts would likely be lower.

$\mu g/m^3$ and 2 $\mu g/m^3$, respectively. Octane emissions are estimated as 0.4 percent of total VOC emissions from the facility (1,202 tons per year), are expected to be less than 5 tons per year. Therefore, impacts of octane will be similar in magnitude to those predicted for H_2SO_4. The estimated 1-hour and 24-hour impacts from octane emissions (approximately 21 $\mu g/m^3$ and 2 $\mu g/m^3$, respectively) are significantly below the corresponding AQG values of 11,000 and 2,900 $\mu g/m^3$, respectively.

Estimated ambient impacts of metals contained in the soils at Carlota also have been quantified. The maximum ambient concentrations of the metals for each of three averaging periods (1-hour, 24-hour, and annual) are estimated as the product of the predicted maximum concentration of PM_{10} for the appropriate averaging period (1,009.3 $\mu g/m^3$, 93.6 $\mu g/m^3$, and 19.7 $\mu g/m^3$, respectively) and the average metals concentrations. *Table 3-20* provides a summary of the average metals concentrations from the soils analyses (in mg/kg), the background and maximum expected metals concentrations for three time-averaging periods, and the corresponding AQGs. The predicted maximum concentrations, combined with the background concentrations, do not exceed the AQGs.

Regulations and Compliance

The proposed facility is classified as a minor source based upon the annual level of process (point source) emissions. In other words, emissions of criteria pollutants (CO, NO_x, PM_{10}, and SO_2) from process (point) sources are not expected to exceed major source threshold levels (250 tons for CO and NO_x, 100 tons for PM_{10} and SO_2, non-attainment pollutants for the area). As a result of this classification, the source is subject to the following regulations: (1) NAAQS, (2) Article 6 (Emission from Existing and New Non-Point Sources) of the Arizona Adminis-

Table 3-20. Ambient Metals Concentrations

Metal	Average Conc. (mg/kg)	Background Conc. (µg/m³)	Estimated Ambient Concentration* (µg/m³)			AQG Concentrations (µg/m³)		
			1-hour	24-hour	Annual	1-hour	24-hour	Annual
Antimony	5.00	9.60×10^{-5}	5.05×10^{-3}	4.68×10^{-1}	9.85×10^{-5}	1.5×10^{1}	4	---
Arsenic	3.69	6.35×10^{-5}	3.72×10^{-3}	3.45×10^{-4}	7.27×10^{-5}	3.2×10^{-1}	8.4×10^{-2}	2.3×10^{-4}
Barium	77.63	1.34×10^{-3}	7.84×10^{-2}	7.27×10^{-3}	1.53×10^{-3}	1.5×10^{1}	4	---
Beryllium	1.18	2.03×10^{-5}	1.19×10^{-3}	1.10×10^{-4}	2.32×10^{-5}	6×10^{-2}	1.6×10^{-2}	5×10^{-4}
Boron	23.25	4.00×10^{-4}	2.35×10^{-2}	2.18×10^{-3}	4.58×10^{-4}	2.3×10^{1}	7.5	---
Cadmium	0.25	4.30×10^{-6}	2.52×10^{-4}	2.34×10^{-5}	4.93×10^{-6}	1.7	1.1×10^{-1}	2.3×10^{-4}
Chromium	10.50	1.81×10^{-4}	1.06×10^{-2}	9.83×10^{-4}	2.07×10^{-4}	1.1×10^{1}	3.8	---
Lead	13.25	2.28×10^{-4}	1.34×10^{-2}	1.24×10^{-3}	2.61×10^{-4}	---	---	1.5**
Manganese	396.00	6.81×10^{-3}	4.00×10^{-1}	3.71×10^{-2}	7.80×10^{-3}	1.5×10^{2}	4×10^{1}	---
Nickel	11.13	1.91×10^{-4}	1.12×10^{-2}	1.04×10^{-3}	2.19×10^{-4}	5.7	1.5	4×10^{-3}
Selenium	5.63	9.68×10^{-5}	5.68×10^{-3}	5.27×10^{-4}	1.11×10^{-4}	6	1.6	---
Silver	0.38	6.54×10^{-6}	3.84×10^{-4}	3.56×10^{-5}	7.49×10^{-6}	3×10^{-1}	7.9×10^{-2}	---
Titanium	324.75	5.59×10^{-3}	3.28×10^{-1}	3.04×10^{-2}	6.40×10^{-3}	1.5×10^{2}	4×10^{1}	---
Vanadium	24.13	4.15×10^{-4}	2.44×10^{-2}	2.26×10^{-3}	4.75×10^{-4}	1.5	4×10^{-1}	---
Zinc	41.63	7.16×10^{-4}	4.20×10^{-2}	3.90×10^{-3}	8.20×10^{-4}	1.5×10^{2}	$4. \times 10^{1}$	---

* Model-predicted PM_{10} impact x metals concentration in soil.

** Corresponds to lead NAAQS and is based on an average each calendar quarter.

trative Code, (3) Arizona and federal New Source Performance Standards (NSPS), (4) the Hayden PM_{10} Non-Attainment Area SIP, and the Globe/Miami SO_2 SIP. The AIP and this impact analysis assess compliance with the NAAQS and compare the predicted ambient air quality impacts of the project to the AQGs.

Article 6 of the Arizona Administrative Code requires the prevention of excessive emissions from material handling, soil storage piles, and roadways. A preventive maintenance schedule and a monthly check would be developed for all water spray systems used to reduce material handling emissions. To prevent excessive emissions from storage piles, water application would be used. Application of water and/or chemical dust suppressants to all unpaved roads would be used to achieve approximately 91 percent (up to 100 percent control on interior haul roads) control efficiency of dust from these roads. Compliance would be demonstrated by maintaining records of chemical dust suppressant purchases and water/chemical applications.

The Carlota crushers, screens, conveyor transfer points, storage bins, and ore truck unloading station are subject to the NSPS for Metallic Mineral Processing Plants specified in 40 CFR 60, Subpart LL. These standards require an opacity limit of 10 percent from process fugitive emission sources. The mine would maintain a certified opacity observer on the site to assess compliance with this requirement.

The diesel, diluent, and organic storage tanks at Carlota may be subject to Subpart Kb of the NSPS regulations. If the vessels are assumed to be larger than 40 cubic meters (approximately 10,000 gallons) and smaller than 75 cubic meters (approximately 20,000 gallons), NSPS only requires readily accessible records of the tank dimensions and an analysis showing the capacity of each storage vessel.

The Carlota Copper Project would be subject to the RACM prescribed by the Hayden/Miami area SIP. These measures include the following:

- Pave, vegetate, or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads
- Develop traffic reduction plans for unpaved roads (i.e., use low speed limits)
- Pave, vegetate, or chemically stabilize unpaved parking areas
- Employ RACT for significant point sources (the secondary crushing circuit would be subject to this requirement)

To fulfill the intent of this plan, non-process particulate emissions from Carlota would be reduced by water/ chemical applications to haul roads and storage piles. A baghouse control on the secondary crusher fulfills the RACT requirement.

SIP Conformity

A portion of the proposed Carlota Copper Project is to be located within an area that has been designated nonattainment for PM_{10} and SO_2. Conformity with the applicable SIP must be demonstrated for all pollutants for which the area is designated nonattainment and for which the project has the potential to emit total emissions (both process and non-process) in an amount exceeding the de minimis threshold of 100 tons per year.

Annual emissions of SO_2 are estimated to be well below the de minimis threshold (10 tons per year with the implementation of additional mitigation measures), while annual emissions of PM_{10} are estimated to be greater than the de minimis threshold. Therefore, a demonstration of conformity with the SO_2 SIP is not required, but a demonstration of conformity with the PM_{10} SIP is required.

The determination that a project conforms with an applicable SIP is made by ensuring that direct and indirect emissions from the project will not:

- Cause or contribute to any new violation of any standard in the area
- Interfere with provisions in the applicable SIP for maintenance of any standard
- Increase the frequency or severity of any existing violation of any standard in any area
- Delay timely attainment of any standard or any required interim emission reductions or other milestones in the SIP for the following purposes:
    - (a) Demonstration of reasonably further progress
    - (b) Demonstration of attainment
    - (c) Maintenance plan

The PM_{10} nonattainment designation for the Hayden/Miami planning area is a result of expected exceedances of the PM_{10} NAAQS proximate to the copper smelting activities in the town of Hayden. As a result, the predicted ambient level of PM_{10} upon which the controls in the SIP are based pertains to particulate levels in Hayden, as opposed to the proposed project site. In November 1994, ADEQ petitioned EPA to realign the Hayden/Miami PM_{10} nonattainment area boundary to exclude the northern portion of the area that contains the proposed Carlota Copper Project site. Furthermore, monitoring of PM_{10} concentrations in Miami does not indicate any exceedances of the PM_{10} standard.

The particulate emission control measures in the SIP pertain only to controlling PM_{10} emissions at two specific copper smelters and associated activities, located in Hayden, approximately 25 miles south of the proposed project. The requirement that the emissions not violate requirements or milestones in the applicable SIP is automatically met because no such requirements or milestones apply to sources other than specifically identified smelter sources in Hayden.

Compliance with the requirement to not cause or contribute to any new violation of any standard or increase the frequency or severity of any existing violation of any standard in any area (i.e., any NAAQS) is adequately demonstrated by a local air quality analysis. This analysis is the only requirement necessary to demonstrate conformity with the PM_{10} SIP. This analysis must meet the applicable requirements of 40 CFR 93.159, Procedures for Conformity Determinations of General Federal

Actions, including accuracy of emission estimation techniques, applicability of air quality models, and accuracy of emissions scenarios reflected in the analysis.

The Globe Ranger District of the Tonto National Forest has reviewed the air quality analysis conducted for the Carlota Copper Project and has determined that:

- The methods for estimating emissions from the project meet the appropriate requirements.
- The local PM_{10} emissions modeling methodology is appropriate for determining whether emissions from the project will cause or contribute to any new violation of the PM_{10} NAAQS.
- The results of the modeling analysis predict maximum 24-hour ambient concentrations at the process area boundary to be 110.8 $\mu g/m^3$ (based on a background concentration of 17.2 $\mu g/m^3$), which is below the ambient standard of 150 $\mu g/m^3$.
- The results of the modeling analysis predict the maximum average annual ambient concentration at the process area boundary to be 36.9 $\mu g/m^3$ (based on a background concentration of 17.2 $\mu g/m^3$), which is below the ambient standard of 50 $\mu g/m^3$.
- The action does not cause or contribute to any new violation of any standard in any area.
- The action does not increase the frequency or severity of any existing violation of any standard in any area.
- The action does not violate any requirements or milestones in the SIP.

Based on these determinations, the proposed activities at the Carlota Copper Project are presumed to conform with the applicable SIP for the project area. The Conformity Determination document (February 1996) provides additional details of the analysis. To ensure the accuracy of the emissions inventories used in this analysis, the AIP will include conditions and voluntary requirements that meet federal enforceability requirements.

Analysis of Air Quality Related Values

As part of the NEPA process, the federal land manager (in this case, the Forest Service) is assessing the potential impact from proposed projects on AQRVs. AQRVs were established for designated Class I areas by the PSD program under the Clean Air Act and represent resources that could be adversely affected by changes in air quality. There are two Class I areas within 50 miles of the proposed Carlota Copper Project: the Superstition Wilderness and the Sierra Ancha Wilderness. Visibility has been identified as a specific AQRV for these wilderness areas. Potential impacts to visibility are discussed below. It has also been recommended that certain terrestrial and aquatic resources be considered AQRVs for these wilderness areas (Blankenship 1991). Potential impacts to terrestrial and aquatic AQRVs are addressed in Appendix D, Acid Deposition and Ozone Analysis. In addition to the Class I areas, the Forest Service requested that potential air quality-related impacts to terrestrial and aquatic resources be evaluated at the Class II Tonto National Monument and the Carlota Copper Project site (not Class I areas). The terrestrial and aquatic resources evaluated for these areas were considered to be the same as the AQRVs identified for the Class I wilderness areas.

Visibility Analysis

Baseline visibility information has been presented in Section 3.1.1, Air Resources - Affected Environment. This section describes the results of a comprehensive visibility modeling analysis. The technical report entitled *Carlota Copper Project Emissions and Potential Impact on Visibility Resources in the Superstition Wilderness* (USDA Forest Service 1997b) contains a complete discussion of the comprehensive visibility modeling analysis. The purpose of this analysis was to determine if there would be potential impacts from the proposed Carlota Copper Project on the nearby Superstition Wilderness and to assess the magnitude and frequency of potential impacts. Visibility modeling was performed using EPA's PLUVUE II visibility model. PLUVUE II predicts the transport, atmospheric diffusion, chemical conversion, surface deposition, and optical effects of emissions from sources. The model estimates visual range reduction, changes in scene contrast, and atmospheric discoloration caused by plumes composed of PM_{10}, NO_x, and SO_2 emissions. For the Carlota visibility analysis, potential visibility impacts were quantified based on PLUVUE II model results for three parameters: visual range reduction, plume contrast, and color difference.

Reduction in SVR is the percent reduction in the farthest distance one can see a large black object (e.g., mountain peak) caused by atmospheric contaminants. This parameter can be interpreted to indicate the haziness or loss of contrast of viewed landscape features caused by these contaminants. Plume contrast (PC) is the relative brightness of a plume compared to a viewing background. Color difference (ΔE) is an indicator of the perceptibility of a plume due to both its contrast and its color compared to a viewing background.

Modeling Inputs and Assumptions. PLUVUE II modeling was performed in accordance with a detailed modeling protocol (USDA Forest Service 1996e). The protocol development included a peer review process that involved representatives from the Forest Service, the Forest Service's technical air quality consultants (Air Sciences Inc. and CH2M HILL), the National Park Service, Carlota Copper Company, Carlota Copper Company's technical air quality consultant (AEC), and EPA Region IX. This protocol specified values for all model input parameters.

Meteorological data collected at the project site over an 18-month period were analyzed and used to develop two worst-case meteorological conditions (i.e., first percentile and fifth percentile worst-case meteorological conditions) according to EPA guidance. These two meteorological conditions represent combinations of wind speed and stability class along a 120 degree wind direction for each season of the year. Wind speeds and stability classes were selected according to their potential to produce visibility impacts. The 120 degree wind direction (winds from the east-southeast) was selected since such winds occur along the Pinto Valley drainage and blow in a direction from the project toward the Superstition Wilderness over the shortest possible distance.

Background pollutant concentrations for NO_x, NO_2, SO_2, and O_3 and the background visual range data, as presented in Section 3.1.1, Affected Environment, were also used in the PLUVUE II modeling.

The visibility modeling analysis considered six alternative emissions inventories that included emission rates for NO_x, PM_{10}, and SO_2. Inventories 1, 2, and 3 represent the most likely maximum unmitigated emissions, the maximum allowable unmitigated emissions, and the average unmitigated emissions, respectively. The inventories for these three alternatives were based on data contained in the AIP and the *Final Air Impact Analyses for the Environmental Impact Statement for the Carlota Copper Project* (AEC 1996c), as well as technical data provided by Carlota during the process of refining the visibility modeling protocol (AEC 1996d). The mitigated emission inventories (Emission Inventories 4, 5, and 6) were based on emissions information provided in the report *Revised Emissions Inventory for Mitigation Measures Planned for the Carlota Copper Project* (AEC 1996a) and the data sources for the first three emissions inventories. These three alternative emissions inventories incorporate additional mitigation measures committed to by Carlota that reduce fugitive particulate emissions and tailpipe emissions of PM_{10}, SO_2, and NO_x. These measures are needed to reduce potential visibility impacts in the Superstition Wilderness. *Table 3-21* summarizes the six alternative emissions inventories used in the Carlota visibility analysis.

The Forest Service has assessed the relative importance of the six alternative emission inventories considered in the visibility modeling analysis. The Forest Service has determined that mitigated emission inventories 4 (maximum daily emissions without emergency generators) and 5 (maximum daily emissions with emergency generators) are more significant than mitigated emission inventory 6 (average daily emissions). The Forest Service considered EPA guidance (EPA 1996b) on modeling maximum emission cases and the lack of federal enforceability (through conditions in the ADEQ Draft Air Installation Permit) associated with the average operating conditions in emission inventory 6 in arriving at this weighting decision.

Table 3-21. Emissions Inventories for the Carlota Visibility Modeling Analysis

Emissions Inventory	Name	Description	Comments
1*	Maximum 24-hour emissions without emergency generators	Emission rates based on maximum 24-hour emission rates, excluding emergency generators, including particulate process emissions from ore processing sources (crushers and conveyors).	Line power available. Cannot occur simultaneously with emissions inventory 2. Most likely maximum emission inventory.[1]
2	Maximum 24-hour emissions with emergency generators	Maximum 24-hour emissions, including emergency generators, excluding particulate process emissions from ore processing sources (crushers and conveyors).	Line power interrupted. Can't occur simultaneously with Emission Inventory 1. Limited by ADEQ AIP condition to 438 hours/year. Consistent with EPA modeling guidance.[2,3,4]
3	Average emissions scenario	Emissions based on maximum annual emission rates divided by 365 days, excluding emergency generators, including ore processing sources (crushers and conveyors).	Annual emissions divided by 365. Carlota represents this inventory as being typical for the operation. No enforceable limits in AIP conditions at these operating rates.[1]
4	Mitigated maximum 24-hour emissions without emergency generators	Emission rates based on maximum 24-hour emissions rates, excluding emergency generators, including particulate process emissions from ore processing sources (crushers and conveyors). *Additional mitigation measures employed.*	Line power available. Cannot occur simultaneously with Emission Inventory 5. Most likely maximum mitigated emission inventory.[1,5]
5	Mitigated maximum 24-hour emissions with emergency generators	Maximum 24-hour emissions, including emergency generators, excluding particulate process emissions from ore processing sources (crushers and conveyors). *Additional mitigation measures employed.*	Line power interrupted. Cannot occur simultaneously with Emission Inventory 4. Limited by AIP condition to 438 hours/year. Consistent with EPA modeling guidance.[2,3,4,5]
6	Mitigated average emissions scenario	Emissions based on maximum annual emission rates divided by 365 days, excluding emergency generators, including ore processing sources (crushers and conveyors). *Additional mitigation measures employed.*	Annual mitigated emission rate divided by 365. Carlota represents this inventory as being typical for the operation. No enforceable limits in AIP conditions at these operating rates.[1,5]

*The numbering system used to present model results in this report is as follows: for each emission scenario, the 1st percentile meteorological condition was modeled and designated with a "-1" (for example, "1-1" for emission scenario 1), and the 5th percentile meteorological condition was modeled and designated with a "-5" (for example, "2-5" for emission scenario 2).

Sources:

[1] AEC 1996d

[2] AEC 1996c

[3] EPA 1996b

[4] 40 CFR Chapter 1, Part 51, Appendix W

[5] AEC 1996a

Four observer locations were chosen at high points in order to provide the best vantage point for looking out over the complex terrain. *Figure 3-2a* shows the location of each observer point (Iron Mountain, Mound Mountain, Government Hill, and Grizzly Mountain) with respect to the Superstition Wilderness and the Carlota project site. All of these observer locations are accessible by hikers.

A complete description of all the values used for the model input parameters is presented in *Table B1-1* of Appendix B1.

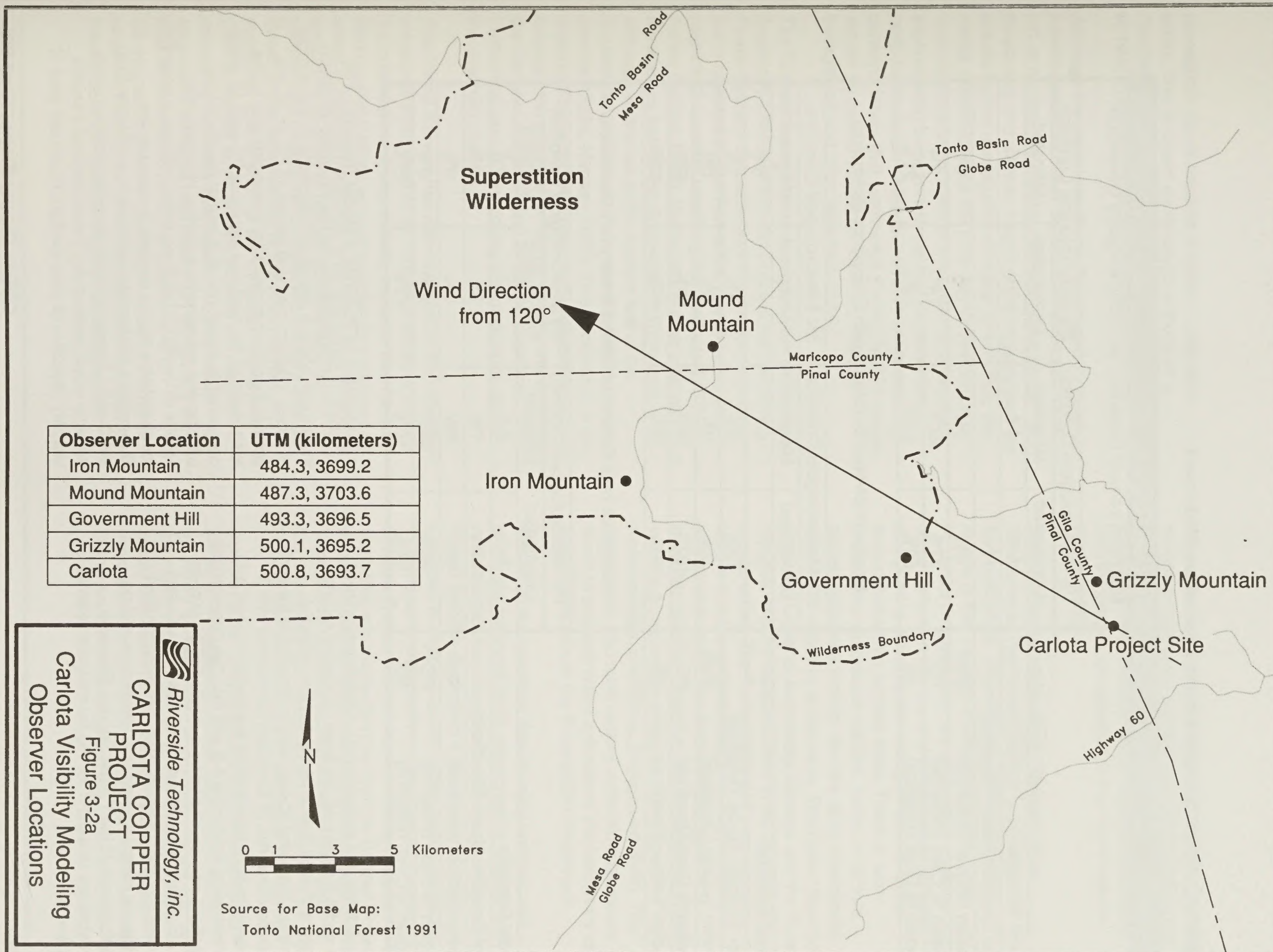
Modeling Approach. PLUVUE II modeling was conducted for 12 modeling scenarios and 4 observer locations. The 12 modeling scenarios were created from a pool of 6 emission scenarios and 2 meteorological conditions. Specific dates and times of year were chosen to represent the range of possible sun paths across the sky. As a result, each modeling scenario required 48 model runs (one model run for each observer location [4], season [4], and time of day [3], 4 x 4 x 3 = 48). Therefore, a total of 576 (12 x 48 = 576) model runs were produced and examined for this visibility modeling analysis.

Model Results. The PLUVUE II model results were compared to perceptibility threshold values as defined by the Forest Service Region 3 (Air Sciences, Inc. 1996d) for each of the three visibility perception parameters (PC, ΔE, and SVR). The perceptibility thresholds of PC, ΔE, and SVR are established according to Region 3's definition of Limits of Acceptable Change for visibility as being a "just noticeable change." If the impacts are above any one of these three thresholds, the plume's effect on visibility conditions is interpreted to be a "just noticeable change." *Table 3-22* presents a summary of the predicted plume visual impacts in the Superstition Wilderness for each of the 12 modeling scenarios. Note that the "% of Samples Above Threshold" does not reflect the amount of time that the Forest Service Region 3 perceptibility thresholds are predicted to be exceeded. Rather, this percentage value reflects the percentage of all valid samples that are predicted to exceed the Forest Service Region 3 perceptibility threshold for the particular model scenario. For example, a value of 35 percent means that 35 percent of the valid samples are predicted to exceed the Forest Service Region 3 perceptibility thresholds for the particular model scenario, and not that the Forest Service Region 3 perceptibility thresholds are predicted to be exceeded 35 percent of the time.

The Forest Service has characterized its best estimate of the frequency of occurrence of impacts as at least 4 daylight hours per year for any exceedance at the first percentile meteorological condition and at least 22 daylight hours per year for any exceedance at the fifth percentile meteorological condition (USDA Forest Service 1997a). Also note that the "Median % Above Threshold" reflects the severity of visibility impacts. For example, a value of 50 percent would represent a more severe visibility impact than a value of 5 percent.

The modeling scenarios containing the unmitigated emission inventories (i.e., modeling scenarios 1-1, 1-5, 2-1, 2-5, 3-1, and 3-5) were modeled first. Modeling scenario 2-1 produced the greatest number of exceedances of the Forest Service Region 3 perceptibility thresholds with 22 percent of the modeled samples (421 samples) predicted to exceed the threshold. For this modeling scenario, the Forest Service Region 3 perceptibility thresholds were exceeded by a median of 107 percent for PC and 80 percent for ΔE. Modeling scenarios 1-5 and 3-5 produced the least number of exceedances with 2 percent of the valid modeled samples predicted to exceed the thresholds for each of these scenarios (47 and 45 samples for 1-5 and 3-5, respectively). For all 6 unmitigated scenarios, the Forest Service Region 3 perceptibility threshold was exceeded by a median ranging from 53 to 107 percent for PC, and from 44 to 80 percent for ΔE. There were no exceedances of the SVR perceptibility threshold for the six unmitigated emission inventories.

The implementation of additional mitigation measures resulted in a substantial reduction in predicted plume impacts in the Superstition Wilderness. The results of the mitigated model runs are presented in *Table 3-22* in modeling scenarios 4-1, 4-5, 5-1, 5-5, 6-1, and 6-5. Modeling scenario 5-1 produced the greatest number of exceedances of the perceptibility thresholds, with 8 percent of the modeled samples (160 samples) (compared to 22 percent [421 samples] for the unmitigated scenario 2-1). For this modeling scenario, the Region 3 perceptibility thresholds were exceeded by a median of 36 percent for PC and 35 percent for ΔE (compared with 107 and 80 for PC and ΔE,



Observer Location	UTM (kilometers)
Iron Mountain	484.3, 3699.2
Mound Mountain	487.3, 3703.6
Government Hill	493.3, 3696.5
Grizzly Mountain	500.1, 3695.2
Carlota	500.8, 3693.7

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Figure 3-2a

Carlota Visibility Modeling Observer Locations

Table 3-22. Visibility Impacts in the Superstition Wilderness

Scenarios		Emissions			
		Maximum 24-hour Emissions without Emergency Generators			
		1% Meteorological Condition		5% Meteorological Condition	
		Unmitigated	Mitigated	Unmitigated	Mitigated
Model Scenario		1-1	4-1	1-5	4-5
% of Samples Above Threshold		17%	1%	2%	<1%
Median % Over Threshold	SVR	0%	0%	0%	0%
Median % Over Threshold	PC	81%	22%	44%	0%
Median % Over Threshold	ΔE	60%	12%	44%	21%
		Maximum 24-hour Emissions with Emergency Generators			
		1% Meteorological Condition		5% Meteorological Condition	
		Unmitigated	Mitigated	Unmitigated	Mitigated
Model Scenario		2-1	6-1	2-5	6-5
% of Samples Above Threshold		22%	8%	0%	1%
Median % Over Threshold	SVR	0%	0%	0%	0%
Median % Over Threshold	PC	107%	36%	44%	55%
Median % Over Threshold	ΔE	60%	35%	45%	33%
		Average 24-hour Emissions without Emergency Generators			
		1% Meteorological Condition		5% Meteorological Condition	
		Unmitigated	Mitigated	Unmitigated	Mitigated
Model Scenario		3-1	6-1	3-5	6-5
% of Samples Above Threshold		16%	1%	2%	<1%
Median % Over Threshold	SVR	0%	0%	0%	0%
Median % Over Threshold	PC	66%	31%	53%	0%
Median % Over Threshold	ΔE	59%	10%	45%	21%

respectively, for scenario 2-1). Modeling scenarios 4-5 and 6-5 produced the least number of exceedances with less than 1 percent of the modeled samples predicted to exceed the thresholds for each of these scenarios (5 samples) (compared with 2 percent for both unmitigated scenarios 1-5 and 3-5). For modeling scenarios 4-5 and 6-5, the perceptibility threshold was exceeded by a median of 21 percent for ΔE. There were no exceedances of the Forest Service Region 3 perceptibility threshold for SVR for the six mitigated emission inventories and no exceedances of the Forest Service Region 3 perceptibility threshold for PC for mitigated scenarios 4-5 and 6-5.

Assessment of PLUVUE II Model Results . The PLUVUE II model results for the mitigated emission inventories show a significant decrease in the number of cases in which modeled values of PC or ΔE are greater than the perceptibility thresholds and in the magnitude of the modeled values of PC and ΔE when compared to the PLUVUE II model results for the unmitigated emission inventories. However, the results of the PLUVUE II modeling indicate a potential for perceptible plume impacts to occur in the Superstition Wilderness because of emissions from the Carlota Copper Project. Any perceptible plume impacts would exceed the Tonto National Forest's visibility objective of zero daylight hours per year of perceptible plume impacts in Class I wilderness areas. This is based on language in Subpart 2, Section 169A(a)(1) of the Clean Air Act Amendments of 1977 (Visibility Protection Goal, Clean Air Act).

Although the model results for the mitigated emission inventories show fewer cases of modeled values of PC or ΔE that are greater than the perceptibility thresholds and a lower magnitude of impacts than the results for the unmitigated emission inventories, the model results indicate the potential for perceptible visibility impacts for each of the observer locations, each viewing background, each of the three time periods, and each of the four seasons. Appendix B2 contains tables that summarize the PLUVUE II model results by season, observer location, viewing background and color, and time of day.

The Superstition Wilderness is one of the most frequently visited wilderness areas in the National Forest System. Seasonal use information is limited but is reported by the Forest Service as being year-round with summer receiving the least use (USDA Forest Service 1990). Visitor use is most intense in the western half of the Superstition Wilderness, although visitor use in the eastern half of the Superstition Wilderness is increasing (USDA Forest Service 1996d; Hansen 1997). This information is an important basis for the Forest Service's decision to evaluate the potential for plume visibility impacts from the Carlota Copper Project in the Superstition Wilderness and in developing its conclusions about the potential impacts.

The Forest Service has also considered the mitigation measures committed to by Carlota in an evaluation of the potential for plume visibility impacts. The Forest Service and Carlota worked together to evaluate and select mitigation measures to be employed to reduce emissions in order to reduce (or eliminate) the number and magnitude of predicted visibility impacts. Based on an assessment of the effectiveness and economic cost of each of the mitigation measures, Carlota agreed to implement three of the mitigation measures that were evaluated: (1) using newer engines in the large haul trucks, (2) eliminating the haul from the crusher to the leach pad, and (3) augmenting water application rates on the main unpaved haul roads (AEC 1996e). (Other mitigation measures were considered and evaluated to be infeasible for the project.) The implementation of the mitigation measures committed to by Carlota would result in a substantial reduction in the number and magnitude of potential visibility impacts associated with the project, as reflected in the model results (*Table 3-22*).

Conclusions and Strategy - Superstition Wilderness. The Forest Service is aware of the technical limits, uncertainties, and conservative nature of this visibility modeling analysis. The PLUVUE II model does not adequately capture complex terrain effects, and it was not specifically designed to address the variety of source types associated with a surface mine. There is also uncertainty associated with the emission factors, control efficiency factors, and the daily operational rates of all activities at the mine. The Forest Service Region 3 Limits of Acceptable Change and the Forest Service visibility objective used in the analysis are conservative. The Tonto National Forest acknowledges that there are a number of factors that are assumed to occur simultaneously in predicting potential visibility impacts in the Superstition Wilderness (e.g., maximum emission rates, specific meteorological conditions, background SVR). The assumption that such factors occur simultaneously leads to a conservative estimate of the frequency of visibility impacts in the Superstition Wilderness.

Based on the results of this visibility analysis and given the technical limits, conservative nature, and uncertainties associated with visibility modeling, the Forest Service developed a monitoring strategy designed to ensure visibility within the Superstition Wilderness is protected from the Carlota Copper Project. The purpose of this monitoring program is to verify that emissions from the Carlota Copper Project do not adversely affect visibility resources within the Superstition Wilderness. A complete description of the monitoring plan is contained in Section 3.1.4, Air Resources - Monitoring and Mitigation Measures.

Conclusions - Sierra Ancha Wilderness/Tonto National Monument. A high ridge, which is the boundary between the Tonto Basin Ranger District (to the north) and the Globe Ranger District (to the south) separates the proposed Carlota Copper Project site (in the Globe Ranger District) from the Sierra Ancha Wilderness and the Class II Tonto

National Monument (in the Tonto Basin Ranger District). This ridge not only interrupts the flow of the plume, but acts as a visual barrier along every line of sight from the Sierra Ancha Wilderness and the Tonto National Monument toward the Carlota Copper Project site. Furthermore, these two areas are sufficiently distant from the project site that sustained, uninterrupted, unidirectional winds over the large distance are unlikely. The Sierra Ancha Wilderness and the Tonto National Monument are, therefore, physically protected from visibility impacts caused by the project's emissions.

3.1.2.2 Alternatives

The alternatives associated with mine rock disposal and leach pad sites have the potential to result in different air emissions than the proposed action. The air quality emissions and impacts of these alternatives are summarized in *Table 3-23*. The other types of alternatives would result in insignificant changes in air emissions.

Mine Rock Disposal Alternatives

The Cactus South and Cactus Central mine rock disposal areas (south and southeast of the mine, respectively) would create an alternative storage capacity for 7.6 million tons of mine rock. Because the mining processes associated with the additional disposal sites would be identical to those in the proposed action, the total storage capacity for mine rock would not increase, and fugitive emissions from mine rock disposal activities of the project would not be expected to increase. Each of the two alternative disposal sites covers approximately 22 acres; therefore, the addition of these two sites would increase the total disturbed area of the project by approximately 5 percent. Because of the availability of the additional disposal sites, the disturbed area of the Main and Cactus Southwest mine rock disposal areas would decrease. This decrease would tend to counteract the effect of the 5 percent increase in disturbed surface areas. As a result, emissions increases resulting from implementing this alternative are expected to be zero.

Approximately 88 million tons of mine rock would be required to backfill the Carlota/Cactus pit to the existing elevation of Pinto Creek. Because of the configuration of the pit, this additional backfilling cannot be done during mining of the Carlota/Cactus pit. The entire backfilling process would therefore take place for 3 to 4 years, beginning at completion of the proposed project. Backfilling would occur at a rate of approximately 26 million tons per year. The predicted project emissions are based on the maximum annual production rate. Therefore, because the additional backfilling rate is equal to the highest predicted processing rate for the proposed project, the emissions from the project should not increase but should simply continue for an additional 3 to 4 years. Emissions during any given year are not expected to be greater than the already estimated maximum annual emissions. Furthermore, as a result of backfilling, an additional 110 acres of the Carlota/Cactus pit and an additional 43 acres of the Main mine rock disposal area would be reclaimed, decreasing post-project emissions that are caused by erosion.

Table 3-23. Summary of Alternatives - Emissions and Impacts

Alternative	Effect on Emissions	Effect on Impacts
Additional Mine Rock Disposal Sites	0 percent to 5 percent increase	0 percent to 5 percent increase
Backfill of Carlota/Cactus Pit	No increase in short term; extend life of project; decrease emissions in long term	Same as maximum modeled case
Backfill of Eder South Pit	No increase in short term; decrease in long term	Same as maximum modeled case
Eder Side-Hill Leach Pad	Minor increase in fugitive emissions from increased hauling distances	Same as maximum modeled case

The total amount of mine rock used for backfilling the Eder South pit would be approximately 5 million tons. This process would be completed during and subsequent to Year 14, when emissions are expected to be substantially lower than peak emissions. The emissions from the additional backfilling combined with emissions from regular processes would still be lower than emissions during the year with the highest activity rate. Furthermore, a total of 49 additional acres would be reclaimed as a result of this alternative, reducing post-project emissions that are caused by erosion. Therefore, the total impact resulting from the additional emissions related to backfilling the Eder South pit would be lower than the estimated maximum impacts expected from the proposed project.

Eder Side-Hill Leach Pad Alternative

The relocation of the Eder mine rock area would result in an increase in mine rock hauling distance from the Eder North pit (and back to the pit for backfilling) and either no change or a slight decrease in hauling distance of mine rock from the Eder South pit. The net change in overall fugitive emissions from these activities in the southern area of the project is expected to be insignificant since haul road dust controls have 91 percent efficiency (up to 100 percent control on interior haul roads), and the increase in emissions would be minor. The smaller capacity of the leach pad (75 million tons) might result in as much as a 25 percent decrease in emissions due to hauling/ conveying of ore over the life of the project. It is also possible that sulfuric acid emissions from the SX/EW tank house could decrease since less ore would be processed, and therefore, less sulfuric acid would be used over the life of the process. It is likely that overall mining activity rates during the maximum year would not be significantly affected by this change in the heap configuration, so short-term and annual impact estimates presented in the EIS are representative of impacts from this proposed alternative.

No Action Alternative

The no action alternative serves as the baseline condition for evaluating the environmental consequences of the proposed action and the project alternatives. Selection of the no action alternative would preclude the development of the Carlota Copper Project. The baseline levels of pollutants in the area of the proposed action, as presented in the affected environment section of the EIS, represent the air quality resulting from the no action alternative. Existing nearby sources (principally, BHP Copper's Pinto Valley Mine) and regional influences on air quality (long-range transport of mobile source emissions from the metropolitan Phoenix area) would remain the primary sources of emissions impacting the air quality of the project site.

3.1.3 Cumulative Impacts

The cumulative impacts associated with the Carlota Copper Project include estimated impacts from the project and impacts associated with other past, present, and reasonably foreseeable future actions that would have an impact on the air resources affected by the proposed project's emissions. These other actions include mining projects, private land development, and highway development. The topography of the area surrounding the proposed project is complex, with steep mountain ranges and narrow valleys (drainages).

These characteristics serve to define reasonably distinct, small air basins that are likely to only be affected by emission sources that are located within the air basin. The location of the Carlota Copper Project fits this description. Therefore, only other emission sources that are in, or expected to be in, the immediate vicinity of the project area (within or adjacent to the valleys defined by Pinto Creek and Powers Gulch) are considered in this cumulative analysis.

As described in the emissions portion of the environmental consequences section, the principal emission of concern for a surface copper mine is dust emissions. As a result, Carlota collected ambient particulate data (PM_{10}) for 15 months (see Section 3.1.1, Air Resources - Affected Environment). These data, although presented in terms of representing background particulate levels, actually represent particulate levels resulting from existing emission sources in the area. In other words, when estimated impacts from the Carlota Copper Project are added to background concentrations (see *Table 3-18*), the resulting total PM_{10} concentration represents the cumulative impact of the proposed project and all existing sources.

The most important existing source that has been accounted for in the PM_{10} monitoring data is the BHP Copper Pinto Valley Mine that is located on the eastern side of Pinto Valley, adjacent to the proposed project site. This project has been operational for 20 years, and background levels of PM_{10} emissions in the Pinto Valley include impacts from the BHP Copper project. Obviously, any other particulate emissions associated with other recreational or small-scale mining (such as the nearby placer mine) or other developments (nearby highways and commercial and residential developments) are also included in the background particulate concentrations of 17.2 $\mu g/m^3$ (24-hour average and annual average). With the addition of the Carlota Copper Project, maximum cumulative impacts of PM_{10} emissions from the project and all existing PM_{10} emission sources are modeled to be 111 $\mu g/m^3$ (24-hour average) and 37 $\mu g/m^3$ (annual average) in a small area to the north of the operation.

The other pollutant of concern with respect to BHP Copper's Pinto Valley Mine is H_2SO_4 mist. BHP Copper's ore processing methods are similar to the proposed project's methods, and emissions of H_2SO_4 mist from each facility's SX/EW plant are assumed to be proportional to the production rate of the mine. Because the Carlota Copper Project's forecasted annual maximum ore processing rate is expected to be comparable to BHP Copper's current process rates, the emission rate of H_2SO_4 mist from the Pinto Valley Mine is assumed to be approximately equal to that from the proposed project facility (as estimated in the Carlota AIP and presented earlier in this analysis). Because emission rates are similar and meteorological conditions at these two operations are also similar (they are located in the same valley), it is assumed that ambient impacts from H_2SO_4 mist emissions from BHP Copper's SX/EW plant are similar to the modeled impacts of the proposed Carlota Copper Project SX/EW plant. In other words, the distribution of impacts caused by emissions from the Carlota SX/EW plant is expected to be very similar to the distribution of impacts resulting from emissions from BHP Copper's SX/EW plant.

To assess the cumulative impact of H_2SO_4 emissions from both projects, maximum off-site H_2SO_4 impacts from the Carlota Copper Project can be summed with estimated impacts from the BHP Copper project for each receptor of interest. The maximum 1-hour off-site impact from the Carlota Copper Project is predicted to be 20.8 $\mu g/m^3$ at a location approximately 2,500 meters north of the proposed SX/EW plant. This location is approximately 1,500 meters west of the BHP Copper SX/EW facility. The maximum 1-hour impact would occur with light, southerly winds. These meteorological conditions are not likely to produce any additional impact at this same location due to emissions from the BHP Copper SX/EW facility. The maximum cumulative impact is represented by the maximum impact from the Carlota SX/EW plant (20.8 $\mu g/m^3$). This concentration is below the 1-hour AQG of 22.5 $\mu g/m^3$.

The maximum 24-hour off-site impact from the Carlota Copper Project is 1.9 $\mu g/m^3$ at a location approximately 1,750 meters south-southeast of the proposed SX/EW plant. This location is approximately 4,100 meters south-southwest of the BHP Copper SX/EW facility. The maximum 24-hour impact at this location caused by H_2SO_4 emissions from the BHP Copper SX/EW facility is expected to be less than 0.1 $\mu g/m^3$. Therefore, the maximum cumulative 24-hour concentration resulting from both projects is likely to be 2 $\mu g/m^3$, below the 24-hour H_2SO_4 AQG of 7.5 $\mu g/m^3$.

Background concentrations of CO, NO_x, and SO_2 are assumed to include current impacts from existing sources (including the Pinto Valley Mine operation). Therefore, the impacts from the proposed Carlota operation plus background are assumed to represent cumulative impacts for CO, NO_x, and SO_2.

Ozone is a pollutant formed by interaction of ozone precursors (NO_x and hydrocarbons) and sunlight and occurs after downwind transport of ozone precursors and sufficient residence time in the atmosphere. Near site levels of ozone are not expected to be affected by sources of precursor emissions at Carlota or Pinto Valley Mine. Again, background concentration of ozone (used in the AQRV analysis) are assumed to represent impacts from existing sources.

The Carlota visibility modeling analysis used estimates of background pollutant concentrations and visual range data obtained from nearby monitoring stations and other technical literature. The visibility modeling analysis incorporated these data along with estimated emissions from the Carlota Copper Project and used them to determine potential plume impacts.

Therefore, the results of the visibility modeling analysis are assumed to portray the cumulative visibility impact of the proposed project and the existing sources in the project area. Mitigation measures and monitoring are being required to ensure that the potential visibility impacts meet the Forest Service Region 3 Limits of Acceptable Change and the Tonto National Forest visibility objective. Data from the visibility monitoring program could indicate impacts from new emission sources in the project area. If visibility monitoring indicates impacts from new sources, the Forest Service could decide to augment the data collection program and/or to investigate emissions and controls of new sources.

BHP Copper has proposed a 1,200-acre expansion of the Pinto Valley Mine. This expansion would provide land for mine rock disposal sites, tailings facilities, and miscellaneous operations. If approved, construction of the facilities would occur in 1997. This expansion would result in increased land disturbance and increased fugitive emissions. However, it is unlikely that the proposed expansion, if approved, would significantly alter the cumulative impacts of the Carlota Copper Project and BHP Copper's Pinto Valley Mine as described above. No other new or expanded mining operations are proposed for the immediate area of the proposed project, although Cyprus Mining has proposed expanding its current leach pad (approximately 3 miles east of the proposed project) by 1,300 acres of disturbance.

Other future developments that are reasonably foreseeable and have the potential to affect the project area include private land development projects (in the form of development of a limited number of lots at Top-of-the World) and several small-scale highway improvements along the U.S. Highway 60-70 system. Private land development at Top-of-the-World has the potential for localized and short-term increases in dust emissions during construction. Because of the limited availability of lots that could be developed, air quality impacts from this development are expected to be insignificant. Planned highway projects are to take place over the next 3 years and will primarily address safety and flow concerns (as opposed to adding lanes to accommodate increases in traffic volume). Small-scale highway projects of this nature are likely to be sources of dust emissions that have the potential to cause localized dust impacts during construction. It is unlikely that any of these projects would result in long-term increases in vehicular emissions that would have any impact on the project area.

The one private land development that has the potential to cause an increase in mobile emissions in the area of the project is the casino that is currently operating on the San Carlos Indian Reservation (approximately 8 miles east of Globe). It is likely that traffic volume along the U.S. Highway 60-70 system will increase since this is a primary corridor between the Phoenix metropolitan area and the San Carlos Indian Reservation. Increases in CO, NO_x, and VOCs could cause increases in ambient concentrations of CO, NO_x, and ozone in the project area, and may contribute to visibility degradation in the Superstition Wilderness (which is 5 miles north of U.S. Highway 60 at its closest point, near Superior). Highway projects, such as widening climbing lanes, improving intersections, and widening shoulders, should enhance traffic flow along the corridor and ameliorate emission impacts associated with heavy congestion (i.e., stop-and-go traffic).

Overall, future developments other than the Carlota Copper Project can be expected to result in ambient air quality impacts that only marginally affect the air quality of the project area. The Carlota Copper Project and BHP Copper's Pinto Valley Mine would be the primary sources of the emissions that affect the area. Lastly, tourism in the Globe/Miami area is being encouraged and Highway 88 is being improved. Both of these factors have the potential to increase traffic flow in the future.

3.1.4 Monitoring and Mitigation Measures

<u>AQ-1:</u> The design of the ventilation system for the tank house would facilitate deposition of H_2SO_4 emissions as close to the tank house as possible.

<u>AQ-2:</u> The Forest Service has considered the implementation of the mitigation measures, the technical limits and uncertainties in the visibility modeling analysis, and the results of the PLUVUE II model runs based on the mitigated emission inventories to evaluate potential perceptible visibility impacts and to formulate a strategy to ensure the protection of visibility within the Superstition Wilderness. Specifically, the Forest Service has developed a monitoring strategy designed to protect

visibility of the Carlota Copper Project in the Superstition Wilderness. It would be maintained until 1 year after the Carlota Copper Project reaches its maximum production rate.

The monitoring plan employs a three-tiered approach. The first tier would be to determine the existence of perceptible plume impacts in the Superstition Wilderness and to determine if emissions from the Carlota Copper Project cause or contribute to perceptible impacts in the Superstition Wilderness. If the findings of the Tier 1 monitoring program indicate that a perceptible impact in the Superstition Wilderness exists and that emissions from the Carlota Copper Project may be the cause of or may contribute to those impacts, then Tier 2 would be invoked to further characterize the impacts and to more accurately attribute impacts to emissions from the Carlota Copper Project. A Tier 2 program could include continuous particulate and NO_x monitoring at locations upwind and downwind from the Carlota Copper Project and/or increased frequency or additional sampling and chemical analysis of particulate matter at the wilderness boundary. The specific configuration of a Tier 2 monitoring program would be determined based on the information gathered in the Tier 1 program. In Tier 3, the data from Tier 1 and Tier 2 would be considered by the Forest Service in consultation with Carlota to identify and implement additional mitigation measures necessary to rectify the impact. The implementation of this monitoring strategy would meet the Forest Service's objectives, existing guidance, and legal responsibilities as they pertain to protecting the visibility of mandatory Class I wilderness areas.

The requirements of the Tier 1 program would be included as a component of the final Plan of Operations for the Carlota Copper Project. The Tier 1 monitoring program would include the following items[1]:

- ***Meteorological Monitoring.*** Continuous meteorological monitoring collected at three locations (on-site, at the Superstition Wilderness boundary, and at a location [to be determined] between the project and the Superstition Wilderness) at the 10-meter level. Parameters to be monitored would include wind speed, wind direction, relative humidity (on-site location only), and precipitation (on-site location only).

  Purpose/Use of Monitoring Element: Continuous meteorological monitoring would provide one line of evidence needed to appropriately attribute to the Carlota Copper Project measured visibility impacts (if any) in the Superstition Wilderness. For perceptible plume impacts in the Superstition Wilderness to be attributed to emissions from the Carlota Copper Project, the wind direction data at the Carlota site must indicate the potential for emissions from the Carlota Copper Project to cause impacts in the Superstition Wilderness. Because of the complex nature of the terrain in the area, data collected at three appropriately sited locations would be necessary to avoid monitoring only micro-scale meteorological conditions. Other meteorological data, such as wind speed and Pasquill-Gifford stability class, would be needed to further characterize the meteorological conditions during the periods of perceptible plume impacts.

- ***Scene.*** Video camera site (if line power is available). (If line power is not available, an 8-millimeter [mm] camera site would be substituted.) The site would be located at a point with an appropriate view for determining impacts to the Superstition Wilderness. The site would be operated continuously during daylight hours and would be equipped with one or two cameras, depending on siting constraints, in order to capture the view looking into the Superstition Wilderness and a view back toward the Carlota Copper Project.

  Purpose/Use of Monitoring Element: The video camera would be used as a surrogate for the human eye. The camera would be situated to monitor the presence of a visible plume leaving the Carlota site and entering the Superstition Wilderness.

[1] The Forest Service has decided not to require aerosol monitoring as part of the Tier 1 monitoring program for the Carlota Copper Project. However, the Forest Service believes that aerosol monitoring is a useful component for characterizing visibility impacts. Aerosol monitoring could be accomplished through a joint effort among the Forest Service, Carlota Copper Company, and other sources that potentially contribute to visibility impacts in the Superstition Wilderness.

- ***Scene.*** A photographic camera site. The site would be located at a point with an appropriate view looking into the Superstition Wilderness and aimed at a critical target within the Superstition Wilderness. The site would be operated with three pictures taken per day. The photographic camera site would be operated by the Forest Service.

  Purpose/Use of Monitoring Element: The 35-mm camera site would further document the scene quality for public presentation purposes. The images would be used to capture visual characteristics within the Superstition Wilderness on the "cleanest" days of the year. The images would be processed, digitized, and modified to show estimated changes in visibility conditions (ΔE and contrast) based on the monitoring data collected adjacent to the Superstition Wilderness.

- ***Optical.*** Continuously operating transmissometer site located near the Superstition Wilderness. A nephelometer may be substituted depending on siting considerations.

Purpose/Use of Monitoring Element: The transmissometer would be used to document hourly average integrated values of the light-extinction coefficient (a measure of light attenuation) within the Superstition Wilderness. The transmissometer data would serve as the primary measure of visibility impairment within the wilderness. Transmissometers are capable of measuring the total extinction of light, which is influenced by light-scattering fine particles and light-absorbing elemental carbon (soot) and nitrogen dioxide.

3.2 Geology and Minerals

3.2.1 Affected Environment

This section addresses the topography, regional geology, bedrock geology, surficial deposits, seismicity, geologic hazards, and mineral resources for the Carlota Copper Project. The regional and local geology summary also provides background information for predicting ground water flow pathways, evaluating potential impact on ground water resources, and designing a ground water monitoring program (see Section 3.3, Water Resources).

3.2.1.1 Topography and Physiographic Setting

The proposed project area is situated within a broad chain of northwest-trending ranges from the Pinal Mountains to the southeast, the Dripping Springs Mountains to the south, and the Superstition Mountains to the west. The topography of the project area, presented in *Figure 2-1b*, is characterized by irregular and varied topographic features that developed in response to erosion across complex fault structures and diverse rock formations. The elevation across the site ranges from approximately 5,000 ft-amsl along the ridge line adjacent to the Eder South pit in the southeast to approximately 3,200 ft-amsl in Pinto Creek in the well field area. Natural slopes flanking the ridges are steep, with gradients typically ranging from 1.5:1 to 2.5:1 (H:V).

The main portion of the project area is drained by two northwest-flowing streams, Pinto Creek and Powers Gulch, that are separated by a broad, northwest-trending ridge. Pinto Creek is the larger of the two and flows along a sinuous course in the eastern portion of the project area and through the site of the proposed Carlota/Cactus pit. Powers Gulch is a small tributary to Haunted Canyon that flows through the western portion of the project area and through the proposed heap-leach pad site; its headwaters are immediately south of the project near U.S. Highway 60. Powers Gulch flows into Haunted Canyon approximately 1 mile downstream from the heap-leach pad site. Haunted Canyon originates in the Superstition Wilderness located west of the project area. The proposed well field would consist of several wells located along the lower reach of Haunted Canyon and along Pinto Creek immediately downstream of the Haunted Canyon-Pinto Creek confluence.

3.2.1.2 Geologic Setting

The project is located within the Globe-Miami Mining District. The rocks exposed within the district are igneous, metamorphic, and sedimentary rocks that range from Precambrian to Tertiary in age. These rocks record a complex structural and depositional history that has included repeated episodes of tectonic uplift, faulting, erosion, and deposition of sedimentary and volcanic materials.

Basement rock throughout the district consists of the Precambrian Pinal Schist that is intruded with Precambrian granite and diabase. Locally, upper Precambrian sedimentary rocks of the Apache Group rest unconformably on the eroded surface of the Pinal Schist. The Apache Group is, in turn, separated from Paleozoic limestones and quartzites by another erosional surface. These older rocks were intruded by bodies of granite porphyry (named the Schultze Granite) during mountain building in the Late Cretaceous to Early Cenozoic eras. A thick sequence of dacitic volcanic and volcaniclastic rocks of Miocene age, and the Gila Conglomerate of Miocene to Pliocene age, mantle the older rock units and fault structures. Erosion during the last several million years in this area has removed portions of these deposits, exposing the older formation.

The distribution of the major rock types in the vicinity of the proposed project, along with their respective ages, are presented in *Figures 3-3* and *3-4*. Representative geologic cross sections through the leach pad, the Carlota/Cactus pit, and the Main mine rock disposal area are presented in Section 3.3, Water Resources *(Figures 3-16, 3-17 and 3-18*). The primary rock units in the vicinity of the project are described below, from oldest to youngest.

<u>**Bedrock Units**</u>

The Pinal Schist and massive bodies of Precambrian diabase intruded into the Pinal Schist comprise the oldest rocks exposed in the area. These rocks underlie large portions of the heap-leach facility and mine rock disposal sites, and would be exposed in the open pits. The Pinal Schist is the main host rock for mineralization at the Eder South deposit and one of several host rocks for mineralization in the Carlota/Cactus pit.

The “Granite on Manitou Hill” (Peterson 1962) is a Precambrian age, weakly foliated granitic intrusion that occurs in Manitou Hill and between Pinto Creek and Powers Gulch in the vicinity of the Cactus Southwest mine rock area.

Rocks of the upper Precambrian Apache Group include three conformable units: the Pioneer Formation (which includes the Pioneer shale and Pioneer Quartzite), Dripping Springs Quartzite, and Mescal Limestone. These units occur beneath portions of the heap-leach facility, Main mine rock disposal area, and well field area. The Dripping Springs and the Pioneer Quartzite locally contain abundant open fractures that readily store and transmit ground water. These fractured quartzites are two of the primary water-yielding rock units encountered in the well field. Pioneer Quartzite is typically a fine- to medium-grained arkosic quartzite that has been extensively intruded by diabase sills and dikes (Peterson 1962). The Dripping Springs Quartzite formation is characterized as a fine- to medium-grained white to vari-colored quartzite with occasional thin shale interbeds.

Paleozoic rocks exposed at the surface near project facilities or in the well field area include the Cambrian Troy Quartzite, the Devonian Martin Limestone, the Mississippian Escabrosa Limestone, and the Permian Naco Group. The Cambrian Troy Quartzite is encountered at depth in the well field. Peterson (1962) describes the Troy Quartzite as having a distinct conglomeratic basal unit that grades upward into dark reddish-brown pebbly sandstone and slabby argillaceous sandstone. In the well field, the Troy Quartzite is a significant water-yielding unit. The limestone units are exposed in the northwest portion of the Main mine rock disposal area, locally along the Kelly fault zone, and in the well field area.

The Tertiary Schultze Granite is exposed over extensive areas south of the proposed Carlota/Cactus and Eder South pits, including the area traversed by U.S. Highway 60 and the Top-of-the-World community. The Schultze Granite is considered to be the mineralizer in the Globe-Miami Mining District and hosts ore in many of the deposits. However, the granite is not mineralized on the project site, and its genetic significance to the copper mineralization within the Carlota Copper Project area has not been established.

The Whitetail Conglomerate is preserved locally in the Carlota Copper Project area. The Whitetail is up to several hundred feet thick in the area and is composed predominantly of poorly stratified sand-to-cobble-sized diabase and limestone fragments. A thick volcanic ash unit near the top of the Whitetail Conglomerate has been dated at approximately 30 million years ago. The Whitetail does not appear to be mineralized in the project area.

The Tertiary Cactus Breccia is the most important ore host rock in the Carlota/Cactus pit in terms of volume. The breccia is composed of variably altered Quartz-Muscovite Schist clasts derived from the Pinal Schist. Other fragments in the breccia appear to be derived from the Schultze Granite, quartzite units of the Apache Group, and other intrusive rocks. The breccia is typically chaotic and unsorted, with clasts generally quite angular and ranging from house-size boulders down to sand-size fragments. Limonite coating on clasts, as well as limonite disseminated within clay matrixes, impart a characteristic red color to the breccia. The preserved thickness of the breccia exceeds 600 feet, and vague layering preserved in the deposit dips moderately northeast. The breccia appears to be of sedimentary origin and likely represents an ancient subaerial landslide deposit. The Cactus Breccia would be exposed in the walls of the final Carlota/Cactus and Eder North pits.

Stratigraphically, the Cactus Breccia is overlain by the Apache Leap Tuff. The tuff is dacitic in composition, generally welded, and often exhibits a crude subhorizontal layering. An approximately 10-foot-thick black vitrophyric (glassy) zone commonly occurs near the base of the tuff. A thin ash layer is also present locally near the base of the tuff. The tuff is a significant ore host in the Carlota project area and would comprise portions of the upper zones in the walls of the final Carlota/Cactus and Eder pits.

The Gila Conglomerate is present in the northeastern part of the area and locally appears to be weakly mineralized. The Gila consists of poorly sorted alluvial fan deposits that record a period of erosion, deposition, and uplift that predates the current period of tectonic activity. Regionally, the Gila is a major ground water aquifer, as discussed in Section 3.3.1.3, Water Resources - Ground Water.

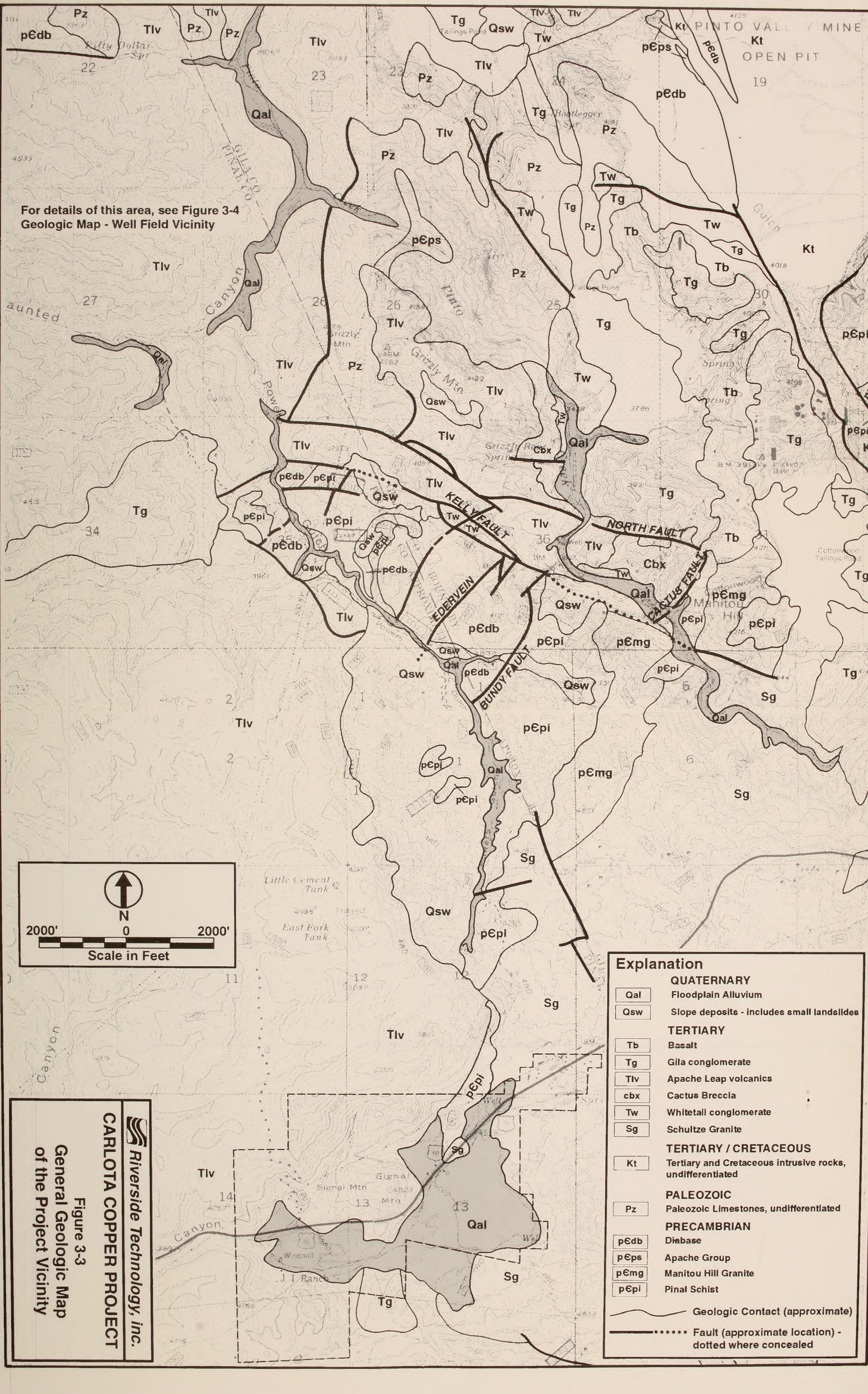

Figure 3-3
General Geologic Map of the Project Vicinity

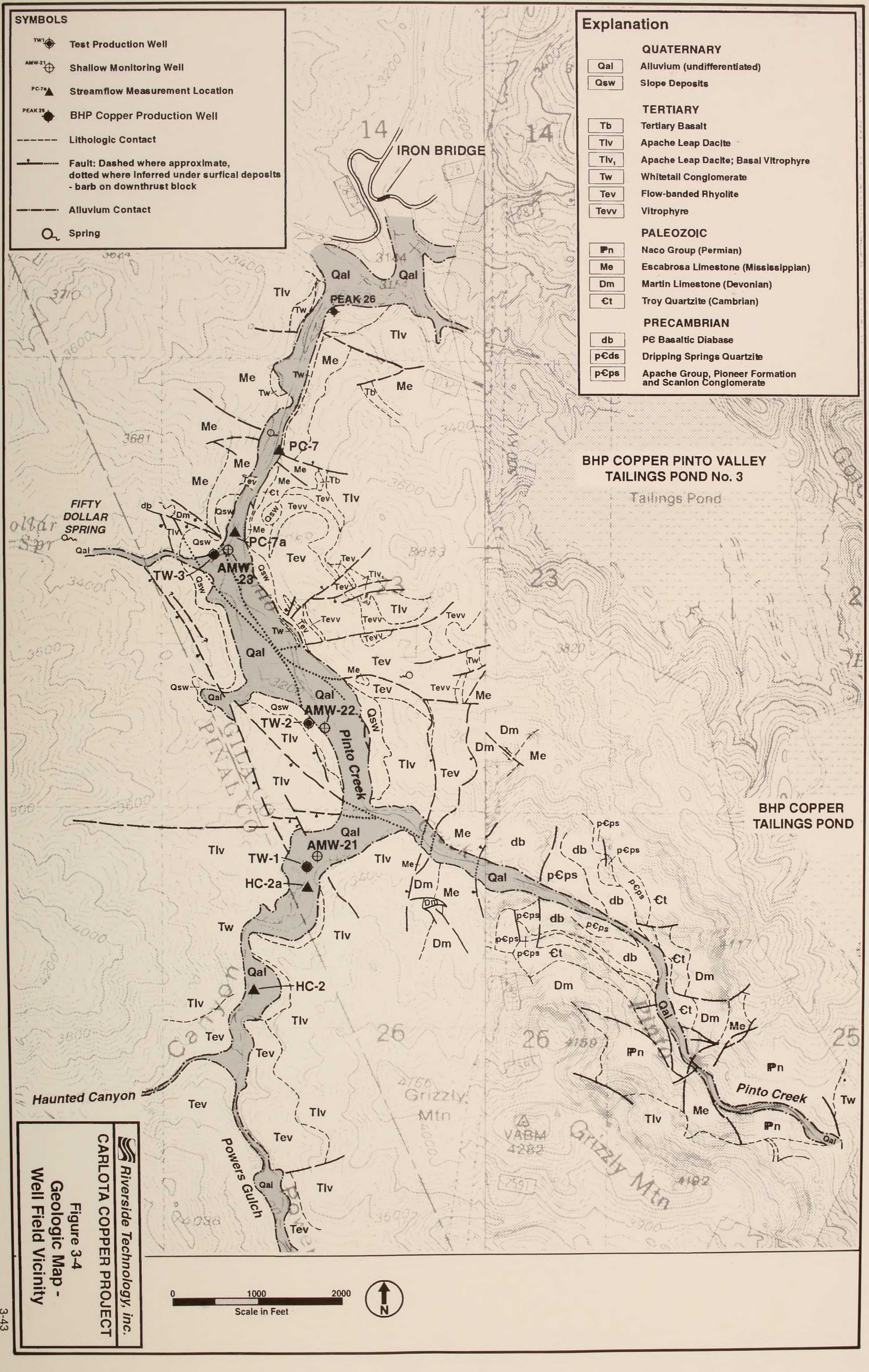

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Figure 3-4
Geologic Map -
Well Field Vicinity

Bedrock Structure

The rocks within the mineral district have been extensively faulted. Some of the faults appear to have contributed to, or controlled, the occurrence of the mineralization. Most of the recognized faults occur along two primary trends: a north to northwestern trend and a northeastern trend. The northeastern faults are associated with mineralization throughout the district and are presumably deep-seated. In addition, these structures appear to be the overall controlling structure for the mineral district; all of the productive mineral deposits in the district are located within a 6-mile-wide northeast-trending band (Peterson 1962).

Major fault block structures have developed in the project area as a result of Tertiary extensional tectonics that affected the region. The north-trending Castle Dome Horst, hosting the Pinto Valley Mine, and the northwest-trending Cactus Graben, hosting the Carlota/Cactus deposit, are the two most significant structural features in the area.

The Cactus Graben consists of a 1,200- to 1,500-foot-wide block that is bound by two northwest-trending parallel faults: the Kelly fault (forms the southern boundary) and the North fault (forms the northern boundary). Movement along the Kelly fault zone was initiated after the emplacement of the breccia in this area. Based largely upon the absence of both breccia and dacite to the south of the fault, the Kelly fault is postulated to have been responsible for several thousand feet of oblique-slip movement. Less movement appears to have occurred on the North fault. In general, the Kelly fault, North fault, and Cactus fault (described below) define the boundaries of the Carlota/Cactus ore body.

The Cactus Breccia is separated from the underlying Precambrian rocks in the Cactus Graben by a 4- to 10-foot-wide, gently dipping fault zone that is referred to as the Cactus fault. This structure may be a remnant of the basal slide plane of the Cactus Breccia, or it may be a thrust fault that developed after the breccia was deposited.

Surficial Deposits

Surficial deposits identified on or near the project facilities and in the well field area include alluvium and undifferentiated slope deposits (*Figures 3-3 and 3-4*).

Alluvium occurs in the floodplain adjacent to Pinto Creek, Powers Gulch, and Haunted Canyon, as well as along several tributary washes in the project area. The alluvium consists of unconsolidated silt, sand, gravel, and boulders. Alluvial deposits are most extensive along Pinto Creek, where the deposits range from 80 to 500 feet in width and up to 30 feet deep (Montgomery & Associates, Inc. 1992).

Undifferentiated slope deposits cover extensive areas adjacent to Powers Gulch, particularly between the Eder North and Eder South pits, in the southern portion of the proposed heap-leach area, and locally along the slopes adjacent to Pinto Creek. These deposits are composed of talus, colluvium, and landslide debris. Talus consists of accumulations of rock fragments of any size or shape that have been heterogeneously deposited by nature at the base of steep slopes. Colluvium develops from the downslope movement of soil and weathered rock caused by slope wash and soil creep processes. Landslide debris generally consists of chaotic mixtures of soil and rock fragments that were deposited by the downslope gravitational movement of these materials (Transportation Research Board 1978). The actual existence, as well as the depth and age, of specific landslide deposits has not been determined.

3.2.1.3 Historic Mine Workings

The locations of known historic mine workings in relation to the proposed mine facilities are shown in *Figure 3-5*. These workings include shafts, shallow prospect pits, side-hill cuts, and adits (drifts) located in Pinto Creek valley and Powers Gulch. Minor amounts of fill typically occur in the vicinity of these prospects and along access roads. These deposits consist of loose soil and rock material. Because of their limited extent, these deposits are not distinguished on the surficial geologic map. However, the general location of these deposits can be inferred from the locations shown on the map of existing mine workings (*Figure 3-5*).

3.2.1.4 Faulting and Seismicity

An active fault is one that shows evidence of displacement during the Holocene (last 10,000 years), and a potentially active fault is a fault that shows evidence of surface displacement during the Pleistocene (last 2,000,000 years). Recent mapping conducted by the Arizona Bureau of Geology and Mineral Technology indicates that there are no known active or potentially active faults in the vicinity of the project site. The nearest potentially active fault in the region is located near the southern shore of Roosevelt Lake, approximately 20 miles north of the project site (Scarborough et al. 1986, Peartree and Scarborough 1984).

The project site is located within a moderately active seismic region. As indicated in *Table 3-24*, four significant earthquakes have affected the area in recent historic times. The largest earthquake was an estimated 7+ Richter magnitude event centered in northern Mexico in 1887. This earthquake was reportedly felt throughout the southwest. The other three seismic events that affected the area were moderate earthquakes centered in the region near Globe, Miami, and San Carlos (30 miles east of the project site).

All four earthquakes produced an estimated modified Mercalli intensity of VI in the project vicinity (DuBois et al. 1982). Intensity VI corresponds to moderate ground-shaking and minor damage, as detailed on the Modified Mercalli Intensity Scale presented in *Table 3-25.*

3.2.1.5 Mineralization

The information on mineralization presented below is based on the visual examination of surface exposures, drill core and cuttings, and associated petrographic work, as presented in the *Update to the* Plan of Operations (Carlota 1993a).

The Cactus Breccia is the primary host rock for mineralization in the Carlota/Cactus and Eder North deposits. Important mineralization also occurs in the dacite overlying the Cactus Breccia, in the Carlota deposit, and along approximately 3,300 feet of the Kelly fault, which bounds the Cactus and Carlota deposits to the south. Mineralization along the Kelly fault is hosted in brecciated diabase (northwest segment) and Pinal Schist (southeast segment). Mineralization in the Eder South deposit is hosted within fractured and brecciated Pinal Schist.

Chrysocolla (hydrous copper silicate) is the dominant ore mineral in all of the deposits; however, significant amounts of chalcocite (copper sulfide) and malachite (copper carbonate) also occur locally. Black copper pitch and/or neotocite (copper, magnesium, and iron oxide) occur(s) locally with chrysocolla. Iron oxides and pyrite (iron sulfide) occurs within local zones in the Cactus Breccia. Clays and iron oxides (hematite) can locally contain significant amounts of copper.

Chalcocite, the only copper sulfide mineral identified, is restricted to isolated zones within the lower parts of the Cactus deposit. The Chalcocite occurs as rimmings or partial to total replacements of pyrite (iron sulfide). Pyrite occurs as both veinlets or disseminated grains within individual breccia fragments.

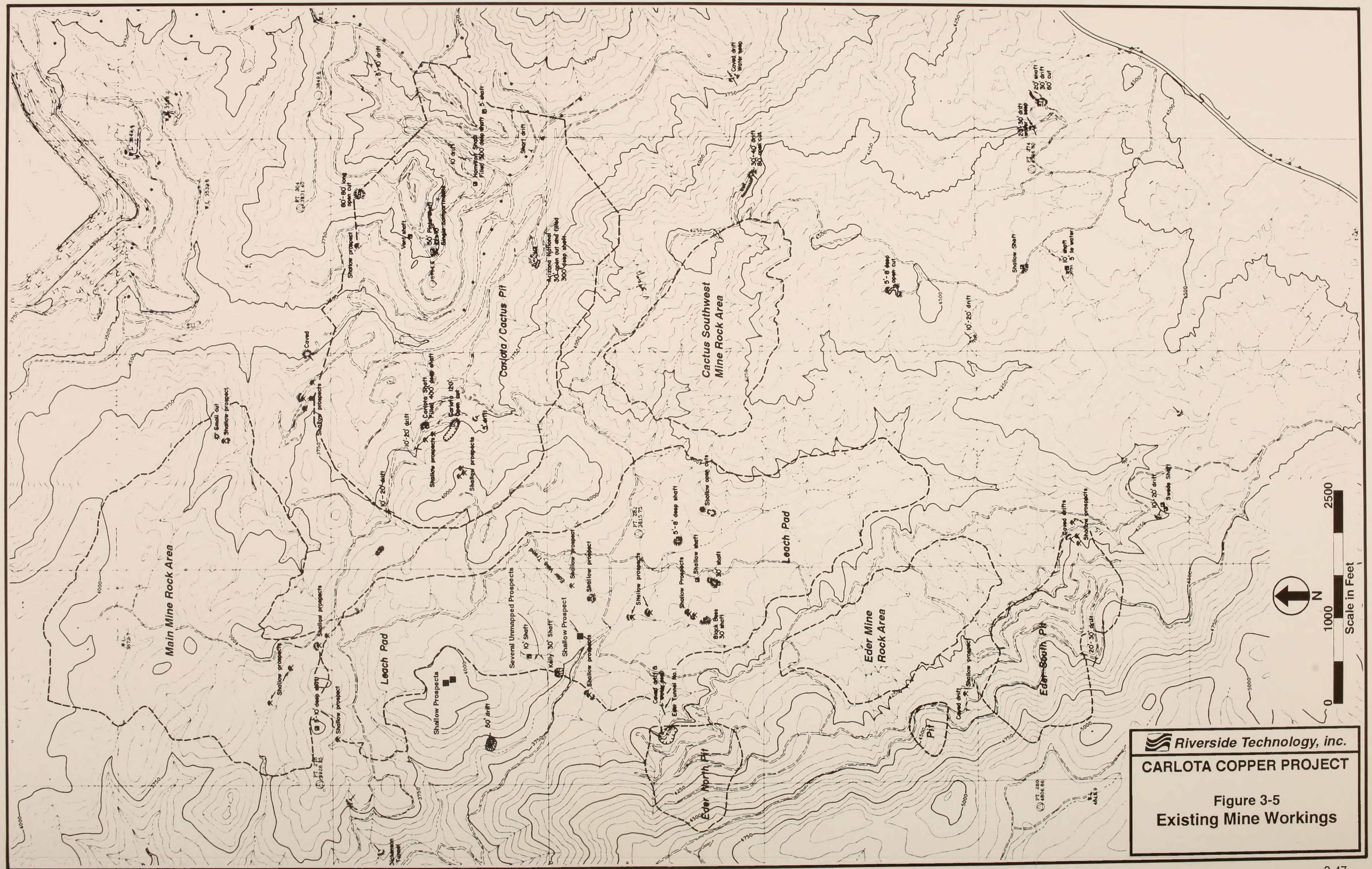
<u>Carlota/Cactus Deposits</u>

The extent and grade of mineralization at the Carlota Copper Project has been determined from extensive drilling, sampling, and assaying. The results of the drilling are presented on cross sections in the Plan of

Table 3-24. Seismic Events Affecting the Site Between 1776 and 1980

Date	Location (nearest town)	Approximate Distance from Site (miles)	Richter Magnitude	Modified Mercalli Intensity in Vicinity of Site
May 3, 1887	Batepito, Mexico	150	7.25±[1]	VI
June 17, 1922	Miami, Arizona	10	unknown	VI
September 11, 1963	Globe, Arizona	15	4.1	VI
December 25, 1969	San Carlos, Arizona	30	4.4	VI

[1]Estimated from historic data
Source: DuBois et al. (1982)



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CARLOTA COPPER PROJECT

Figure 3-5
Existing Mine Workings

Table 3-25. Descriptions of the 12 Levels of Earthquake Intensity on the Modified Mercalli Scale

I. Not felt.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks, or sensation of a jolt like a heavy ball striking the walls. Standing automobiles rock. Windows, dishes, doors rattle. Wooden walls and frame may creak.

V. Felt outdoors; direction estimated. Sleepers waken. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc. off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked.

VII. Difficult to stand. Noticed by drivers of automobiles. Hanging objects quiver. Furniture broken. Weak chimneys broken at roof line. Damage to masonry D, including cracks; plaster, loose bricks, stones, tiles, and unbraced parapets fall. Small slides and caving in and along sand or gravel banks. Large bells ring.

VIII. Steering of automobiles affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Stucco and some masonry walls fall. Chimneys, factory stacks, monuments, towers, elevated tanks twist and/or fall. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling breaks off. Branches break from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted, shift off foundations. Frames racked. Serious damage to reservoirs. Underground pipes break. Conspicuous cracks in ground and liquefaction.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shift horizontally on beaches and flat land. Rails bend slightly.

XI. Rails bend greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.

Masonry A: Good workmanship and mortar, reinforced designed to resist lateral force.
Masonry B: Good workmanship and mortar, reinforced.
Masonry C: Good workmanship and mortar, unreinforced.
Masonry D: Poor workmanship and mortar and weak materials, like adobe.

Source: Blair and Spangle (1979)

Operations (Carlota 1992). The Carlota and Cactus deposits are adjacent to each other and would be mined together in the Carlota/Cactus pit. The Cactus deposit is defined as being east of Pinto Creek; the Carlota deposit is defined as being west of Pinto Creek. Significant mineralization is noted for roughly 3,600 feet along the length of the two deposits, as well as in the Cactus Breccia and the Kelly fault, and locally within the dacite. This zone of mineralization extends to a depth of up to 600 feet in the Carlota deposit and 400 feet in the Cactus deposit.

Within the Cactus deposit, only oxide-type mineralization is found in outcrops, while a mixed oxide-sulfide mineralization occurs at depth. The Kelly fault defines the southern and western limit of mineralization in both the Carlota and Cactus deposits and contains oxide mineralization over widths of 10 to 70 feet, with typical grades of 0.6 to 1.0 percent copper. Mineralization in both deposits is generally floored by the low-angle Cactus fault, which separates the overlying mineralized Cactus Breccia from underlying, generally barren Pinal Schist. Mineralization in both deposits appears to be strongest (greater than 0.50 percent total copper) adjacent to or in close proximity to the Kelly fault, with diminishing intensity farther away from the fault. However, significant mineralization is present up to 1,000 feet away from the fault toward the east.

Mineralization in the Carlota deposit is entirely of the oxide type, while mixed oxide-sulfide type ore would be mined in the Cactus deposit. Over much of the Cactus deposit, the oxide-sulfide boundary, defined as where the ratio of nonsulfide copper to total copper is less than 50 percent, mimics the current ground water table and is as close as 50 feet to the surface. Where sulfide mineralization (chalcocite) is present, it is generally quite uniform and consistent, often grading approximately 0.7 percent copper, but with multipercent grades often present immediately below the oxide-sulfide boundary. Surface mineralization in the Cactus deposit is generally present as chrysocolla, which appears to have formed after preexisting malachite. Malachite is the most common oxide mineral that occurs between the surface and the oxide-sulfide boundary.

Essentially all of the ore in the bottom of the Cactus deposit, including the mixed sulfide-oxide ore, would be mined. As a result, little, if any, sulfide material would remain in the bottom or sides of the pit at the conclusion of mining. In the Carlota deposit, and in the segment of the pit between the Carlota and Cactus deposits, some ore would remain below the final pit floor. Although this ore meets the 0.15 percent copper cutoff grade, it is not economically feasible to mine because of the increased stripping required to enlarge the pit to extract the ore and the relatively low grade of the material.

Eder North and South Deposits

Mineralization in the Eder North deposit is hosted within the Cactus Breccia, which apparently infills a northeast-southwest trending depression into the underlying Pinal Schist and Whitetail Conglomerate. The north and south limits of the deposit are poorly defined, but the deposit is known to extend roughly 1,000 feet across the axis of the channel. The eastern limit is defined by erosion, while the western limit, although poorly defined, is known to extend for over 1,300 feet downward from the surface exposure, under the overlying, essentially barren Apache Leap Dacite. However, an economic limit is imposed in this direction because of the westwardly dip of the breccia into the steep, dacite-capped ridge.

Mineralization in the Eder South and Eder Middle pits occurs mainly as chrysocolla along fractures within the Pinal Schist. The mineralization in these pits consists of copper oxide; no sulfide mineralization has been found. Significant (greater than 0.15 percent) near-surface copper mineralization in the Eder South pit is present over an area measuring roughly 2,400 feet (north-south) by 1,000 feet (east-west). Mineralization often extends from the surface to depths of roughly 200 to 300 feet; the base of the mineralization is at approximately 4,200 ft-amsl. The western portion of the deposit is overlain by essentially barren Apache Leap Dacite, and the eastern edge of the mineralization is defined by erosion. As with the Eder North pit, mineralization is known to extend at least 1,000 feet west of the outcropping zone under the dacite cap that forms a steep ridge; however, because of the depth to this segment of the ore body, as well as the ore grades, mining this portion of the ore body is not considered economically viable. The mineralization to the north and south of these pits appears to diminish gradually, perhaps related to a lack of faulting and ground preparation. Near the south end of the deposit, the mineralization appears to increase along the east-west-trending structural/ intrusive boundary of the Schultze Granite and then diminish within the granite further to the south.

Mineral Reserves

The mineral reserve is defined as the in-place mineral inventory without the imposition of economic constraints. The mineral reserve was estimated from the computer block model of the deposits and was based on data from all of the exploration drill holes (Carlota 1993a). The reserve estimates are based on an ore cutoff grade of 0.15 percent total copper. The resulting geologic resource for the three-pit area totals approximately 140 million tons (Carlota/Cactus, 95 million tons; Eder South, 31 million tons; and Eder North, 14 million tons).

The mineable reserve is defined as the portion that can be economically recovered and has been determined for the Carlota/Cactus, Eder South, and Eder North deposits. The mineable portion of these deposits is calculated based on the pit geometry, which is determined using a computer-generated floating cone. The floating-cone computer algorithm uses the computer block model of the ore body, current economics, and operating costs to estimate the break-even economic limits of a pit. The estimated production costs were based on previous studies and actual costs from similar-size mines and SX/EW plants. The copper recoveries are based on column tests run on the various ore types.

The mineable reserves are summarized in *Table 2-1*. The reserves presented in this report are the sum of proven and probable reserves. The current mine plan would recover approximately 72 percent of the available resource (approximately 100 million tons of mineable ore out of the estimated 140-million ton mineral reserve). Remaining mineral reserves would include approximately 14 million tons within the Carlota/Cactus deposit and approximately 25 million tons within the Eder deposits. These reserves are not considered economically recoverable at this time.

Other Mineral Deposits

Drilling conducted by Carlota during the exploration phase of the project has thoroughly defined the economic-grade copper mineralization (grading greater than 0.15 percent copper) within the area of the planned Carlota/ Cactus, Eder North, and Eder South pits. The initial geological investigations also delineated areas within the project site that were determined to be economically unfavorable for the development of mineral deposits. Other drill holes, including bedrock monitoring wells, geotechnical holes, and ground water test wells, were routinely assayed for copper. Additional condemnation drilling was conducted to determine if any possible economic copper or other mineralization existed in areas planned for the mine rock areas, heap-leach pile, and processing facilities. The results of these combined geological investigations indicate that no mineralized areas exist within the project site other than the Carlota/Cactus and Eder orebodies.

3.2.2 Environmental Consequences

Issues related to geology and minerals for the proposed Carlota Copper Project include (1) impacts to potential future development of mineral resources, and (2) creation or exacerbation of geologic hazards from project operations that affect project facilities.

The evaluation criteria used to analyze the impacts of the proposed action and alternatives on geology and minerals are given below:

- Results of condemnation drilling within the project area and the identification of non-leachable ores
- Local and regional geologic characteristics
- Geological instability associated with project facilities (slope stability analysis of mine rock areas, pits, and leach pad) and with mining activities (adits and shafts)

3.2.2.1 Proposed Action

The direct impacts of the proposed action on geologic and mineral resources would include (1) the generation of approximately 211 million tons of mine rock to be left on the site in reclaimed mine rock areas and as partial backfill for the Carlota/Cactus pit and the Eder North and Eder South pits, (2) the generation of approximately 100 million tons of spent ore to be left in the closed and reclaimed heap-leach facility, and (3) the extraction of 900 million pounds of copper from the geologic resource. Under the proposed action, these direct impacts would not be mitigated.

Additional direct impacts could include the effects of ground vibration on nearby residences caused by blasting, as discussed below. Potential water quality impacts caused by the heap-leach and mine rock facilities are discussed in Section 3.3, Water Resources.

Indirect impacts from the proposed action could include subsidence around pre-existing mine workings and induced slope instability and seismic ground shaking, as discussed below. Surficial materials would be altered over approximately 1,428 acres. Land disturbance could potentially increase erosion and sedimentation; the potential impacts from increased erosion and sedimentation are addressed in Section 3.3, Water Resources, and Section 3.4, Soils and Reclamation.

Ground Subsidence

Ground subsidence over existing historic mine openings is a potential hazard on the project site. Mineral exploration and mine development activities occurred on the site intermittently between 1908 and 1929 (Peterson 1962). The locations of the known mine workings and prospects are shown in *Figure 3-5.* The major underground workings are located within the footprint area of the Carlota/Cactus pit and the heap-leach pad. These included the 400-foot-deep Carlota Shaft, the 500-foot-deep Hamilton Shaft, the 300-foot-deep Arizona National Shaft, and 6,500 feet of lateral workings on three levels driven off the Hamilton Shaft. These workings are inaccessible and partially filled in or buried. The proposed Carlota/Cactus pit would remove most of the buried mine workings and shallow surface openings in this area. Six additional shallow shafts, with openings ranging from 5 to 30 feet deep, and several other shallow workings have been identified within the footprint of the leach pad. There is little, if any, information on the original depth, lateral extent, or amount of backfill already present in these workings. If not properly backfilled, the potential exists for settling and/or subsidence to occur beneath the heap, resulting in a tear or puncture in the leach pad liner. A break in the liner material could result in process solutions entering into the ground water system.

Carlota has provided a plan and conceptual drawings for backfilling and sealing existing mine workings (Carlota 1994a). This plan has been incorporated into the proposed action. Under the proposed action, all shafts would be decommissioned by backfilling them with rock to within 5 feet of the surface. The walls would be excavated to a 1:1 (H:V) slope. The remaining opening of the shaft would be sealed with mass concrete. Adits that are 6 feet or greater in diameter would be cleaned to their full extent and backfilled with mass rock fill to within 15 feet of the portal. The outer 15 feet of the adit would be sealed as a cast-in-place concrete bulkhead. Adits that are less than 6 feet in diameter would be backfilled from the back of the adit forward using the tremie method and capped at the surface with a cast-in-place concrete bulkhead. Other adits or near horizontal workings located in areas where minor subsidence is unlikely to damage any of the project facilities would be backfilled with rock and sealed at the surface with a concrete bulkhead. Additional mitigations for sealing the mine workings are provided in Section 3.2.4, Geology and Minerals - Monitoring and Mitigation Measures. If properly executed, these procedures should mitigate potential subsidence or the potential for infiltration of fugitive process solutions.

Landslides and Slope Stability

Landslides are a potential hazard in mountainous terrain and could potentially damage any facility located within the landslide pathway. Landslides can also be induced by placing mine rock piles or heap-leach facilities on potentially unstable slopes. Adverse geologic structures and ground water conditions encountered in the pit can result in failure of the pit walls, endangering workers and facilities in the pit or on the rim of the pit.

Based on concerns regarding slope stability in some key areas of the project (USDA Forest Service 1994) the Forest Service requested the U.S. Geological Survey (USGS) Branch of Earthquake and Landslide Hazards to perform a field reconnaissance and review of geologic data to evaluate the potential risk associated with the project from slope instability. In the area of the Eder slope west of Powers Gulch, the USGS observed little evidence of large-scale landslide deposits, identifying only small rock-fall, debris-flow, and possible debris-avalanche deposits estimated to be relatively shallow (generally 0 to 15 feet thick, locally up to a maximum of 15 to 30 feet thick) (Ellis and Baum 1995). In addition, no evidence was found of large-scale block slides in the ridge area between the Carlota/Cactus pit and the Cactus Southwest mine rock disposal area. The rocks appeared to be competent and maintaining steep slopes. The USGS concluded that careful investigation, design, and implementation practices should prevent any potential problems from becoming a serious threat to mining operations or to permanent post-mining features, such as the pits, diversion systems, or leach pad. Following the USGS study, Carlota conducted a geological investigation that included a subsurface investigation in the western portion of Powers Gulch in the vicinity of the Eder pits and Eder mine rock disposal area (Womack & Associates 1996a). The results of this investigation generally agreed with those of the USGS and indicated that large-scale slumping or other forms of landsliding have not occurred in this area. However, an apparent shallow slip surface was observed in a test trench located near the toe of the proposed Eder mine rock disposal area that could potentially result in instabilities in the Eder mine rock disposal area. Therefore, mitigation is proposed in Section 3.2.4, Geology and Minerals - Monitoring and Mitigation Measures, for site-specific slope improvement measures to be developed prior to construction.

The potential for landslides, slope failure in or beneath the mine rock piles, or failure of the pit walls has been evaluated by Call and Nicholas, Inc. (1992, 1993). Along an east-west section in the northern part of the Main mine rock disposal area, the factor of safety under the most favorable conditions was 1.13. Assuming that less than ideal seismic and drainage conditions are likely to exist during the life of the project (including the reclamation phase), there may be inadequate protection against mass failure in this area. Small localized rock slides along the face of the dumps and rock avalanche-type failures are not uncommon on rock dumps. These types of failures are generally unavoidable and could affect the immediate area downslope from the dumps.

Slope stability problems in the Carlota/Cactus pit could occur because of the presence of the basal ash layer associated with the Apache Leap Tuff unit. Additional drilling is necessary to determine the continuity and orientation of the ash layer in the northeastern segment of the pit. If the ash layer is continuous and adversely oriented, it could create a weak zone in the pit wall and could potentially cause a slope stability problem. Although the risk appears to be relatively low, a large failure in the north segment of the pit wall could potentially damage the Pinto Creek diversion channel. In any of the pits where the rocks exhibit near-vertical fractures, rock toppling could occur. Several proposed facilities are situated within proximity to the final pit rim, including the SX-EW plant, the stockpile and secondary crushing area, and the mine shop/warehouse area. Depending on the location and extent of slope failure, there is some potential for future slope instability of the pit wall to damage facilities.

Portions of the original pit walls would remain in the Carlota/Cactus pit and the Eder North and Eder South pits following project reclamation and closure. After some period of weathering, it is likely that portions of the pit walls would eventually experience some degree of slope failure. Typical slope failures that occur in steep rock cuts of this nature include rock falls, toppling, and localized block slides. Mitigation measures for postclosure pit wall instability are addressed in Section 3.2.4.2, Geology and Minerals - Slope Stability.

Stability analyses were also conducted by Knight Piésold and Company (1995a) on the proposed heap-leach pad and the process solution ponds. Based on these analyses, the leach pad and the pond embankment designs were determined to be structurally stable under static and seismic loading conditions (Knight Piésold 1995a).

The proposed Powers Gulch diversion channel traverses the lower portion of the western valley slope that flanks Powers Gulch. Existing access roads in the vicinity of the alignment suggest most of the diversion would be constructed in intact bedrock. However, the alignment crosses swale areas and shallow ravines that are covered by slope deposits. These slope deposits probably include talus, colluvium, and shallow landslide deposits. Since these deposits occur on a relatively gentle slope, and appear to be relatively thin, major slope stability problems along the alignment are not anticipated. Although the risk appears low, there is some potential for small failures (i.e., debris slides, debris flows) to impact or damage the diversion during operation and postclosure. Failure of the diversion could damage the heap-leach pad. Impacts from this type of failure are addressed in Section 3.3, Water Resources.

Debris flows are rapidly moving landslides initiated after prolonged and intense rainfall in relatively steep areas covered by granular soils. Debris flows typically originate near the head of a steep ravine, travel down the ravine channel, and are deposited where the slope flattens or opens into a valley. Since the Pinto Creek diversion is located in a relatively broad valley with a moderate gradient, the risk of debris flows impacting the diversion is considered to be low.

The water pipeline between the well field and the processing facilities and the transmission line traverse areas of bedrock exposure or shallow soils over bedrock. Based on the known conditions, significant landslide or slope stability problems are not anticipated.

The proposed water supply access road from the Iron Bridge to the well sites would follow along the lower portion of the western side of the Pinto Creek valley. Based on the available maps, the road would be constructed on relatively steep sideslopes with gradients that range from approximately 1.5:1 to 2:1 (H:V). The road in this area would be located outside and above the alluvial valley floor. Because of the steep terrain, the road would require grading to cut the bedrock slopes and to fill the swales and gullies. The distance the cut and fill slopes would extend upslope and downslope from the roadway would depend on the design cutslope and fill slope angle.

Although there are no known landslides in this area, there is always some risk of inducing slope failures when cutting along the toe of a steep slope. In addition, considering the steep terrain, both the cut slopes and fill slopes would be susceptible to accelerated erosion. Given the close proximity of the road to Pinto Creek, it is likely that even with standard erosion control measures in place, there may be some increase in sedimentation into Pinto Creek from the road construction. If the grading activity induced a major slope failure (landslide), the failure could contribute a large influx of material into Pinto Creek.

Seismicity

The Uniform Building Code places the site within Seismic Zone 2, which corresponds to a 5.6 Richter magnitude event and a maximum intensity of VII. Based on the historic seismicity outlined in *Table 3-24*, moderate seismic events could potentially affect the site during the life of the project. Deformation analyses performed by Knight Piésold and Company (1993b) on the leach pad and PLS ponds concluded that during seismic shaking, significant permanent deformation of the designed structures would be highly unlikely. Design and construction procedures for the mine facilities, heap-leach pad, mine rock disposal areas, and mine pit slopes are expected to adequately minimize the potential for seismic damage or seismically induced slope stability problems.

Blasting

Mining would be conducted using conventional bench highwall techniques with benches created as part of ore and mine rock extraction. Benches would be drilled and shot with ammonium nitrate and fuel oil (ANFO) as the blasting agent. A major concern with blasting is the potential effects of ground vibration on nearby residences. The Office of Surface Mining Reclamation and Enforcement (OSMRE 1987) has developed regulations designed to protect the general public from the potential effects of blasting. These regulations are based on extensive research conducted by the U.S. Bureau of Mines (USBM) to quantify ground vibration and air blasts and their effects on structures. The potential impacts of blasting-induced ground vibration to residential structures in the vicinity of the Carlota Copper Project were evaluated based on these regulations using (1) the maximum charge weight per 8 millisecond delay (provided by Carlota 1995f), (2) the minimum distance between existing residential structures and the blast point (scaled distance between the nearest Top-of-the-World residence and the Eder South Pit), and (3) calculated peak particle velocity and scaled-distance factors as defined by OSMRE (1987). The calculated peak particle velocity and scaled-distance factors were then compared with the maximum allowable peak particle velocity and scaled-distance factors established by OSMRE to protect residential structures.

The results of this evaluation are summarized in *Table 3-26*. These results indicate that the maximum charge weights and generated peak particle velocities are below the maximum values allowed using either the USBM criteria or OSMRE regulations. The USBM criteria for peak particle velocity are sufficiently conservative as "to provide essentially 100 percent

Table 3-26. Blasting Vibration Evaluation

	Calculated Values[1]	USBM Criteria (USBM 1980)	OSMRE Maximum Allowable Values (OSMRE 1987)
Explosive Weight Per 8 Millisecond Delay	3,660	- - -	5,831[3]
Peak Particle Velocity (inches per second)	0.27[2]	0.5 to 2.0	1.0

[1]Based on blasting design information provided by Carlota assuming a maximum charge weight of 3,660 pounds per delay (915 pounds per blast hole multiplied by 4 blast holes) and a minimum distance of 4,200 feet between the Eder South Pit and Top-of-the-World.
[2]Estimated maximum horizontal particle velocity based on the minimum scaled distance between the Eder South Pit and Top-of-the-World and a conservative two standard deviations from the mean regressions value for measured vibrations at a large variety of sites (USBM 1980).
[3]Based on the recommended scaled distance factor of 55 (Page 23, OSMRE 1987) and scaled distance of 4,200 feet.

protection of such structures, regardless of repair" (Siskind 1994). Since the maximum allowable criteria established by the USBM and OSMRE would not be exceeded and were established to protect residential structures, blasting as proposed by Carlota is not anticipated to result in damage to structures or property in the vicinity of the project.

Research conducted by the USBM (Siskind and Kopp 1987), which included monitoring numerous residential wells near blasting sites, concluded that no significant impacts to water wells were observed from vibration levels at or below the levels established to protect residential structures (Siskind 1994). Based on the proposed blasting design, no adverse impacts to water wells from blasting are anticipated.

3.2.2.2 Alternatives

<u>Mine Rock Disposal Alternatives</u>

Alternative Mine Rock Disposal Sites. The alternative Cactus South and Cactus Central mine rock disposal areas would increase the total disturbed area of the project by approximately 44 acres. Since there are no known mineral deposits in the footprint area of these alternative mine rock disposal sites, this alternative would have no impact on the mineral resource. In addition, there are no known geologic hazards, such as landslides, in the vicinity of these alternative mine rock and disposal sites.

Additional Backfill of the Carlota/Cactus Pit. The placement of backfill in the Carlota/Cactus pit to the approximately 3,520 ft-amsl elevation of Pinto Creek would decrease the overall slope height and thereby increase the long-term stability of the pit walls. The backfill would also eliminate the potential for a failure of the north margin of the pit wall to adversely affect the Pinto Creek diversion channel.

Approximately 14 million tons of mineral resource (greater than 0.15 percent copper) would remain beneath the floor of the western and central portion of the pit after mining ceases. Since the market for copper is volatile, there is some possibility that this remaining mineralization may become economically viable in the future. However, by placing the additional backfill into the pit, these mineral reserves would be essentially rendered uneconomic to recover in the future.

Additional Backfill of the Eder South Pit. Decreasing the overall slope height in the Eder South pit from 710 to 570 feet by placing additional backfill would tend to incrementally increase the long-term stability of the pit wall. However, slope failures may still occur over time because of the weathering of the over-steepened bedrock. Use of the material from the Eder mine rock disposal area for both backfill and capping material for the heap leach pad at closure would remove all of the material in the disposal area. Removal of the disposal area would increase long-term stability of the Eder slope and Powers Gulch areas and reduce threats to the diversion system and leach pad. Approximately 25 million tons of mineral resource (greater than 0.15 percent copper) would remain at the conclusion of mining. Since the remainder of the mineral reserve is located at a greater depth in a southwest direction from the pits, the location of the additional backfill should not inhibit any future attempt to recover these deposits.

Leach Pad Alternative

Eder Side-Hill Leach Pad Alternative. A portion of the alternative heap-leach site is located on an east-facing slope that descends from below the ridge that hosts the Eder ore deposits to Powers Gulch. The slope has an approximate average gradient of 3:1 (H:V). As shown on the geologic map (*Figure 3-3*), large portions of this slope area are covered by slope deposits that include talus, colluvium, and possibly small, localized landslide deposits. Exploration roads constructed in this area have typically encountered bedrock at shallow depths. The subsurface conditions inferred from condemnation drill holes, monitor wells, and geotechnical boreholes and test pits completed in this area indicate that these slope deposits are up to 20 to 30 feet thick. Some of these deeper slope deposits may include intact weathered bedrock. Present data indicate that there is no subsurface evidence to support the existence of any large or deep-seated landslides in the vicinity of the alternative heap-leach site; however, evidence does indicate the possibility that there may be smaller isolated landslide deposits within the slope deposit material. Depending on the location and physical characteristics of these materials, they could potentially pose a risk to the short- and long-term stability of this alternative heap-leach site.

The overall slope stability of the side-hill leach pad alternative is marginal and requires special features, such as a large toe berm (ranging from approximately 40 to 50 feet in height), to maintain a minimum factor of safety. Knight Piésold and Company's (Carlota 1994b) preliminary analyses indicate the minimum factors of safety for this scenario were 1.3 for static and 1.0 for pseudostatic. These factors of safety are less than the minimum factors of safety (1.5 static and 1.1 pseudostatic) used for dam design. Based on both the uncertainty regarding the subsurface conditions underlying the alternative site, and relatively low factors of safety for the design, there appears to be some risk regarding the short- and long-term stability of this heap-leach alternative. As a result, there appears to be a greater risk of slope failure impacting the heap during both operation and closure for this alternative compared to the proposed heap-leach location.

Water Supply Alternative

Low-Quality Water, Water Supply Wells, and Dewatering Wells. This alternative would require the construction and maintenance of several miles of pipeline through mountainous terrain. The engineering geologic and geotechnical conditions have not been assessed along the pipeline alignment. For any pipeline traversing moderately steep slopes, the potential exists for the pipeline to be damaged by land slides or rockfall. These risks could be reduced by adjusting the alignment during final design based on the results of engineering geologic analysis.

Alternative Water Supply Well Field Access Roads

A summary of the potential impacts of the well field access road alternatives is presented in *Table 3-27* and is discussed below. Evaluations listed in *Table 3-27* would reflect potential conditions until BMPs are implemented.

Access Road Alternative A. This alternative access would restrict the amount of new disturbance to the alluvium in the valley floor of Pinto Creek. Sections of this access road would flood and become inaccessible during periods of high flow in Pinto Creek. The flooding and movement of coarse material down the drainage could require periodic regrading and road maintenance. Disturbed soils could be susceptible to erosion and could cause increased sedimentation in Pinto Creek. These potential effects would be minimized by implementation of adequate road drainage and erosion and sedimentation controls similar to those described in the proposed action.

Access Road Alternative B. This alternative access road alignment would require the construction of a new road from existing Forest Service Road 287A down a moderate gradient along the Fifty Dollar Spring drainage to the existing well field access road.

Table 3-27. Potential Geologic Considerations Associated with the Well Field Access Road Alternatives

	Proposed	Alternative A	Alternative B
Slopes	steep	gentle	moderate
Cuts and Fills Required	many	few, if any	some
Estimated Risk of Induced Slope Instability (landslides)	moderate to high	low	low to moderate
Potential for Accelerated Erosion[1]	high	moderate	low to moderate
Potential for Increased Sedimentation in Pinto Creek[1]	high	moderate to high	moderate
Potential for Damage during Flooding[1]	low	very high (probably unavoidable)	low to moderate

[1]The potential for significant impacts from these considerations would be minimized by erosion and sedimentation controls and implementation of the Storm Water Protection Plan to which Carlota is committed as part of the proposed action. The relative level of involvement necessary to implement such measures on the alternatives may be inferred from this table.

Based on the map presented in *Figure 2-19*, the alignment should require only minor cuts and fills.

Since the amount of hillside grading would be limited, the risk of induced slope failure would be low. Without BMPs to control erosion, sedimentation, and drainage, the amount of erosion and sediment yield could be anticipated to increase because the road would disturb the soil and bedrock within or immediately adjacent to the stream channel. However, similar to the proposed action, road drainage features and erosion and sedimentation controls would be implemented to minimize the potential for these effects.

<u>No Action Alternative</u>

The no action alternative would eliminate the recovery of approximately 900 million pounds of copper. The proposed action indicates a 20-year mine life and an average yearly production of approximately 60 million pounds of copper. This production rate represents approximately 1 percent of the current annual copper consumption in the United States, based on statistics provided by the U.S. Bureau of Mines (Edelstein 1994). The mineral resource would still be available for future mining.

3.2.3 Cumulative Impacts

Surface mining activity affects the geology and mineral resources through excavating, modifying, or covering natural topographic and geomorphic features and by removing mineral deposits. The study area for the cumulative impact analysis for geology and mineral resources was restricted to the Globe-Miami-Superior mineral belt. The existence of disturbed mining areas within the mineral belt was determined by interpreting recent black and white aerial photographs. The boundary of each identified disturbed area was planimetered to determine the affected acreages.

Mining disturbance has included open-pit and underground mining, waste rock disposal, heap leaching, ore milling and processing, tailings disposal, and exploration (road construction, drill pads, and bulk sample areas). Mining projects within the study area include BHP Copper's Pinto Valley Mine, Old Carlota Mine, Gibson Underground Mine, Copper Cities Mine, Miami Unit, Cyprus Miami Mine, Ray Mine, and Superior BHP Copper's Underground Mine. The location of the disturbed mining areas and the corresponding estimated acreages of disturbed land are presented in *Figure 1-3*. The estimated cumulative area affected by past mining activity includes 59 identified disturbed sites and a total of approximately 16,525 acres.

The project would create approximately 1,428 acres of additional disturbance. Assuming that acreages of past disturbance are reasonable estimates, implementation of the proposed action would increase the total disturbed acreage in the mining district by approximately 8 percent. Because copper mining is a major activity in the district, it is reasonable to assume that large-scale mining will continue and will result in the creation or expansion of other open pits, mine rock disposal areas, heap-leach pads, and tailings facilities in the foreseeable future. Considering the current level of activity in the district, it is reasonably foreseeable that in addition to the proposed Carlota and other projects, the district could expand the acreage of disturbance by another 5 to 10 percent in the next decade.

3.2.4 Monitoring and Mitigation Measures

Potential impacts to geology and minerals would be minimized by the following mitigation measures. These measures apply to the proposed action and, where noted, to specific alternatives.

3.2.4.1 Ground Subsidence

GM-1: The following mitigations for abandonment of shafts, adits, and other workings are intended to supplement the measures provided by Carlota (1994a) and incorporated into the proposed action:

(1) All wood, garbage, or other debris or loose material would be removed from the openings prior to backfilling.

(2) All rock backfill for shafts would consist of large rocks at least 1 foot across their largest dimension.

(3) A grout or cement that is designed to function or exist in an acidic environment would be used for all mass concrete work to fill openings within the footprint of the leach pad.

GM-2: All existing drill holes (exploration, geotechnical, monitoring, etc.) within the leach pad footprint would be plugged and abandoned with grout or cement that is designed to function or exist in an acidic environment. Well abandonment would be in accordance with all applicable Arizona regulations.

3.2.4.2 Slope Stability

GM-3: Potential slope stability problems in the Carlota/Cactus pit and the Eder pits would be effectively mitigated by the recommendations proposed by Call and Nicholas, Inc. (1993) and the USGS (1995). These recommendations include (1) engineering geologic mapping as mining progresses to identify any potentially adverse geologic conditions in the pit walls, (2) rock-coring to further define the existence and orientation of the basal ash layer or other potential failure planes that may be suspected, (3) slope dewatering, (4) slope monitoring to detect initial signs of instability, and (5) contingency planning to anticipate or react to potential slope instabilities. Options to preclude impacts to facilities from future pit slope failures include modifying the final pit rim location or adjusting a facility location to provide an adequate setback distance. If potentially adverse geologic conditions are exposed in the pit wall as mining progresses, the final setback distance of any potentially affected facility would be modified as necessary to reduce the potential for damage.

At closure, the stability of the pit walls would be assessed from operational information, and berms and fences would be placed beyond the projected limits of any potential mass failures. Monitoring for such occurrences would continue for a number of years after closure. The length of monitoring would be determined by the Forest Service and other agencies, as appropriate. If additional geologic or geotechnical investigations related to pit wall stability are determined to be necessary during operations or the postclosure monitoring period, they would be conducted according to appropriate agency recommendations.

GM-4: Road design and alignment for the water supply access road would be approved by the Forest Service. The potential for induced slope instability and increased erosion resulting from project construction can be effectively reduced by designing the road based on the results of a geotechnical investigation to determine existing slope conditions and appropriate grading design and erosion control measures. Erosion could be effectively minimized by building the portion of road that traverses the hillslope entirely in cut bedrock and hauling generated fill material to relatively flat areas where the material would not be subjected to accelerated erosion.

GM-5: Site-specific mitigation measures for potential slope stability problems associated with the Powers Gulch diversion and embankment, Eder mine rock disposal area Eder side-hill leach pad alternative, and low-quality water pipeline associated with the low quality water supply alternative would depend upon the actual geologic and slope conditions and development plans in specific areas. The site-specific mitigation measures would be developed after a thorough (design-level) geotechnical investigation and analysis of the slope conditions. Appropriate design and slope improvement measures would be developed as needed to minimize the potential for slope failure during operation and postclosure. If other preferred closure technologies for the heap leach pad are identified during the life of the project which do not require the use material from the Eder mine rock disposal area for a water balance cover, all remaining material in the Eder mine rock disposal area will still be removed and placed on the heap leach pad or other areas for revegetation purposes. Final design of the Powers Gulch diversion, Eder mine rock disposal area, Eder side-hill leach pad alternative, and low-quality water pipeline would be approved by the Forest Service.

GM-6: There may be some potential for unstable slope conditions to develop during seismic loading or if local saturated conditions develop in any of the mine rock disposal areas (Proposed Action and alternative mine rock disposal sites). Therefore, the final design for the mine rock areas would be approved by the Forest Service. The approval would depend on demonstration, through geotechnical analysis, that the mine rock facilities would be stable during both the operational and postclosure periods. Geotechnical considerations to be addressed include foundation stability and stability of the mine rock facilities under static, seismic loading, and local saturation conditions. Other issues to be considered for the final design that could affect stability include long-term drainage and erosion control.

3.3 Water Resources

3.3.1 Affected Environment

3.3.1.1 Hydrometeorology

<u>**Precipitation**</u>

The proposed project is located in the Central Highland physiographic province of Arizona, in a transition zone between the forested plateaus to the north and east and the arid desert to the southwest. Significant precipitation variations occur over short distances because of the effects of mountainous topography (GWRC 1994). The regional climate is characterized by semiarid conditions with two seasons of maximum precipitation. Most warm-season rainfall occurs during July and August, usually as intense, short-duration thunderstorms over a limited area. Winter precipitation occurs primarily during December, January, February, and March. Winter precipitation is typically gentler, more widespread, and of longer duration than summer rainfall. From year to year, cool-season precipitation is considerably more variable than that of the warm season. High accumulations of precipitation may occur over several days during the winter months (Sellers and Hill 1974). In any given year, the total amount of precipitation may differ considerably from the long-term average (*Figure 3-6*).

Records indicate that mean annual precipitation varies from locale to locale and typically increases with elevation. Data for Miami, Arizona, and the Pinto Valley Mine comprise the most recent and complete precipitation records for the area (*Table* 3-28). From 1973 through 1995, the Pinto Valley Mine, at an elevation of 4,000 ft-amsl, averaged approximately 23.8 inches of precipitation annually (*Tables 3-28* and *3-29*).

Table 3-28. Average Monthly and Annual Precipitation for Miami and Pinto Valley Mine

Precipitation Means (inches)[1]		
Month	**Miami**	**Pinto Valley**
January	2.52	2.92
February	2.16	2.59
March	2.57	3.04
April	0.58	0.69
May	0.54	0.72
June	0.23	0.21
July	2.32	2.60
August	2.72	3.14
September	1.69	1.92
October	1.40	1.57
November	1.67	1.87
December	2.13	2.52
Total	20.56	23.81

[1]Monthly means from 1973-1995

Source: Earthinfo, Inc. (1996) and GWRC (1994, 1995b, 1996)

Table 3-29. Pinto Valley Mine Annual Precipitation Data

Year	Annual Precipitation (inches)	Year	Annual Precipitation (inches)
1973	17.95	1985	30.36
1978	18.79	1986	29.94
1975	16.75	1987	13.62
1976	17.85	1986	15.28
1977	13.23	1985	10.15
1978	38.73	1986	20.24
1978	21.27	1991	23.71
1984	20.70	1992	30.92
1984	23.67	1993	30.44
1982	35.31	1991	19.69
1983	41.24	1995	17.71
1984	40.15		

Average annual precipitation = 23.81 inches

Source: GWRC (1994, 1995b, 1996)

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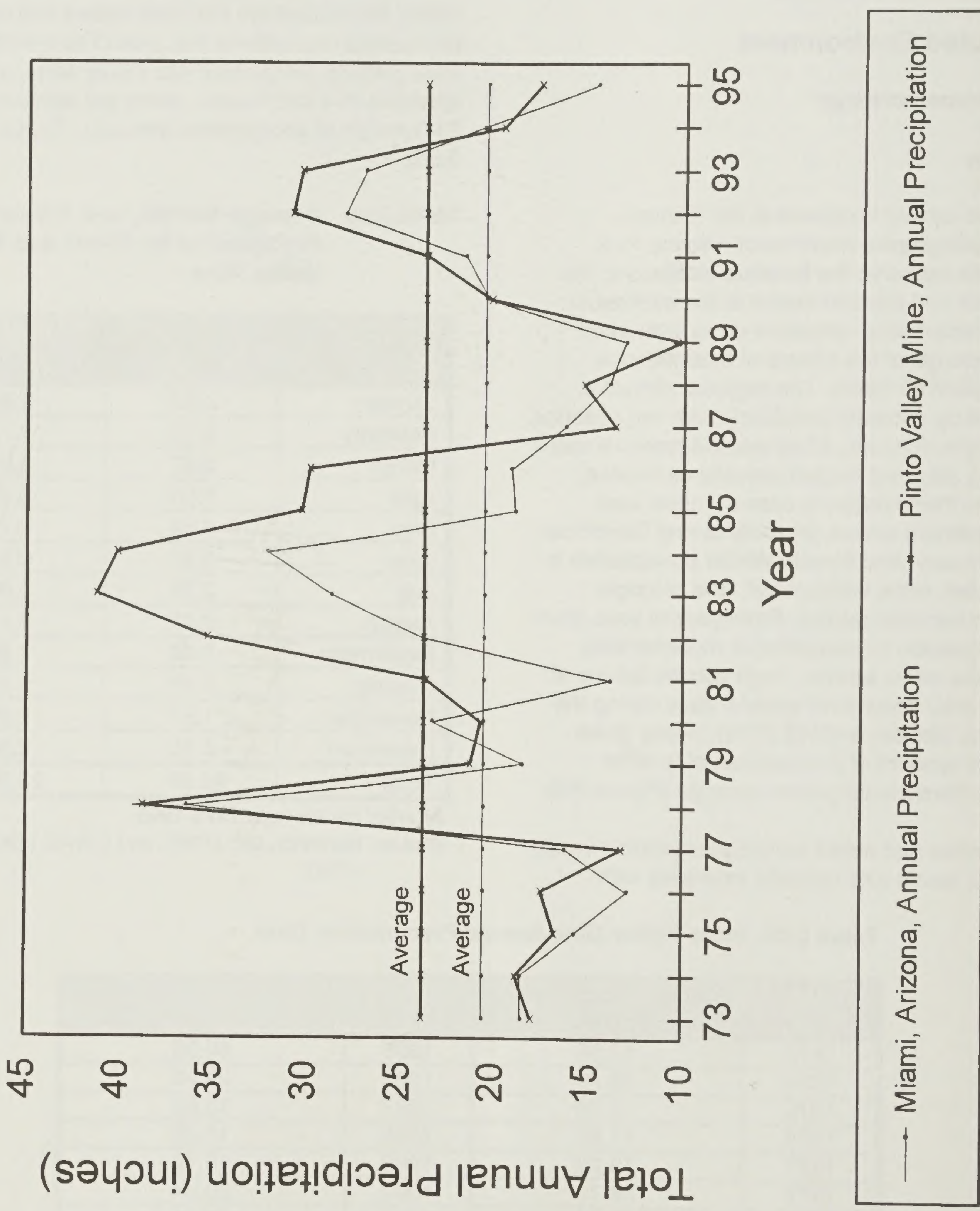

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Figure 3-6
General Precipitation Patterns
in the Vicinity of the
Project Study Area

Miami, at 3,560 ft-amsl, had an annual mean of approximately 20.6 inches of precipitation for the same period (Earthinfo, Inc. 1996, GWRC 1994, 1995b, 1996). The weather station at the Pinto Valley Mine is located within approximately 2 miles of the project area and is probably the most representative of project area conditions (GWRC 1994). Regionally, the total annual precipitation varies widely between given years, as shown in *Figure 3-6*. This is typical of arid and semiarid environments. For example, at Miami the recorded total annual precipitation ranges from approximately 12.9 to 36.4 inches. At the Pinto Valley Mine, the recorded range is approximately 10.2 to 41.2 inches. Total annual precipitation at the project area probably varies similarly to the Pinto Valley Mine site.

Temperature

The temperature station at Miami is the closest known long-term recording station to the site. Temperature data for Miami indicate a mean daily maximum of 55°F and a mean daily minimum of 32.7°F for January. For Miami during July, the mean daily maximum is 97°F, and the mean daily minimum is 70.3°F (*Table 3-30*). The freeze-free period (32°F) is typically from March 22 through November 22, and the period between killing frosts (28°F) is typically February 12 through December 9 (Sellers and Hill 1974). The location of this station may reasonably represent long-term temperature and frost-free conditions in the region. Since portions of the project site are at a slightly higher elevation, temperatures in the project area itself may be cooler, with shorter frost-free seasons. Additional regional and site-specific temperature information is presented in Section 3.1, Air Resources.

Evaporation

National Weather Service (NWS) information (NOAA 1982) indicates free water surface evaporation in the project locale is estimated to average approximately 65 inches per year. This figure closely represents the potential evaporation from a shallow lake, watered vegetation, or very wet soil. Monthly estimates of evaporation rates are shown for the Pinto Valley area in *Table 3-31* (GWRC 1994). These figures total 66.65 inches per year and are in close agreement with NWS estimates.

3.3.1.2 Surface Water

General Watershed Characteristics

Three major drainages, Pinto Creek, Powers Gulch, and Haunted Canyon, occur in the project area. The Powers Gulch and Haunted Canyon subwatersheds form part of the overall Pinto Creek watershed. Pinto Creek drains into Roosevelt Lake (located on the Salt River) approximately 18 miles downstream from the project area. The watershed, major subwatersheds, and streamcourses are shown in *Figure 3-7*. The proposed mining operation is located in the upper portion of the overall Pinto Creek watershed. Upstream of the project area, the watershed extends in a southeasterly direction up to the ponderosa pine

Table 3-30. Temperature Data for Miami

Temperature (°F) Means			
Month	Daily Maximum	Daily Minimum	Monthly
January	55.0	32.7	43.9
February	60.4	35.4	47.9
March	65.1	39.5	52.3
April	74.7	47.3	61.0
May	84.5	55.7	70.1
June	93.7	64.2	79.0
July	97.0	70.3	83.7
August	93.9	67.9	80.9
September	89.7	62.9	76.3
October	78.8	52.0	65.4
November	65.4	40.5	53.0
December	56.6	34.2	45.4

Source: Sellers and Hill (1974)

Table 3-31. Estimated Monthly Evaporation Rates for Pinto Valley Area

Month	Average Monthly Evaporation Rate (inches)
January	2.03
February	2.85
March	4.60
April	6.07
May	8.30
June	9.12
July	9.11
August	8.29
September	6.36
October	4.88
November	3.03
December	2.01

Average annual evaporation = 66.65 inches
Source: GWRC (1994)

Table 3-32. Summary of Pinto Creek Basin Contributing Subwatershed Areas[1]

Pinto Creek Subwatershed	Area		
	Square Miles	Acres	Incremental Mean Discharge[2]
Powers Gulch	5.5	3,520	769
Haunted Canyon	12.3	7,872	1,719
West Fork of Pinto Creek	27.2	17,408	3,801
Horrell Creek	11.8	7,552	1,649
Willow Spring Creek	5.0	3,200	699
Pinto Valley	20.1	12,864	2,809
Upper Pinto Creek	15.1	9,664	2,110
Lower Pinto Creek	78.4	50,176	N/A[3]
Existing Non-Contributing Mining Operation Area	2.8	1,792	0
TOTALS	178.2	114,048	N/A[3]

[1]For locations, see *Figure 3-7*.
[2]In acre feet/year per subwatershed as a general estimate; actual values may vary from those shown. Values are derived from a relationship explained under "Mean Annual Runoff."
[3]No gaging data are available below the Pinto Valley weir.

zone in the Pinal Mountains. Runoff through the project area is affected by upstream contributions as well as by conditions in the project area itself. The overall area of the Pinto Creek watershed (178.2 square miles) can be divided into several smaller drainages. The area for each contributing subwatershed is summarized in *Table 3-32*. Approximately 2.8 square miles of area within the overall watershed are occupied by existing mining operations that totally contain precipitation falling within that area and do not contribute to surface runoff.

Several major tributaries to Pinto Creek occur downstream from the proposed mine facilities. These tributaries provide a significant source of water to Pinto Creek, both in the form of surface flow and ground water recharge to alluvium. These tributaries, as shown in *Figure 3-7*, include Haunted Canyon, the West Fork of Pinto Creek, and Horrell Creek.

The Pinto Creek watershed is mountainous, with steeper, more rugged topography in the project area transitioning to flatter, less rugged terrain nearer the Salt River. Surface conditions in the project area are dominated by dense interior chaparral, which comprises approximately half of the vegetative cover in the area. Approximately 15 percent of the project area vegetation is made up of rubbleland chaparral, which is similar in species composition to the interior

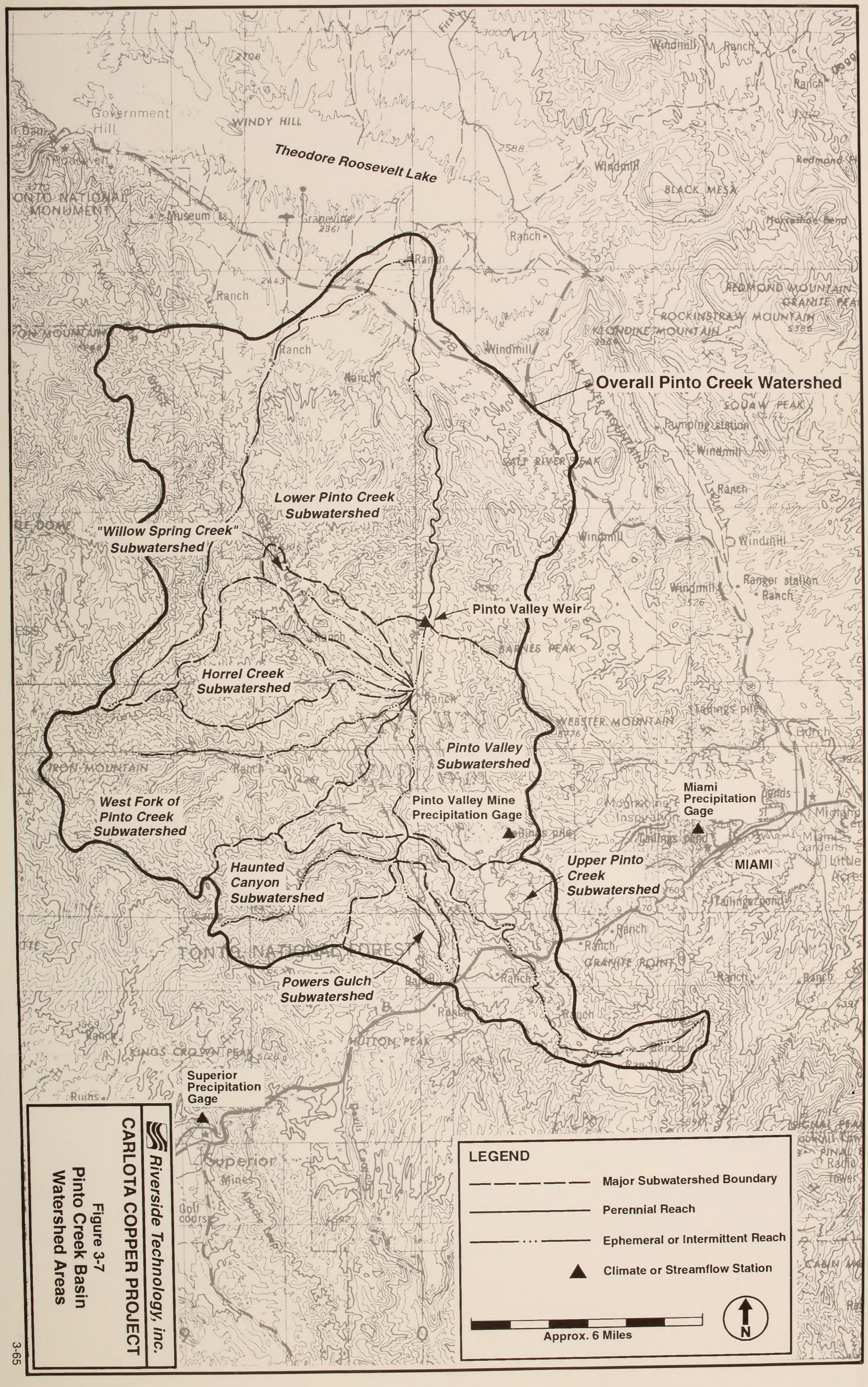

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Figure 3-7
Pinto Creek Basin
Watershed Areas

chaparral type but includes significant areas of rock outcrops and boulder fields.

Approximately 25 percent of the vegetation in the project area is made up of dry slope desert brush, which typically occurs on dry, south-facing slopes. Smaller percentages of the vegetation in the project area and surrounding region are made up of juniper-grassland and riparian types. Further descriptions of vegetation in the region are presented in Section 3.5, Biological Resources.

Within the project area and surrounding region, large nonvegetated areas are covered with rock as outcrops or as individual particles ranging from gravels to boulders. Finer-grained soils complete the remainder of the watershed surface and are typically shallow over bedrock (Cedar Creek Associates, Inc. 1994). Soils in the project area typically are in Hydrologic Soil Group D (high runoff potential). High rates of runoff occur on these soils primarily because of their shallowness over bedrock. Deeper soils occur in isolated areas along toeslopes and in alluvial valleys. Soils in these small areas are in Hydrologic Soil Groups A and B (low to moderate runoff potential). For the overall watershed, total erosion rates are limited by large areas of dense vegetation, rock outcrops and other erosion-resistant surfaces.

Channel gradients along Pinto Creek are 80 to 120 feet per mile in the proposed pit area and approximately 50 feet per mile downstream near the confluence with Haunted Canyon. Farther downstream, near the confluence with Horrell Creek, the gradient is approximately 35 feet per mile. Short reaches of steeper or flatter gradients exist along the streamcourse.

Being in close proximity to Pinto Creek, the Powers Gulch and Haunted Canyon watersheds and channel characteristics are similar. The channels are mountain streams with relatively steep slopes and coarse bed material. Channel morphology is often controlled by exposed bedrock. Existing channel gradients in Powers Gulch are approximately 225 feet per mile in the vicinity of the proposed leach pad, and range from approximately 530 feet per mile in the headwaters south of the proposed leach pad to approximately 95 feet per mile at the confluence with Haunted Canyon. The existing channel gradient in Haunted Canyon is approximately 150 feet per mile upstream of Powers Gulch, 130 feet per mile just below the confluence with Powers Gulch, and approximately 50 feet per mile at the confluence with Pinto Creek. Short reaches of steeper or flatter gradients exist along these streamcourses.

Streamflows. A stream gaging station known as the Pinto Valley weir has operated for several years on Pinto Creek, approximately 7.5 miles downstream of the Carlota Copper Project (GWRC 1994). The drainage area for Pinto Creek at the Pinto Valley weir is composed of the following subwatersheds: Powers Gulch, Haunted Canyon, the West Fork of Pinto Creek, Horrell Creek, Willow Spring Creek, Upper Pinto Creek, and Pinto Valley. The watershed gaged by this station is approximately 97 square miles. The Pinto Valley weir was established in the early 1980s by Magma Copper Company. The USGS assumed operating responsibility for this station in October 1994. Daily stream discharge records are available for periods of several weeks or months, ranging from mid-July 1985 through the present. These partial records comprise the most recent, closest, and most continuous discharge data for the Pinto Creek watershed area.

Carlota Copper Company implemented a surface water and ground water monitoring program in the project area and nearby locale during 1992 and 1993 (Montgomery & Associates 1993; GWRC 1994). Surface water monitoring stations associated with this program are shown in *Figure 3-8*. At locations identified as M & A in *Figure 3-8*, discharge estimates were made on a quarterly basis from May through December 1992 by Montgomery & Associates. The remaining stations were gaged approximately biweekly by GWRC during April, May, June, August, and October 1993 (GWRC 1994). Carlota has subsequently continued to collect surface water data at many of the sites established in the 1992-1993 program (GWRC 1995d, 1996b). In March 1996, Carlota installed and began operating three continuous-recording stream gaging stations on Haunted Canyon (HC-2, HC-3, and HC-4). Additionally, the USGS recently installed and began operating a continuous-recording stream gaging station on Pinto Creek (PC-7) downstream from the Haunted Canyon confluence. A description of each gaging station location, including information on watershed areas contributing to each station, is presented in *Table 3-33*.

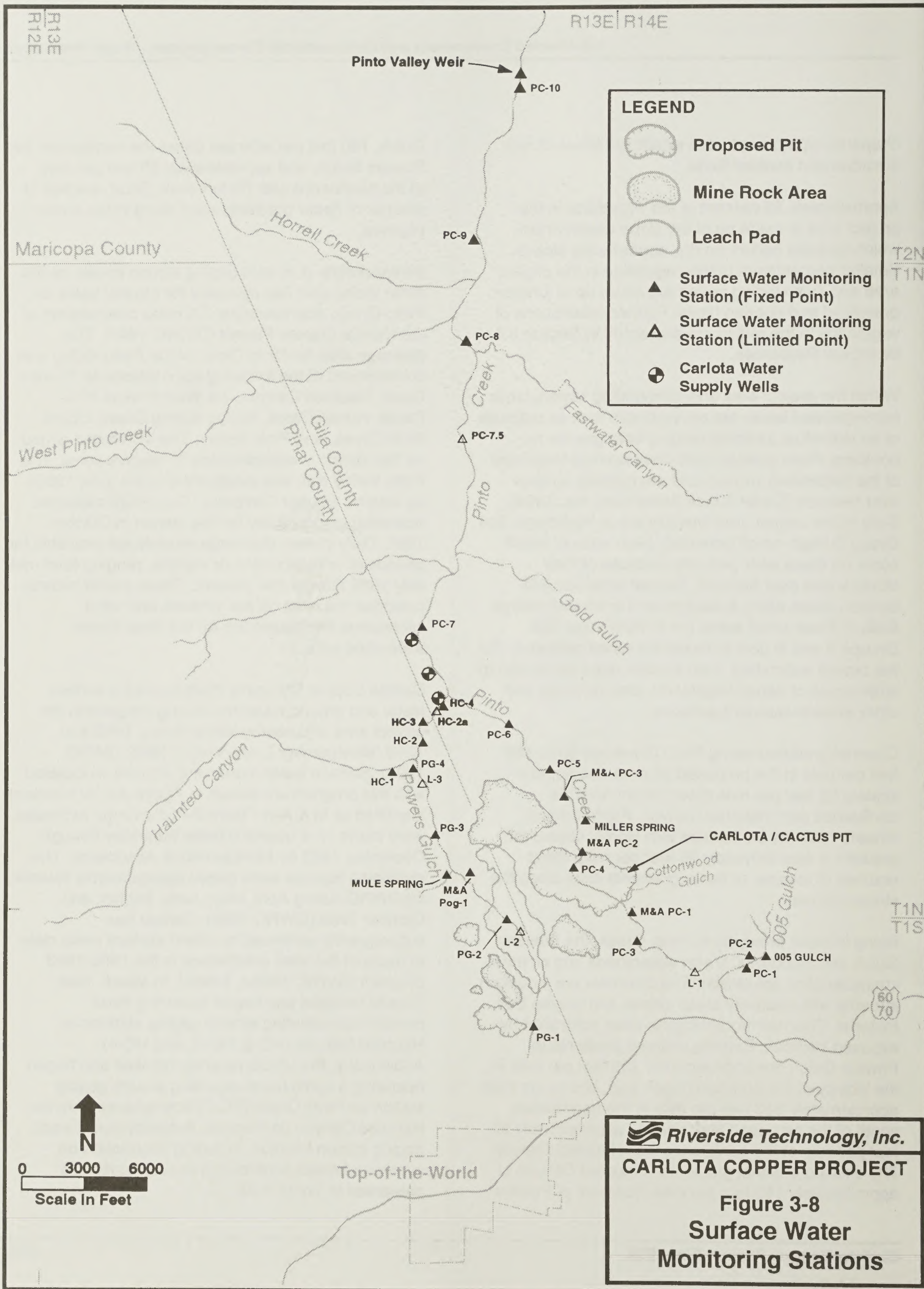

Figure 3-8
Surface Water Monitoring Stations

Table 3-33. Gaging Station Descriptions

Station	Description	Approximate Watershed Area (square miles)	Proportion of Pinto Creek Watershed Area above PC-10[1]	Proportion of Pinto Creek Watershed Area above Roosevelt Lake[2]
PC-1	Pinto Creek above 005 Gulch	7.9	8.1%	4.5%
PC-2	Pinto Creek below 005 Gulch	10.0	10.3%	5.7%
PC-3	Pinto Creek above Carlota/Cactus pit	11.0	11.3%	6.3%
PC-4	Pinto Creek below Cactus well 126	14.0	14.4%	8.0%
PC-5	Pinto Creek below BHP Copper domestic well 37	14.8	15.3%	8.5%
PC-6	Pinto Creek above Haunted Canyon	15.1	15.6%	8.6%
PG-1	Powers Gulch above proposed leach pad	0.6	0.6%	0.3%
PG-2	Powers Gulch @ well cluster PG-2/PG-2A	1.9	2.0%	1.1%
PG-3	Powers Gulch @ west end of Kelly fault	5.0	5.2%	2.9%
PG-4	Powers Gulch above confluence with Haunted Canyon	5.5	5.7%	3.1%
HC-1	Haunted Canyon above Powers Gulch	11.4	11.8%	6.5%
HC-2	Haunted Canyon below Powers Gulch	17.1	17.6%	9.8%
HC-3	Haunted Canyon between Powers Gulch and Pinto Creek	17.2	17.7%	9.8%
HC-4	Haunted Canyon above confluence with Pinto Creek	17.6	18.1%	10.1%
PC-7	Pinto Creek below Haunted Canyon	34.3	35.4%	19.6%
PC-8	Pinto Creek above W. Pinto Creek	47.6	49.1%	27.2%
PC-9	Pinto Creek below Horrell Creek	94.2	97.1%	53.8%
PC-10	Pinto Creek @ BHP Copper Weir	97.0	100%	55.4%
L-1	Limited station between PC-2 and PC-3	10.1	10.4%	5.8%
L-2	Limited station on Powers Gulch near monitor well PG-5	1.6	1.6%	0.9%
L-3	Limited station on Powers Gulch west of proposed mine rock disposal area	13.9	14.3%	7.9%

[1]The contributing Pinto Creek watershed area above PC-10 (Pinto Valley Weir) is approximately 97 square miles.
[2]The contributing Pinto Creek watershed area above Roosevelt Lake is approximately 175 square miles.

Although the baseline monitoring program has been relatively limited in duration and does not approach the historical range of flow conditions, it enables some general inferences about the nature of flows in the watershed. Data from the Pinto Valley Mine precipitation station for 1992 indicate that total annual precipitation levels were approximately 28 percent higher than the 20-year historical average at that station, and approximately 37 percent higher than the 20-year historical average at Miami, Arizona. As a result, the initial monitoring program generally reflects surface runoff conditions higher than typical for the site.

The spatial and temporal distribution of streamflows during the monitoring period is presented in *Table 3-34*. The major source of the perennial baseflow at the Pinto Valley weir is near-surface ground water flow surfacing from alluvial deposits. On the basis of site investigations during years of above-average

Table 3-34. Spatial and Temporal Distribution of Streamflows in the Upper Pinto Creek Watershed

	Pinto Creek above Haunted Canyon Instantaneous Discharge (cfs)						Powers Gulch Instantaneous Discharge (cfs)				Haunted Canyon ntaneous Discharge		Pinto Creek below Haunted Canyon Instantaneous Discharge (cfs)				
Date/Station	PC-1	PC-2	PC-3	PC-4	PC-5	PC-6	PG-1	PG-2	PG-3	PG-4	HC-1	HC-2	PC-7	PC-7.5	PC-8	PC-9	PC-10
1993																	
Apr. 26-28				1.44	1.66	1.63	~ 0.00222	0.137	0.38			3.27	4.8		5.78		25.71
May 05-07			0.675	0.91	1.18	1.34	0	0.0608	0.308	1.64	1.88	2.8	3.55		4.89	16.31	21.85
May 17-19	0.92	0.5	0.547	0.68	1.05	0.87	0	0.0342	0.137	0.406	1.82	1.38	2.97		3.43	14.64	19.20
Jun. 02-04	0.0422	0.0827	0.0067	0.0608	0.28	0.243	0	0.0106	0.0827	0	0.97	1.21	1.02		1.15	6.23	9.30
Jun. 16-18	0	0.0207	0	0.0106	0.137	0.0713	0	~ 0.00222	~ 0.00222	0	0.43	0.84	0.83		0.97	3.72	6.98
Jun. 28-30	0	0.000918	0	~ 0.00222	0.027	0.0342	0	0	0	0	0.23	0.38	0.79		0.63	1.88	5.27
Aug. 03-04	0	0	0	~ 0.00222	0.0147	0.0102	0	0	0	0	0	0.08	0.0588		0	0	4.93
Oct. 27-28	0	0.0172	0	~ 0.00222	0.147	0.0918	0	0	0	0	0	0.0106	1.51		1.07	0	1.96
Nov. 30	0	0.0422	0.0827	0.0827	0.0827	0.152	0	0	0.0949	~ 0.00668	0.488	0.41	0.768		0.642	0	3.73
1994																	
Jan. 08-09	0.0608	0.0949	0.0949	0.0827	0.122	0.152	0	0	0	0	0.0713	0.3312	0.68		0.78	0	3.43
Feb. 21			5.16	1.76	1.66		~ 0.00445	0.169	0.84						5.03	4.62	6.90
Mar. 21-22	1.39	1.57	3.04	3.03	2.94	4.83	0.0342	0.108	0.78	1	0.71	1.83	8.43		7.86	7.58	7.52
Apr. 12-13	0.03	0.14	0.0949	0.22	0.169	0.65	0	0	0.0608	0	0.44	0.83	1.06	0.99	1.48	0.13	5.43
May 12-13	0	0.042	0.0106	0.0827	0.0608	0.0949	0	0	0.0207	0	0.152	0.37	0.488	0.78	0.78	0	5.16
Jun. 20-21	0	~ 0.00445	0	~ 0.00222	0	0	0	0	0	0	~ 0.00222	16	0.0949	0.204	0.331	0	3.10
Jul. 14	0	0	0	0	0	0	0	0	0	0	0	0.054	0.0172	0.045	0	0	1.62
Aug. 09	0	0	0	0	0	0	0	0	0	0	0	0.0588	0.0037	0.0016	0	0	1.83
Sep. 14-16	0.0588	0.095	0.111	0.054	0.287	0.216	0	0	0.0261	0	~ 0.00222	0.155	0.16	0.21	0.0229	0	1.23
Oct. 24-25	0.00826	0.0408	0.0102	0.0229	0.098	0.0050	0	0	0.0229	0	~ 0.00445	0.23	0.22	0.155	0.0588	0	1.84
Nov. 21-22	0.0342	0.0713	0.00367	0.0658	0.169	0.137	0	0	0.045	0	~ 0.00445	0.17	0.52	0.97	0.76	0	1.24
Dec. 27-29	1.12	1.54	4.41	3.59	3.1	4.83	0.331	0.204	3.95	1.82	0.72	2.60	5.63	7.44	7.59	7.19	3.33
1995																	
Jan. 31-02	3.09	3.51	5.5	6.35	5.95	5.95	0.16	0.68	2.86	2.35	3.58	5.42	12.18	17.22	18.74	17.37	30.75
Feb. 27-01	3.57	4.12	9.89	9.21	8.68	8.04	0.4	1.13	1.74	2.32	5.95	7.71	14.45	19.73	19.39	30.43	36.18
Mar. 28-30	1.54	2.81	2.07	2.19	2.01	2.22	0	0.25	0.77	0.57	2.96	2.96	5.91	6.38	8.50	15.11	21.40
Apr. 26-28	0.2	0.27	0.17	0.56	0.71	0.65	0	0.0511	0.30	0.0207	1.29	1.60	2.05	2.94	3.09	6.36	10.50
May 31-02	0	0.0152	0	0.0152	0.0827	0.0152	0	0	0.0152	0	0.23	0.53	0.29	0.88	1.07	0	6.11
Jun. 26-27	0	0	0	~ 0.00222	0	0	0	0	0	0	~ 0.00222	0.17	0.25	0.122	0	0	5.01
Jul. 24-26	0	0	0	0	0	0	0	0	0	0	~< 0.0044	0.095	0.0608	0.027	0	0	3.96
Aug. 28-30	0.001	0.0037	0.0147	0.004	0.004	0	0	0	0.0009	0	0.0422	0.27	0.51	0.33	0.1690	0	3.25
Sep. 25-26	0	0	0	0	0	0	0	0	0	0	0.0052	0.2	0.187	0.2	0	0	2.82
Oct. 23-24	0	0	0	0	0	0	0	0	0	0	0.0033	0.12	0.14	0.49	0.26	0	3.65
Nov. 29-30	0	0.0102	0	0.0011	0.004	0	0	0	0.0033	0	0.0033	0.152	0.35	0.4	0.1010	0	3.66
Dec. 27-28	0	0.0102	0.0052	0.0033	0.0133	0	0	0	0.0075	0	0.0052	0.11	0.33	0.18	0.0468	0	4.14

Note: A blank cell indicates no data available.
~ indicates the measured flow was approximated.
< indicates flow less than the given number.

Source: GWRC 1996b

precipitation and recent site investigations during a period of below-average precipitation (fall 1995 through fall 1996), Pinto Creek is intermittent over much of its course above the Pinto Valley weir (*Figure 3-7).*

In general, reaches of Pinto Creek having perennial flow during the monitoring program were associated with bedrock-lined channel conditions (GWRC 1994). This is the case for the stream reach at station PC-4, the portions of the reach between stations PC-5 and PC-6, and the stream reach at station PC-7, all locations where the creek is generally incised into bedrock. High specific conductivities in surface water samples may indicate that a percentage of the low flow in the reach between PC-5 and PC-6 originates from existing tailings pond seepage from the adjacent Pinto Valley Mine.

Most tributaries to Pinto Creek within the project study area are intermittent; on-site observations of the smaller tributaries indicate that most are ephemeral, flowing only in direct response to precipitation events. Cottonwood Gulch was noted to carry surface flows during part of the year (Cedar Creek Associates, Inc. 1993c). In addition, the 005 Gulch tributary exhibited flow throughout the monitoring program (*Table 3-35*), but this location is an NPDES discharge point for the existing Pinto Valley Mine. Ephemeral surface flow was observed in Gold Gulch.

Flows in Powers Gulch are intermittent. The only significant tributary flow to Powers Gulch originates from Mule Spring. This spring did not go dry during the monitoring period, but flows were less than 0.002 cfs (1 gpm) by late June (*Table 3-35*).

Flows in Haunted Canyon were intermittent above the Powers Gulch confluence and perennial over most of its length from below Powers Gulch to its confluence with Pinto Creek. Streamflow, ground water, and water quality data collected in Haunted Canyon suggest that perennial reaches are sustained during baseflow periods by the discharge of ground water from the confined bedrock system into the alluvium and the stream.

Ponds. Small ponds occur as man-caused features at the Yo Tambien Mine in the southeastern part of the project area and at a stock pond in the northern part of the project area, as shown in *Figure 3-9* (Cedar Creek Associates, Inc. 1993b). The volume and surface area of these ponds fluctuate seasonally. Typically, the pool at Yo Tambien is less than 0.05 acre in size, and the stock pond ranges from dry conditions to a pool size of approximately 0.3 acre.

Mean Annual Runoff

An extrapolation of site-specific rainfall and runoff data was used to estimate mean annual runoff for the project area. Although errors may be introduced by extrapolating relationships based on this short period of record, these data are the most accurate information available for the project area, and are useful for comparative purposes in impact analysis. The impact analysis considered daily flow data for the Pinto Valley weir (approximately 200 feet downstream of PC-10, *Figure 3-8)* and annual precipitation records for the Pinto Valley rain gage as collected by Magma Copper Company. A statistical relationship based on linear regression (R^2=0.99998) was developed between precipitation and streamflow for the Pinto Valley gages (*Figure 3-10*). The period used to estimate this relationship included both wet and dry years, and provided a basis for comparisons using data collected in the vicinity. The mean annual discharge at the Pinto Valley weir, as calculated by this method, was approximately 13,570 acre-feet from 1973 through 1995 (*Table 3-36*). The available data indicate that the average annual areal runoff per square mile from the watersheds above the Pinto Valley weir is approximately 2.62 inches per year for the 23-year period of precipitation recorded. This estimate is intended for comparative purposes. The actual annual yield will vary from this estimate according to the accuracy of the extrapolated precipitation runoff relationship and specific precipitation and watershed characteristics. The estimated mean annual discharges for key Pinto Creek subwatersheds are shown in *Table 3-32.*

As shown in *Figure 3-11*, little precipitation runs off to become streamflow. Precipitation contributions to flow are greatest in the winter and early spring. Over the examined historical record, relatively heavy precipitation contributed to mean annual flow peaks ranging from 23 cfs to approximately 3,230 cfs. Runoff and streamflows decrease quickly as precipitation declines in late spring. Throughout the summer and fall, the effects of high evapotranspiration and soil moisture deficits can be seen in

Table 3-35. Instantaneous Flow Measurements at 005 Gulch, Miller Spring, and Mule Spring

Date	005 Gulch		Miller Spring @ Pinto Creek		Mule Spring	
	gpm	cfs	gpm	cfs	gpm	cfs
1993						
Apr. 27			110	0.243	12	0.027
May 07	6.8	0.0152	130	0.285	12	0.027
May 17-19	18.9	0.0422	68	0.152	6.8	0.0152
Jun. 02-04	4.8	0.0106	32	0.0713	6.8	0.0152
Jun. 16-18	4.8	0.0106	31	0.0688	4.8	0.0106
Jun. 28-30	0.0	0.005	0.0	0	0.41	0.000918
Aug. 03-04	0.7	0.00163	7.2	0.016	0.73	0.00163
Oct. 28-29			17	0.0368	17	0.0372
Nov. 30			0.0	0	8.1	0.018
1994						
Jan. 09	37	0.0827	0.0	0	7.3	0.0163
Feb. 21			0.0	0	190	0.422
Mar. 22	92	0.204	0.0	0	97	0.217
Apr. 12-14	27	0.0608	0.0	0	8.1	0.018
May 13-21	3.1	0.0608	0.0	0	13	0.0291
Jun. 14-21	0.0	0	0.0	0	4.4	0.0098
Jul. 14			0.0	0	8.0	0.0179
Aug. 09	0.0	0	0.0	0	1.0	~ 0.002228
Sep. 14-15	7.7	0.0172	81	0.18	5.5	0.0123
Oct. 24	6.8	0.0147	0.0	0	5.4	0.012
Nov. 21-22	9.3	0.0207	0.0	0	1.8	0.004
Dec. 27-28	120	0.27	110	0.25	900	2.00
1995						
Jan. 09						
Feb. 01-02	560	1.24	170	0.37	230	0.52
Feb. 27-01	350	0.78	130	0.25	110	0.24
Mar. 28-29	67	0.15	99	0.22	45	0.10
Apr. 27-28	43	0.0949	81	0.18	4.5	0.01
May 31-02	6.8	0.0152	27	0.06	4.8	0.0106
Jun. 26-31	1.0	~ 0.002228	0.0	0	2.0	~ 0.004456
Jul. 14-26	0.0	0	0.0	0	5.0	~ 0.01114
Aug. 28-30	4.8	0.0102	0.0	0	0.40	0.0009
Sep. 25-26	0.99	0.0022	0.0	0	2.0	0.0044
Oct. 24	9.0	0.02	0.0	0	1.5	0.0033
Nov. 29	4.6	0.0102	0.0	0	6.0	0.0133
Dec. 27-28	3.4	0.0075	0.0	0	6.0	0.0133

Note: A blank cell indicates no data available.
~ indicates the measured flow was approximated.
Source: GWRC 1996b

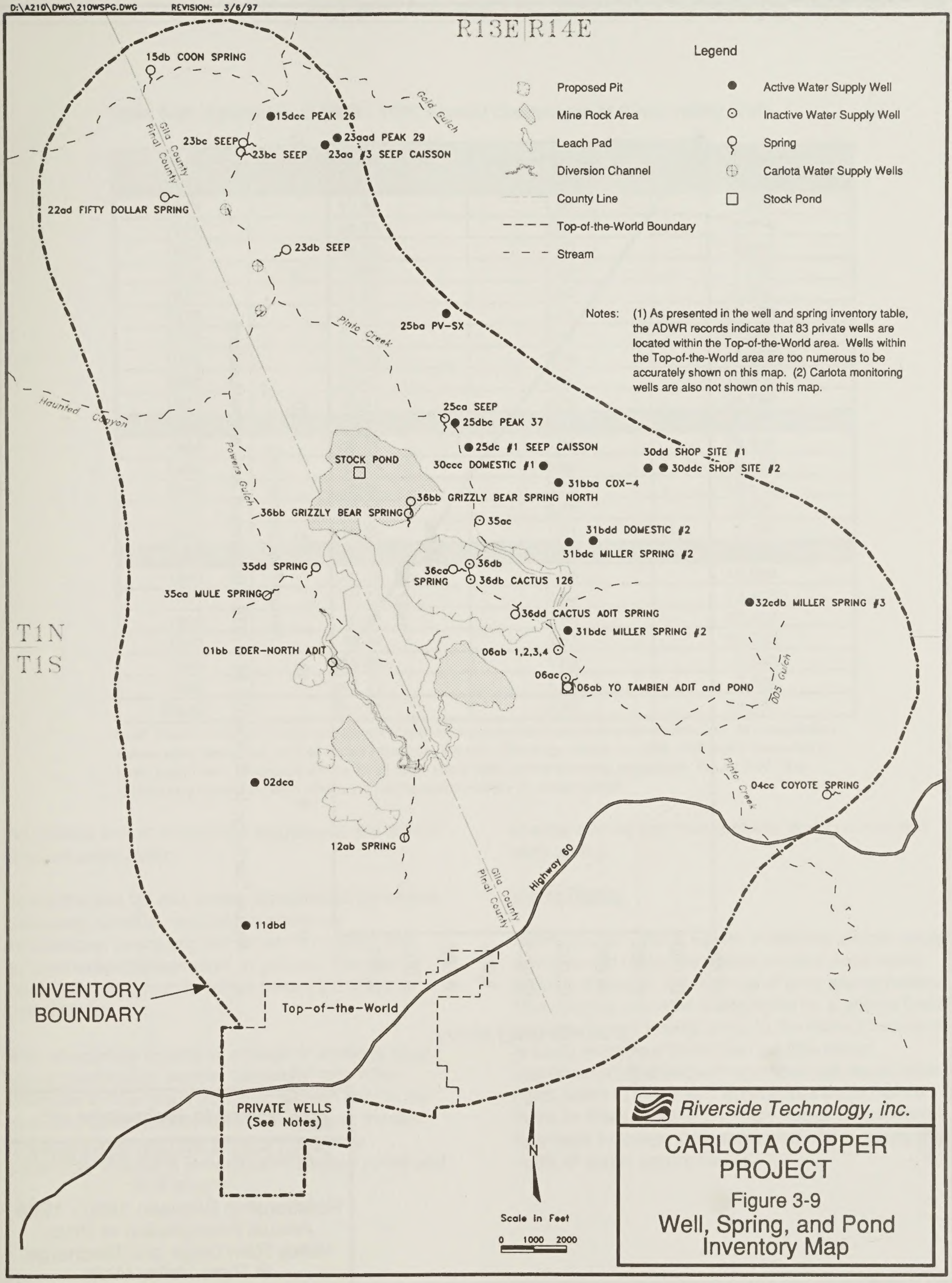

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Figure 3-9
Well, Spring, and Pond Inventory Map

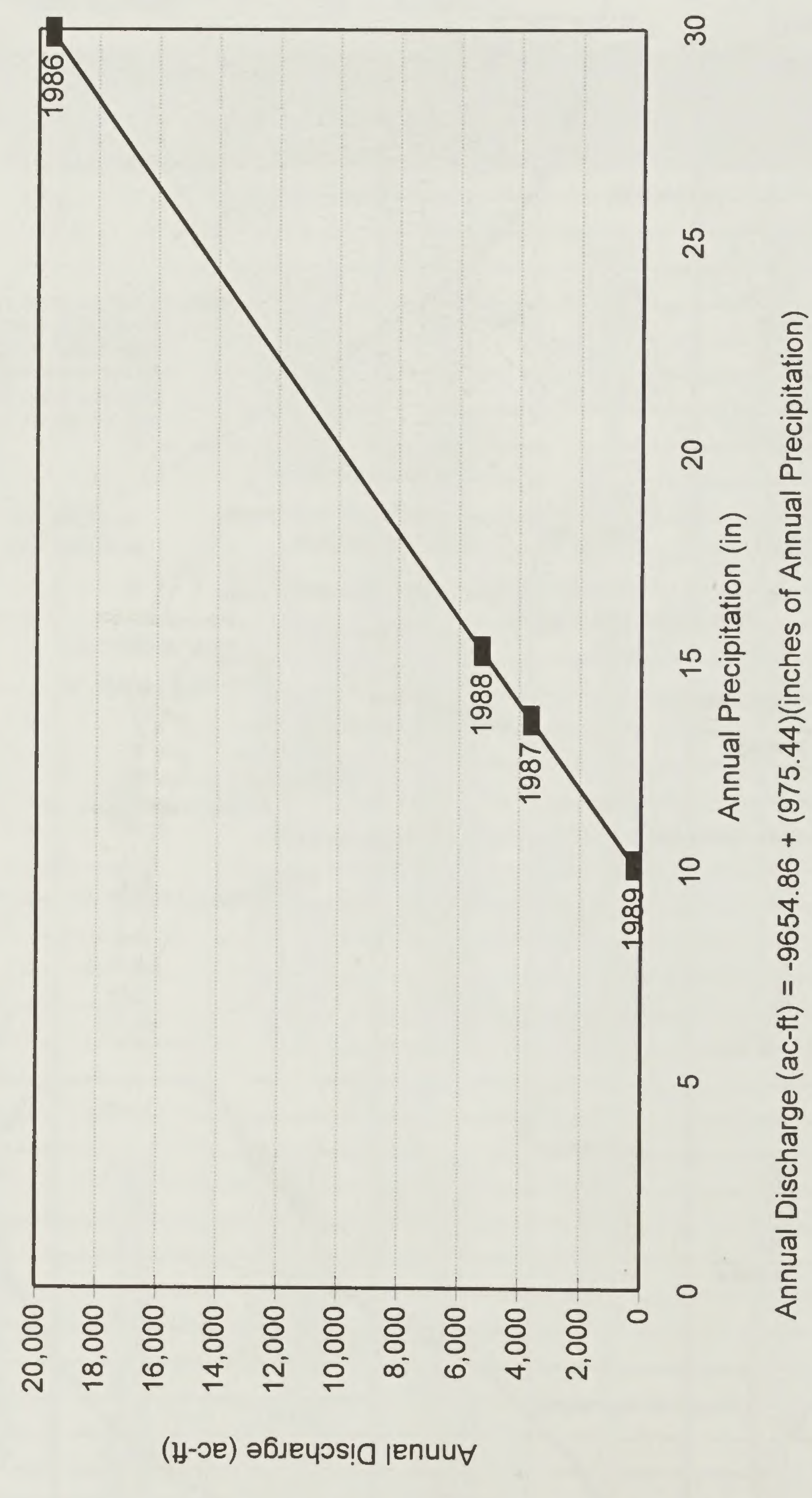

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Figure 3-10

Relationship Between 1986 - 1989 Annual Precipitation at Pinto Valley Rain Gage and Discharge at Pinto Valley Weir

Table 3-36. Estimates of 1973 - 1995 Annual Discharges at Pinto Valley Weir

Year	Annual Precipitation (inches)	Annual Discharge (inches)	Annual Discharge (acre-feet)
1973	17.95	1.52	7,854
1974	18.79	1.68	8,674
1975	16.75	1.29	6,684
1986	17.95	1.50	7,757
1987	13.23	0.63	3,250
1978	38.73	5.70	28,124
1974	21.27	2.14	11,093
1980	20.70	2.04	10,537
1991	23.67	2.60	13,434
1988	35.31	4.79	24,788
1983	41.24	5.91	30,572
1984	40.15	5.70	29,509
1986	30.36	3.86	19,959
1986	29.94	0.78	19,550
1987	13.62	0.70	3,631
1988	15.28	1.01	5,250
1986	10.15	0.05	246
1990	20.24	1.95	10,088
1991	23.71	2.60	13,473
1990	30.92	3.96	29,509
1990	30.44	3.87	20,038
1994	19.69	1.95	9,552
1995	17.71	1.47	7,620
MEAN	23.81	2.62	13,573

Note: Years of highest (1983) and lowest (1989) total precipitation and discharge are shaded. All precipitation values were measured at Pinto Valley Mine near the site. Discharge values for 1986-1989 were measured at Pinto Valley weir. Discharge values for all other years were estimated using equation in *Figure 3-10*. The contributing watershed area above the weir is approximately 97 square miles.

the general lack of streamflow response to the normal range of precipitation.

During the late fall and winter, precipitation generates increasing runoff in response to cooler air temperature, increasing soil moisture content, and reduced evapotranspiration. In general, this effect reaches its maximum between December and the end of March.

Most streamflow occurs as a result of winter to early spring precipitation events. Generally, only minor increases in flow result from precipitation later in the year, and flows typically recede throughout the late spring, summer, and fall. Most of the annual streamflow volume is generated by surface runoff and shallow alluvial flow that surfaces during winter and early spring.

Water Rights

Rights to use surface waters in Arizona are generally administered under the state's surface water code, which is based on the doctrine of prior appropriation. This doctrine allocates water rights on a priority basis with the highest priority going to the first appropriator to apply water to a beneficial use (the senior appropriator). Subsequent appropriators would have rights junior to those who appropriate water before them. In times of water shortage, junior appropriators may have to forego their appropriations to satisfy the rights of senior appropriators.

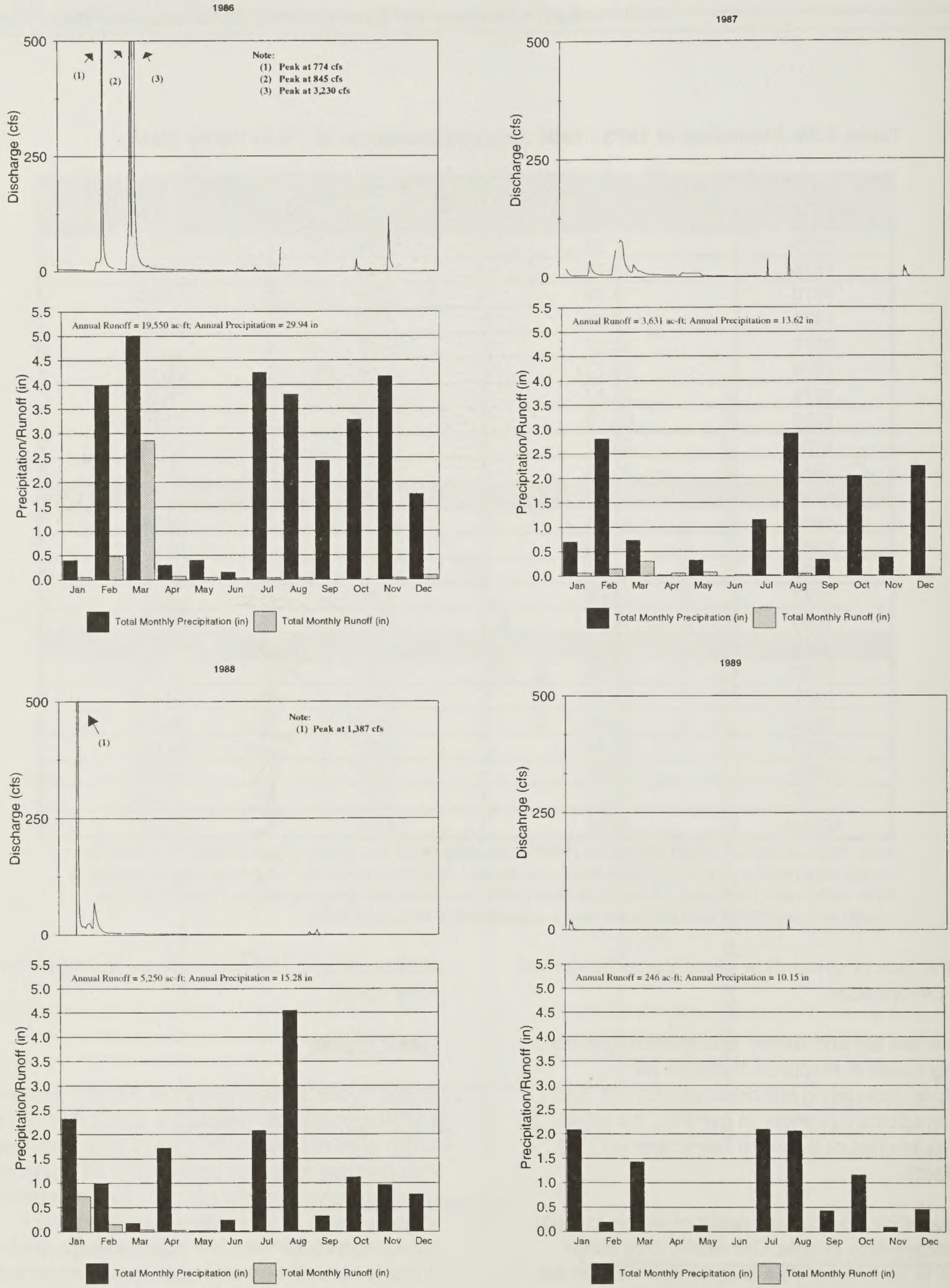

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Figure 3-11

Comparison of Discharge and Runoff at Pinto Valley Weir to Monthly Precipitation for Years 1986 - 1989

Several water rights exist within and downstream of the project area. The Salt River Valley Water Users' Association owns and operates a number of reservoirs downstream of the project area and claims rights to most of the water upstream of these reservoirs. Salt River Project's rights were adjudicated in the Kent Decree in 1910. Ultimate quantification of its rights (and those of all other claimants in the upper Salt River watershed) will be determined in the Upper Salt River adjudication, which is currently in progress. The Tonto National Forest has claims and certificates of water rights for springs, stock tanks, instream flow uses, and diversions both within and downstream of the project area. Tonto National Forest water rights claims are identified in *Table 3*-37.

The Tonto National Forest also has a water right permit (33-89109) that begins near the Pinto Valley weir (PC-10) for maintenance of instream flows in Pinto Creek. The purpose of this appropriation is to protect water-dependent resources, such as wildlife and fish, by requiring that certain water flows be maintained within the creek. This right varies by month and ranges from 1.0 to 2.69 cfs. Other water rights also allow for withdrawal of water from Pinto Creek downstream of the project area. These water rights are associated with private lands bordering Pinto Creek and include claims to 32 acre-feet per year for stock watering at the Barnes Property private lands (36-29478.0001) in T2NR13E Sec 24 and claims for 17 acre-feet per year for irrigation and stock watering at the Henderson Ranch private lands in T2NR13E Sec 1. Numerous wells owned and operated by BHP Copper (Pinto Valley Mine) are also located near Pinto Creek downstream of the project area. The water rights status of these wells will be determined with the completion of the Upper Salt River adjudication.

Flood Flows

Storm runoff events were modeled at important points of concentration within the project area. The Pima County Department of Transportation and Flood Control District (PCDOT&FCD) procedure (PCDOT&FCD 1972) was used to estimate flood peaks associated with storm recurrences of 2 years to 500 years (SLA 1993). The Corps of Engineers HEC-1 flood hydrograph procedure (COE 1990) was used to estimate flood peaks and volumes associated with 1/2 PMP events (Knight Piésold 1996e and 1996).

The procedure developed for Pima County is based on determining watershed characteristics such as area, length and mean slope of the longest watercourse, vegetation, soils, and land surface types. Empirical relationships between these factors are used to calculate the peak flow resulting from selected precipitation events. Precipitation estimates for various durations and recurrence intervals are shown in *Table 3-38*; these estimates were developed primarily from the Rainfall Frequency Atlas for Arizona (SLA 1993, NOAA 1973).

The 500-year, 1-hour precipitation estimates were developed by SLA using a logarithmic extrapolation based on the 2-year, 1-hour and 100-year, 1-hour precipitation values identified from NOAA maps (SLA 1991). These values were used as inputs to the flood peak and sediment transport rate estimation procedures.

Flood peaks associated with the selected rainfall events are shown in *Table 3-39*, as determined by the PCDOT&FCD procedure. These peak flow analyses were conducted for Pinto Creek and Powers Gulch at major points of interest (*Figure 3-12*), and for smaller tributary watersheds in the immediate vicinity of the Carlota Copper Project. *Figure 3-12* shows the locations of several of the watershed outlets where flood hydrology was modeled (SLA 1993). Flood peaks were simulated along Pinto Creek, Powers Gulch, and Haunted Canyon. Concentration points used for hydrologic and hydraulic simulations are denoted by an "S" in their alphanumeric identifiers. The locations of these points may differ from surface water field monitoring stations which lack the "S." As shown in *Table 3-39*, the magnitude of simulated flood peaks are not directly proportional to watershed area. This is because of the varying effects of different watershed and channel characteristics.

Estimates of general and local storm PMP were computed by Knight Piésold (Knight Piésold 1996e) using the method presented in "Hydrometeorological Report No. 49, Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainage" (NOAA and COE 1984). PMP and 1/2 PMP estimates are presented in *Table 3-40*. The 1/2 PMP peak flow

Table 3-37. Tonto National Forest Water Rights

Name	Water Right No.	Location	Quantity (acre-feet/year)
Mule Spring	36-14670	T1NR13E Sec 35	.11
Indian Spring	36-103383	T1NR13E Sec 35NENW	.11
Horse Shoe Spring	36-103165	T1NR13E Sec 26	.26
Haunted Spring	36-103028	T1NR13E Sec 26	.26
Grizzly Bear Spring	36-14670	T1nR13E Sec 36	.15
Yo Tambien Spring	36-14794	T1NR13E Sec 6	.15
Frenchy Spring	36-103117	T1NR13E Sec 23	.26
Grizzly Mtn. Tank	38-14617	T1NR13E Sec 26	.32
Pinto Creek Diversion	36-24007	T1NR13E Sec 23	16.2
Pinto Creek Instream Use	Certificate 2326.001	T1NR13E Sec 14 through T2NR13E Sec 23	6.27
Haunted Canyon Instream Use	Certificate 2305.001	T1NR13E Sec 28 through T1NR13E Sec 14	.92

Table 3-38. Storm Rainfall Estimates for Pinto Creek and Powers Gulch Watersheds

Duration	Areal Reduction Factor[1]	Point Rainfall (inches)						
		2-year	5-year	10-year	25-year	50-year	100-year	500-year[2]
1-hour	0.930	1.24	1.63	1.89	2.22	2.52	2.81	3.50
2-hour	0.945	1.50	1.97	2.27	2.67	3.03	3.39	4.20
3-hour	0.965	1.67	2.19	2.53	2.98	3.38	3.77	4.60
6-hour	0.973	2.00	2.62	3.02	3.55	4.03	4.50	5.50
24-hour	0.982	3.00	3.89	4.47	5.24	5.92	6.60	8.20

[1]Because of its larger size, areal-reduction factors only apply to the Pinto Creek watershed.
[2]Note: Five-hundred-year rainfall values were logarithmically extrapolated from NOAA 1973.
Source: SLA (1993)

and volume analyses were conducted for Powers Gulch.

One-half the probable maximum flood (1/2 PMF) peaks and volumes associated with seasonally representative 1/2 PMP events, as determined using the HEC-1 flood hydrograph procedure (Knight Piésold 1996e, 1996f, 1996g), are presented in *Table 3-41.*

The magnitude of recorded peaks varies widely in response to precipitation. For isolated runoff events identified in recent records (1986-1989) at the Pinto Valley weir, average daily high flows ranged from 6.5 cfs to 3,239 cfs. These mean daily flows corresponded to a daily precipitation at Miami of 0.34 inch and 1.09 inches, respectively. The smaller event occurred during a period of no preceding rain, whereas the larger event was preceded by 1.79 inches of rain in the previous week. Some periods of missing data occur in the weir records for these years, but they primarily occur during continued low flow periods and do not appear to significantly affect annual yield projections.

In general, streamflows respond rapidly to intense precipitation, with runoff creating flashy events that sharply rise and recede. Streamflows from major flood events will respond similarly. Peak discharges are significantly higher than typical flows in the channels, and provide high-energy conditions for sediment transport. These conditions are generally

Table 3-39. Estimated Peak Discharges Under Existing Conditions at Key Concentration Points[1]

Concentration Point	Description	Contributing Area (square miles)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)	Q500 (cfs)
SPG-1	Powers Gulch at downstream limit of the proposed diversion channel	2.28	246	801	1,287	2,051	2,822	3,660	5,682
SPG-3	Powers Gulch at downstream limit of the project study area	5.52	500	1,601	2,618	4,203	5,895	7,630	N/A
SHC-2	Haunted Canyon immediately downstream of Powers Gulch confluence	17.86	594	2,242	3,840	6,313	8,920	11,697	N/A
SPC-1A	Pinto Creek at upstream limit of the project study area	13.18	316	1,192	2,009	3,367	4,829	5,895	10,100
SPC-2	Pinto Creek at downstream limit of the project study area	14.45	335	1,269	2,123	3,532	5,044	6,729	N/A
SPC-4[2]	Pinto Creek immediately downstream of Haunted Canyon confluence	35.97	882	3,296	5,246	8,217	11,281	14,554	N/A

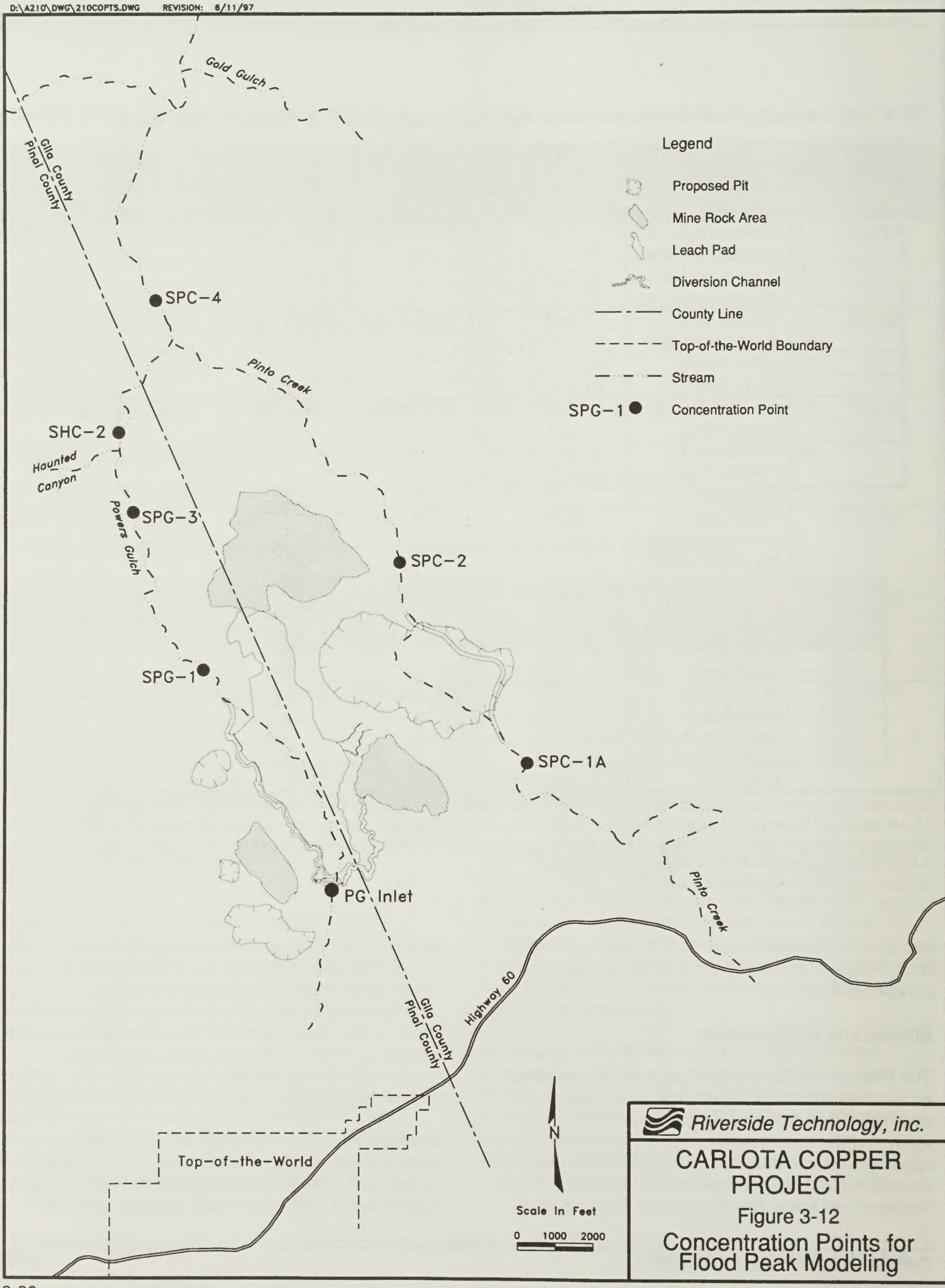
[1]Concentration points used for hydrologic and hydraulic simulations are denoted by an "S" in their identifiers (See *Figure 3-12*). The locations of these points may differ from surface water field monitoring locations. "Q" signifies discharge (e.g., Q100 signifies the estimated peak discharge from a storm that has a 1 in 100 chance of occurring in any given year). Values reflect a 1-hour thunderstorm event unless otherwise indicated.
[2]Values reflect a 24-hour storm event.
Source: SLA (1993)

capable of flushing fine sediments through and out of the headwater channel systems in the vicinity of the project area.

Erosion and Sedimentation

The Pinto Creek basin watersheds may be described as relatively mountainous with steep channels in the upstream areas transitioning into flatter and wider valleys further downstream. Large portions of the upper watersheds (including the project area) are densely vegetated, and significant portions of nonvegetated areas are covered with rock, either as outcroppings or gravel- to boulder-sized material. Past and current mining operations are located in the Pinto Creek watershed in the general vicinity of the proposed project. Because of the vegetative and rock cover, the existing watershed is reasonably stable with respect to erosion. Although significant hillslope erosion occurs in some areas that have a soil mantle, sediment supply from the overall watershed is limited.

Sediment transport rates were calculated using the Zeller-Fullerton equation (SLA 1993). Transport rates for selected cross sections of upper Pinto Creek and Powers Gulch were ranked low, medium, and high.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Gold Gulch
Gila County
Pinal County
Legend
Proposed Pit
Mine Rock Area
Leach Pad
Diversion Channel
County Line
Top-of-the-World Boundary
Stream
SPG-1
Concentration Point
SPC-4
Pinto Creek
SHC-2
Haunted Canyon
SPG-3
Powers Gulch
SPC-2
SPG-1
SPC-1A
PG Inlet
Pinto Creek
Highway 60
Gila County
Pinal County
Top-of-the-World
N
Scale In Feet
0 1000 2000
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Figure 3-12
Concentration Points for Flood Peak Modeling

Table 3-40. PMP and 1/2 PMP Estimates for Pinto Creek and Powers Gulch Watersheds[1]

Time of Year	Storm Type	PMP (inches)	1/2 PMP (inches)
January	72-hour general	23.1	11.6
February	72-hour general	22.8	11.4
March	72-hour general	22.1	11.4
April	72-hour general	20.2	10.1
May	72-hour general	18.6	9.3
June	72-hour general	18.6	9.5
July	72-hour general	25.6	12.8
August	72-hour general	25.3	14.9
September	72-hour general	29.7	14.9
October	72-hour general	25.3	13.6
November	72-hour general	25.3	12.8
December	72-hour general	23.6	11.8
Summer	6-hour local	14.1	7.1

[1]PMP estimates derived from HMR49 (NOAA and COE 1984)
Source: Knight Piésold (1996e)

Table 3-41. Estimated 1/2 PMF Peaks and Volumes Under Existing Conditions at Key Concentration Points

Concentration Point	Description	Flood Peak or Volume	6-hr Local Storm 1/2 PMF	72-hr August General Storm 1/2 PMF	72-hr October General Storm 1/2 PMF	72-hr February General Storm 1/2 PMF
PG-Inlet	Powers Gulch at upstream limit of the proposed diversion channel	Peak (cfs)	4,861	499	456	321
		Volume (cf)	11,952,000	25,961,760	25,177,680	19,732,680
		Volume (ac-ft)	274	596	578	453
		Volume (gal)	89,412,912	194,219,926	188,354,223	147,620,179
SPG-1	Powers Gulch at downstream limit of the proposed diversion channel	Peak (cfs)	12,838	1,474	1,348	950
		Volume (cf)	36,532,800	76,970,520	74,574,720	58,413,960
		Volume (ac-ft)	838	1,767	1,712	1,341
		Volume (gal)	273,301,877	575,816,458	557,893,478	436,994,833

Source: Knight Piésold 1996g

The average medium sediment transport rates for the cross sections were increased statistically to represent the upper 95 percent confidence limit of the medium values. The results are shown in *Table 3-42.* This table shows reasonable estimates of sediment transport rates associated with streamflows for the runoff events listed.

SLA also modeled average annual sediment yields using the Universal Soil Loss Equation (USLE) and a sediment delivery ratio. The results for selected points of interest are shown in *Table 3-43* for existing conditions. The results show that, on a unit area basis, relatively higher sediment yields originate from the Powers Gulch/Haunted Canyon area, and relatively lower yields originate from the upper Pinto Creek watershed.

Pinto Creek Mainstem Watershed. Channel geometry and bed material characteristics were documented in reports prepared for Carlota (SLA 1993) and in a report of on-site observations (Simons

Table 3-42. Summary of Sediment Transport Rates

Watercourse	Sediment Transport Rates (in cfs) by Return Interval			
	10-yr	50-yr	100-yr	500-yr
Pinto Creek	18	59	89	136
Powers Gulch	44	100	141	234

Source: SLA (1993)

Table 3-43. Summary of USLE Average Annual Sediment Yields for Existing Conditions

Concentration Point	Drainage Area (acres)	Existing Conditions (acre-feet/yr)
SPG1	1,457	0.49
SPG3	3,534	1.09
SHC2	11,422	4.50
SPC2	9,246	2.03
SPC4	23,012	6.05

Source: SLA (1993)

& Associates 1993). The bed of Pinto Creek in the project area is stable, consisting primarily of cobble-sized material but containing material ranging from sand size up to boulder size. The stream banks are vegetated and, in general, appear to be stable. At the time of the site visit, the moderate flow in the channel was clear with virtually no sediment transport.

Some tailings deposits are evident on floodplains along reaches of Pinto Creek located downstream from BHP Copper's Pinto Valley Mine. Some of these materials were released from tailings facilities located adjacent to Pinto Creek during the winter of 1992-1993. Other deposits accumulated from tailings releases that occurred prior to the 1992-1993 winter. Some of the deposited tailings were removed from the drainage during cleanup activities under the direction of the EPA, Arizona Game and Fish, and the Forest Service in 1993.

Observations made during high discharges at other times of the year indicate that a substantial amount of fine-grained material is carried by higher flows. As sand- and silt-sized material is washed from sideslopes into the channel during heavy precipitation, it contributes to higher turbidity levels. Short-duration, high-intensity rainfall and relatively steep channel slopes in the project area contribute to flashy flow events with considerable sediment transport capacity. Most of the fine-grained material is washed downstream.

As previously described, the overall watershed is either densely vegetated or occupied by non-erodible rock surfaces. This, in effect, limits sediment supply. High transport capacities accompanied by limited sediment supplies typically lead to channel degradation, bank erosion, and lateral channel migration. In the project area, however, this tendency is typically overcome by the presence of large sediment sizes (e.g., coarse gravels and cobbles) and bedrock-lined channel sections. These factors restrict the scour of finer sediments and provide geomorphic controls, respectively. The result is that for a large range of discharges, the Pinto Creek channel is stable or in a state of dynamic equilibrium with the watershed.

Powers Gulch and Haunted Canyon Watersheds. The watershed and channel characteristics in both of these tributaries are similar to Pinto Creek. The channels are mountain streams with relatively steep slopes and coarse bed material. Much of the Powers Gulch and Haunted Canyon watershed area is armored against erosion because of dense chaparral vegetation and exposed bedrock or other large-sized rock materials. In addition, the Powers Gulch and Haunted Canyon channels are relatively stable.

Similar to Pinto Creek, the sediment transport capacity of these streams significantly exceeds the natural sediment supply produced by the watershed, particularly at higher flows.

Surface Water Quality

Water quality requirements for surface waters in the project area are defined in Arizona's surface water quality rules (Arizona Administrative Code R18-11-101 through R18-11-205). These rules identify that water quality in Pinto Creek and its tributaries is for protection of the following designated uses: Warm Water Fishery (A&Ww), Full Body Contact Recreation (FBC), Fish Consumption (FC), Agricultural Irrigation (AI), and Agricultural Livestock Watering (AgL).

Narrative water quality standards (adopted as of April 24, 1996) are based on the EPA's list of “free-from” pollutants in amounts or combinations that settle to form significant bottom deposits; cause objectionable odors; cause off-flavor in aquatic organisms (e.g., fish) or waterfowl; are toxic to humans, animals, or plants; cause noxious aquatic plant growth; or cause or contribute to a violation of an aquifer water quality standard. "Free from" refers to a narrative requirement for waters to be free from individual or mixtures of toxic substances in toxic amounts. Numeric water quality standards include levels not to be exceeded for bacteria, physical properties (e.g., temperature and turbidity), inorganic nonmetal (e.g., pH, dissolved oxygen, fluoride, sulfide, nitrate, and phosphate), and total recoverable and dissolved metals. Numeric water quality standards for Pinto Creek and its tributaries are listed in *Table 3-44*.

General Surface Water Quality. The water quality data used to evaluate surface water conditions included data collected from 1992 through 1995 (Montgomery & Associates 1993, GWRC 1996b, Miller & Associates 1994). Data were available for Pinto Creek, Powers Gulch, and Haunted Canyon. Pinto Creek was divided into three reaches for summarization: upstream and downstream of the proposed Carlota/Cactus Pit and from below the Haunted Canyon confluence to above the confluence with the Salt River (*Table C1-1* in Appendix C, Water Resources Data). Available historical water quality data from Pinto Creek (Central Arizona Association of Governments 1981 and 1983) support the general water quality conditions described in the summary.

Powers Gulch was also divided into two reaches for summarization: upstream and downstream of the proposed heap leach pad and mine rock disposal areas (Table C1-2 in Appendix C, Water Resources Data). Haunted Canyon was summarized separately as one reach (*Table C1-2* in Appendix C, Water Resources Data). The quality control data provided for field duplicates and blanks, although not supplied with all results, generally met the established criteria or were determined to be acceptable on a case-by-case basis.

A condensed list of water quality constituents was selected from the detailed summary tables in Appendix C, Water Resources Data, to characterize and compare the water quality of Pinto Creek, Powers Gulch, and Haunted Canyon (*Table 3-45*). The water type of all three monitored reaches of Pinto Creek is predominantly calcium-sulfate. The upstream reach of Powers Gulch is a sodium, calcium-bicarbonate, sulfate water type, while the downstream reach of Powers Gulch is a calcium, sodium-bicarbonate water type. The Haunted Canyon water type is calcium-bicarbonate. TDS concentrations were higher in the Pinto Creek reach downstream of the proposed Carlota/Cactus Pit than in the upstream reach of Pinto Creek or in Powers Gulch or Haunted Canyon.

Flows varied greatly throughout the system. Sporadic fluctuations in chemistry most likely relate to timing with major storm events. TDS concentrations roughly increased with decreasing flows, while stream temperatures seemed to be more independent of flows and varied more with season (GWRC 1996). Measurements of pH were always within standard limits. Metals concentrations were generally low and below water quality standards, with a few exceptions. These exceptions included copper within Pinto Creek above and below the proposed Carlota/Cactus pit and lead in Powers Gulch downstream of the proposed heap-leach pad and mine rock disposal areas.

Above normal precipitation during the months of December 1992 and January 1993 resulted in an accidental release of mine tailings and PLS from existing Pinto Valley Mine operations into Pinto Creek (Hargis and Associates 1993). Water quality data are available for Pinto Creek within and below the project area shortly after these releases (Hargis and Associates 1993, Montgomery & Associates 1993,

Table 3-44. Surface and Ground Water Quality Standards for the Carlota Copper Project

Constituent	Units	Arizona Aquifer Standard[1]	Federal MCL	Numeric Water Quality Criterion					
				A & Ww[4]					
				Acute	Chronic	FBC	FC	AgI	AgL
Physical and Aggregate Properties									
Total Dissolved Solids	mg/L @ 180°C	---	500[3]	---	---	---	---	---	---
Turbidity	NTU	5	---	50	50	50	---	---	---
Water Temperature	Deg. Celsius	---	---	3.0[5]	3.0[5]	---	----	---	---
Major Cations									
Calcium	mg/L as Cd	---	---	---	---	---	---	---	---
Magnesium	mg/L as Mg	---	---	---	---	---	---	---	---
Potassium	mg/L as B	---	---	---	---	---	---	---	---
Sodium	mg/L as Na	---	---	---	---	---	---	---	---
Major Anions									
Bicarbonate	mg/L as $CaCO_3$	---	---	---	---	---	---	---	---
Chloride	mg/L as Cr	---	250[3]	---	---	---	---	---	---
Sulfate	mg/L as SO_4	---	250[3]	---	---	---	---	---	---
Inorganic Nonmetallics									
Boron	mg/L as B	---	---	---	---	12.6[6]	---	1.0 TR	---
Cyanide	mg/L as Cr	0.2	0.2[2]	0.041 TR	0.0097 TR	2.8 TR[6]	210 TR	---	0.2 TR
Dissolved Oxygen	mg/L as O_2	---	---	6.0	---	---	---	---	---
Fluoride	mg/L as B	4.0	4.0[2]/2.0[3]	---	---	8.4[6]	---	---	---
Nitrate	mg/L as N	10	10[2]	---	---	224[6]	---	---	---
Nitrate + Nitrite	mg/L as N	10	10[2]	---	---	---	---	---	---
Nitrite	mg/L as N	1	1[2]	---	---	14.0[6]	---	---	---
Orthosphosphate	mg/L as P	---	---	---	---	---	---	---	---
pH	standard units	---	6.5-8.5[3]	6.5-9.0	6.5-9.0	6.5-9.0	- - -	4.5-9.0	6.5-9.0
Sulfide	mg/L as S	---	---	0.1	---	---	---	---	---
Total Ammonia	mg/L as N	---	---	[8]	---	---	---	---	---
Total Nitrogen	mg/L as N	---	---	2.00	0.60	---	---	---	---
Total Phosphorus	mg/L as B	---	---	1.00	0.12	---	---	---	---
Metals									
Aluminum	mg/L as Al	---	0.05-0.2[3]	---	---	---	---	---	---
Antimony	mg/L as Sb	0.005	0.006[2]	0.088 D	0.030 D	0.056 TR	0.14 TR	---	---
Arsenic	mg/L as As	0.05	0.05[2]	0.360 D	0.190 D	0.05 TR	1.45 TR[6]	2.0 TR	0.2 TR
Barium	mg/L as B.	2	2[2]	---	---	9.8 D[6]	---	---	---
Beryllium	mg/L as Be	0.004	0.004[2]	0.065 D	0.0053 D	0.004 TR[6]	0.00021 TR	---	---
Cadmium	mg/L as Cd	0.005	0.006[2]	0.053 D	0.002 D	0.07 TR	0.041 TR[6]	0.05 TR	0.05 TR
Chromium (III)	mg/L as Cr	---	---	3.1 D	0.37 D	140.0 TR[6]	67.0 TR[6]	---	---
Chromium (VI)	mg/L as Cr	---	---	0.016D	0.011D	0.7 TR[6]	3.4 TR[6]	---	---
Chromium (total)	mg/L as Cr	0.1	0.1[2]	---	---	---	---	1 TR	1 TR
Cobalt	mg/L as Co	---	---	---	---	---	---	---	---
Copper	mg/L as Cr	---	1.3[2,7]/1.0[3]	0.034 D	0.021 D	5.2 D	---	5.0 TR	0.5 TR
Iron	mg/L as Fe	---	0.3[3]	---	---	---	---	- - -	---
Lead	mg/L as Fe	0.05	0.015[2,7]	0.197 D	0.008 D	---	---	10.0 TR	0.1 TR
Manganese	mg/L as Mn	---	0.05[3]	---	---	19.6 TR[6]	---	10.0	---
Mercury	mg/L as Hg	0.002	0.002[2]	0.0024 D	0.00001 D	0.042TR	0.0006 TR	- - -	0.01 TR
Molybdenum	mg/L as Mo	---	---	---	---	---	---	---	---
Nickel	mg/L as Ni	0.1	0.1[2]	2.5491 D	0.2834 D	2.8 TR	0.73 TR[6]	---	---
Selenium	mg/L as Se	0.05	0.05[2]	0.02 TR	0.002 TR	0.7 TR[6]	9.0 TR	0.02 TR	0.05 TR
Silver	mg/L as Ag	---	0.1[3]	0.013 D	---	---	---	---	---
Strontium	mg/L as Sb	---	---	---	---	---	---	---	---
Thallium	mg/L as Al	0.002	0.002[2]	0.70 D	0.15 D	0.012 TR[6]	0.041 TR[6]	---	---
Zinc	mg/L as Zn	---	5.0[3]	0.21 D	0.15 D	42.0 TR[6]	22.0 TR[6]	10.0 TR	25.0 TR
Radionuclides									
Gross Alpha Activity	pCi/L	15	15[2]	---	---	---	---	---	---
Gross Beta Activity	mrem/yr	4	4 (50 pCi/L)	---	---	---	---	---	---
Radium 226 + 228	pCi/L	5	5[2]	---	---	---	---	---	---

[1]Arizona Aquifer Water Quality Standard (1996)
[2]Federal Primary maximum contaminant level (MCL) for drinking water
[3]Federal Secondary MCL for drinking water
[4]A concentration of 200 mg/L as $CaCO_3$ was used for calculating water quality criteria that are hardness dependent (Cd, Cu, Pb, Ni, Ag, Zn)
[5]Temperature criteria are given as increases from ambient levels
[6]Arizona-adopted (as of April 24, 1996) water quality criterion under review by EPA
[7]Action level for treatment technique requirement
[8]Total ammonia criterion is based on field measurements of pH and water temperature

D = Dissolved fraction
TR = Total recoverable fraction
A&Ww = Aquatic and wildlife (warm water fishery)
FBC = Full body contact
FC = Fish consumption
Agl = Agricultural irrigation
AgL = Agricultural livestock watering

Table 3-45. Summary of Surface Water Quality for Affected Environment

Surface Water	Water Type	Mean ± 1 Standard Deviation							Water Quality Criterion Exceedances[2]
		pH (s.u.)	Water Temperature (°C)	Dissolved Oxygen (mg/L as O_2)	TDS (mg/L @ 180°C)	TSS (mg/L @ 103°C)	Sulfate (mg/L as SO_4)	Flow[1] (cfs)	
Pinto Creek									
Upstream of Proposed Carlota/Cactus Pit	Ca - SO_4	7.7 ± 0.4	15.3 ± 3.92	8.1 ±2.3	384 ± 111	6 ± 4	169 ± 73.1	1.4 ± 2.7	DO, Cu
Downstream of Proposed Carlota/Cactus Pit	Ca - SO_4	7.7 ± 0.4	15.4 ± 4.3	7.4 ±1.2	932 ± 343	0.8 ± 0.8	463 ± 184	1.66 ± 2.68	DO, Cu
Below Haunted Canyon Confluence to above Salt River Confluence	Ca - SO_4	7.5 ± 0.3	19.1 ± 3.2	8.1 ± 2.3	840 ± 449	3.6 ± 2.7	347 ± 275	1.2 ± 1.25	DO
Powers Gulch									
Upstream of Proposed Heap Leach Pad and Mine Rock Disposal Areas	Na, Ca- HCO_3, SO_4	7.8 ±0.0	9 ±0	8.85 ±0.00	110 ±0	144 ±0	16.7 ±0.0	0.16 ±0.00	No Exceedances
Downstream of Proposed Heap Leach Pad and Mine Rock Disposal Areas	Ca, Na- HCO_3	7.3 ±0.0	5.5 ±0.0	9.86 ±0.00	124 ±0	5 ±0	21.3 ±0.0	2.35 ±0.00	Pb
Haunted Canyon	Ca - HCO_3	7.5 ± 0.3	17 ± 4	4.7 ±0.0	326 ± 59	2.4 ± 2.7	52.1 ± 20.3	0.21 ± 0.18	DO

[1]During water quality sampling.
[2]Constituents with values that exceeded a water quality criterion in at least one sample.

Magma Copper Corporation 1993). These values might not be indicative of naturally-occurring baseline conditions and, therefore, were not included in the concentration ranges and calculations of average baseline copper concentrations presented in *Table 3-45* and *Table C1-1* of Appendix C, Water Resources Data. Copper concentrations in samples affected by the accidental release of tailings and PLS ranged from 0.018 mg/L to 0.193 mg/L dissolved copper and from 0.025 mg/L to 1.83 mg/L total recoverable copper (Hargis and Associates 1993, Montgomery & Associates 1993, Magma Copper Corporation 1993). Samples collected since the release (GWRC 1996) did not reflect the same elevated copper concentrations.

Pinto Creek Water Quality. Pinto Creek surface water quality data were summarized for three reaches upstream and downstream of the proposed Carlota/Cactus pit and below the Haunted Canyon confluence to above the Salt River confluence (*Figure 3-8*) (PC-3, PC-5, PC-7, PC-7.5, PC-8, and PC-10).

Pinto Creek surface water is a calcium-sulfate type. *Table 3-45* summarizes the pH, water temperature, dissolved oxygen, TDS, TSS, sulfate, and flow for Pinto Creek. Analyses of samples collected in Pinto Creek both upstream and downstream of the Carlota/Cactus pit and below the Haunted Canyon confluence met applicable stream standards for all constituents except dissolved oxygen and copper (Pinto Creek above and below the Carlota/Cactus pit only) (*Table C1-1 in* Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: cyanide, total phosphorus, antimony, beryllium, cadmium, copper (Pinto Creek station below Haunted Canyon confluence only), mercury, selenium, and thallium. Copper is common in pyrite ores found throughout the region, and potential sources to surface waters include natural oxidation processes and historic mining operations.

ADEQ's Water Quality Assessment Report for 1996 (ADEQ 1996) identifies that the reach of Pinto Creek from its headwaters to the confluence with Spring Creek does not support its designated uses because of a violation of the dissolved copper standard for warm water fisheries recorded below the Gibson Mine in 1992 and for a violation of the state's narrative standards as a result of a tailings spill from the Pinto Valley Mine in 1991. The assessment also reports that the dissolved copper standard was violated in 1993 as a result of a major leach solution and tailings spill from this same mine.

Powers Gulch Water Quality. Powers Gulch surface water quality data were summarized for two reaches upstream and downstream of the proposed heap-leach pad and mine rock disposal areas (PG-1 and PG-4). *Table 3-45* summarizes pH, water temperature, dissolved oxygen, TDS, TSS, sulfate, and flow. Analyses of water samples collected upstream of the proposed heap-leach pad and mine rock disposal areas indicated no water quality standard exceedances, while at the downstream site only lead exceeded water quality standards (*Table C1-2* in Appendix C, Water Resources Data).

The single exceedance (0.094 mg/L as Pb) of a lead standard (0.008 mg/L as Pb for chronic aquatic wildlife) may be a result of sampling or analytical error considering that the dissolved lead concentration is more than an order of magnitude greater than the total recoverable concentration, and because lead solubility is relatively low (less than 0.05 mg/L as Pb) in oxidizing waters of neutral pH. Provided the reported lead concentration is credible, possible sources of lead include the localized geology or resuspension of sediment deposits originating in upstream reaches.

Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: cyanide, beryllium, cadmium, mercury, selenium, and thallium. In addition, total phosphorous analyses were not available for either reach.

Haunted Canyon Water Quality. Haunted Canyon surface water (HC-2) is generally a calcium-bicarbonate type. The pH, water temperature, dissolved oxygen, TDS, TSS, sulfate, and flow are summarized in *Table 3-45.* Analyses of water quality samples collected from Haunted Canyon consistently met applicable Arizona Surface Water Quality Standards for all constituents tested except dissolved oxygen (*Tables C1-2* in Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: cyanide, total phosphorus, antimony, beryllium, cadmium, copper, mercury, selenium, and thallium.

Well Field Area Water Quality. The well field area for the Carlota Copper Project lies adjacent to Pinto Creek and Haunted Canyon in the area of their confluence. Surface water quality data were available from upstream and downstream of the well field. Upstream water quality in Haunted Canyon is described in the previous paragraph. The water chemistry in Haunted Canyon was a very dominant calcium bicarbonate water type, while at a sampling location in Pinto Creek (PC-5) located upstream from the Haunted Canyon confluence, the water chemistry was a very dominant calcium sulfate water type (GWRC 1996). At a sampling point downstream of the Haunted Canyon-Pinto Creek confluence and well field (PC-7), the water type was a calcium-bicarbonate type, indicating that Haunted Canyon streamflows exert an influence on the water chemistry of Pinto Creek below the confluence of these two streams. This change in water type is limited because further downstream in Pinto Creek (PC-7.5) the water type reverts back to the calcium sulfate type (GWRC 1996b). TDS appears to behave similarly, exhibiting a mixing of the two streams (GWRC 1994).

3.3.1.3 Ground Water

Several hydrogeologic investigations have been conducted for the project to provide the necessary background information for this EIS and to support the Aquifer Protection Permit application (Montgomery & Associates 1992, 1993, GWRC 1994). These investigations have focused on defining the hydrogeologic conditions in the project area and in the vicinity of the well field. These investigations have included monitoring well installation, aquifer testing and analysis, water quality monitoring, and drawdown analysis. Ground water monitoring included measuring water levels monthly in up to 32 wells located in the project vicinity. Quarterly water quality samples were collected in up to 18 wells.

Regional Hydrogeology and Ground Water Use

The general lithologic and structural conditions in the region are discussed in Section 3.2, Geology and Minerals. Three principal hydrostratigraphic units have been recognized in the region: (1) bedrock complex, (2) Gila Conglomerate, and (3) alluvium.

The bedrock complex is composed of sedimentary, volcanic, and metamorphic rocks that range from the Precambrian to the Tertiary age. Yields from wells in the bedrock complex are generally low (less than 50 gpm), although fractured sections of Precambrian Quartzite and Paleozoic Limestone can locally yield up to several hundred gpm. The Schultze Granite and Apache Leap Dacite, which underlie areas just south of the project facilities, yield small quantities of water to domestic wells in the Top-of-the-World community.

The Gila Conglomerate is the principal aquifer in Pinto Valley and in the Globe-Miami area. The conglomerate aquifer provides ground water to several mining projects within the Globe-Miami Mining District, including the adjacent Pinto Valley Mine. Wells drilled 500 to 800 feet deep typically yield 50 to 150 gpm. Overdraft has depleted the quantity of water available in the Gila Conglomerate (Peterson 1962). Although the Gila Conglomerate is present on the project site, it is not considered an aquifer since it occurs above the general water table elevation for the area.

Alluvium occurs as a thin, discontinuous ribbon that veneers portions of valley bottoms along Pinto Creek and its tributaries. This material consists of porous unconsolidated sand, silt, gravel, and boulders transported by surface runoff and deposited in stream channels and floodplains. From the headwaters to the Pinto Valley weir, the width of the alluvium ranges from approximately 0 to 1,200 feet, with an estimated average of 100 to 200 feet. The alluvium has an estimated maximum thickness of approximately 50 feet. However, the average thickness of the alluvium between the project site and BHP Copper's Pinto Valley weir is probably on the order of 10 to 20 feet. Because of the alluvium's limited extent, the volume of water it stores is limited.

The static water level elevations in the unconfined and poorly confined units are generally lower in downstream areas of the drainages as compared to upstream areas. These water level data indicate that, where unimpeded by ground water barriers, ground water throughout the area generally moves from higher elevation areas toward the axis of major valleys and then down the axis of the valleys.

Ground water in the region is withdrawn primarily for mining and domestic use. According to the Arizona Department of Water Resources (ADWR) records, a total of 99 water supply wells have been permitted in the project vicinity. All permitted wells, excluding monitoring wells, are summarized in *Table C2-1* in Appendix C, Water Resources Data; the well locations, except for wells at Top-of-the-World, are shown in *Figure 3-9*. Uncertainty regarding precise locations, coupled with the large number of wells, precluded presenting the private wells at Top-of-the-World in *Figure 3-9*. However, the general location of these wells is indicated by the well number code[1] in *Table C2-1* in Appendix C, Water Resources Data.

BHP Copper owns 11 water supply wells with reported yields[2] that range from 10 to 445 gpm within the inventory boundary. These wells are located east and north of the Carlota/Cactus pit area. BHP Copper

[1] The well number includes the a-b-c-d well location system of the ADWR in accordance with the BLM's system of land subdivision that identifies the township, range, section, quarter section, and quarter-quarter section.

[2] The reported yields are based on information provided on driller's logs submitted to the ADWR. These yields are typically based on short-term pump tests and may be greater than the actual long-term sustainable yield for the well.

also has two large-diameter, caisson-type wells that are apparently used to capture seepage from the tailings facilities.

In the area outlined as Top-of-the-World in *Figure 3-9*, there are 83 known wells—78 private wells and 5 wells owned by ASARCO. The private wells within the Top-of-the-World area have reported yields that average 12 gpm and range from less than 1 gpm to 40 gpm. The total depth of the private wells at Top-of-the-World ranges from 8 to 1,002 feet. These existing data do not indicate any apparent trends regarding yield versus depth.

Hydrogeology of the Project Area

Knowledge of the hydrogeologic conditions in the project area is based on detailed geologic mapping and exploration drilling and on information obtained from monitoring wells. The locations of the monitoring wells are shown in *Figure 3-13*. The wells are clustered in three primary areas: (1) Pinto Creek in the vicinity of the Carlota/ Cactus pit, (2) Powers Gulch in the vicinity of the heap-leach pad and Eder pits, and (3) the well field area. Ground water occurs in the bedrock complex that underlies the area and in the alluvium that veneers bedrock along major drainage courses.

Bedrock. In the bedrock complex, the recharge, storage, flow, and discharge of ground water is controlled by the porosity, permeability, and structure (i.e., fault and fracture zones) of the geologic materials. As presented in Section 3.2, Geology and Minerals, the lithology and structural conditions within the project area are complex. For example, through detailed geologic mapping in the immediate project area and in the vicinity of the well field, Carlota has identified over 30 different rock units and numerous fault zones that range from Precambrian (greater than 600 million years before present [mybp]) to late Tertiary (5 mybp). Ground water in these bedrock units is stored and transmitted through a system of interconnected fractures, or fracture networks. Because of the broad variation of rock types and the complex pattern of fracturing present in the project area, the concentration and interconnection of fractures is envisioned to be highly variable across the area.

Ground water flow pathways in the bedrock complex are further complicated by major faults (i.e., Kelly fault, North fault, Cactus fault, Bundy fault, and Eder fault system, as shown on the geologic map in *Figure 3-3*) that offset and displace various rock units. Faulting commonly forms zones of crushed and pulverized rock that may behave as barriers to ground water movement. Depending on the physical properties of the rock mass and the amount of movement, faulting can also create conduits along the fault trace, resulting in zones of relatively high ground water flow and storage capacity compared to the unfaulted surrounding rock.

The results of pump tests conducted in selected bedrock monitoring wells (excluding the water supply test wells) are presented in *Table C3-1* in Appendix C, Water Resources Data. During short-term pump tests (several hours), most wells exhibited rapid drawdown at low pumping rates (1 to 94 gpm). In fact, most monitoring wells could sustain pumping of only a few gpm. The transmissivity computed from analyzing water level drawdown data is low, ranging from less than 1 to 380 gallons per day (gpd) per foot of aquifer; hydraulic conductivity is also low, ranging from less than 0.005 to 9.5 gpd per square foot of aquifer. It is important to note that these values represent the bulk hydraulic properties of the entire saturated thickness of bedrock tested. This saturated test interval typically includes several rock types and is up to 580 feet long. Considering that the hydraulic conductivity is controlled by fractures, and that the quantity, size, interconnection, and orientation of these fractures are not uniform within individual rock units or between different rock units, the hydraulic properties within each monitoring well are undoubtedly heterogeneous (different from one segment of the well to another) and strongly anisotropic (different in different directions).

The principal source of recharge to the bedrock complex is from infiltration of rainfall and snowmelt to fractures in bedrock outcrops. In addition, the bedrock probably receives some recharge seasonally from the alluvial aquifer. Locally, where the stream channel is incised into bedrock, the bedrock complex is probably also seasonally recharged directly by streamflow.

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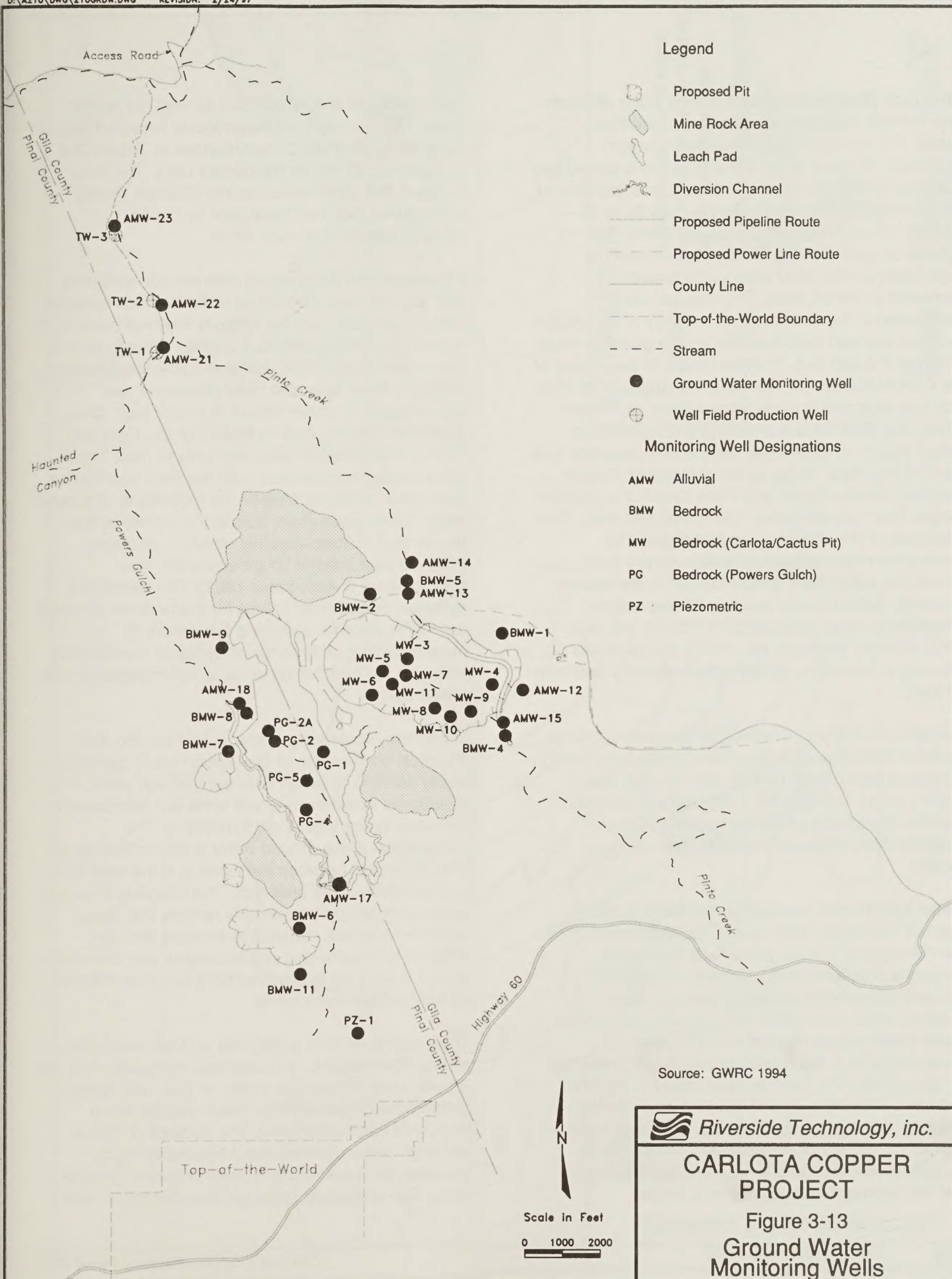

CARLOTA COPPER PROJECT

Figure 3-13
Ground Water Monitoring Wells

Alluvium. Ground water also occurs in the alluvium that veneers bedrock in the bottom of the Pinto Creek, Powers Gulch, and Haunted Canyon drainages. Ground water in the alluvium is stored and transmitted through interconnected pores; porosity of the alluvium is estimated to range from 30 to 40 percent (Montgomery & Associates 1992). The volume of water flowing through the alluvium is dependent on the areal extent and saturated thickness of the alluvium. The mapped areal distribution of the alluvium in the vicinity of the project facilities and well field is shown on the geologic maps (*Figures 3-3 and 3-4*). In Pinto Creek, in the vicinity of the Carlota/Cactus pit, the alluvium ranges from 80 to 500 feet wide and is up to 30 feet deep. In Powers Gulch, the alluvium occurs along a discontinuous ribbon that is up to 500 feet wide and is generally less than 20 feet thick. In the reach of Haunted Canyon between Powers Gulch and Pinto Creek, the alluvium ranges from approximately 150 to 400 feet wide. The thickness of the alluvium was investigated by conducting three seismic refraction survey lines across the valley floor (perpendicular to the stream channel). Based on the results of these seismic refraction surveys (hdyroGEOPHYSICS, Inc. and BIRD Seismic Services, Inc. 1995), the thickness of alluvium is inferred to be very thin (generally less than 10 feet).

The alluvial aquifer in Pinto Creek receives recharge from the infiltration of streamflows, particularly during periods of high runoff. Locally, the alluvium may receive some recharge from the bedrock complex (see the discussion under the heading "Ground Water/Surface Water Interactions" for additional details).

Water Levels and Ground Water Flow. Existing bedrock monitoring wells are of variable construction. For this reason, it is not possible to define the variations in potentiometric (head) conditions in the bedrock complex at depth, between major lithologic units, or on either side of major structures. Water level contours based on water level measurements in the monitoring wells are presented in *Figure 3-14*. The contour map indicates that the hydraulic potential exists for ground water to flow from the higher elevation ridges toward, and down the axis of, the principal drainage features (Pinto Creek and Powers Gulch). This implies, however, that the bedrock unit behaves as a single hydrogeologic unit, which may or may not be the case. The fluctuation of water levels recorded for each monitoring well is summarized in *Table C3-2* in Appendix C, Water Resources Data. The data suggest that some wells tap into different blocks of fractured rock that have poor hydraulic communication with each other.

Observations during drilling also provide evidence that ground water conditions in the bedrock complex may be variable, and the bedrock may not behave as a single continuous bedrock aquifer. Montgomery & Associates (1992) indicates that during exploration drilling, a large hydraulic head difference was encountered on either side of the Kelly fault. Also, exploration drilling data indicate that the Kelly and Cactus faults contain large amounts of clay. These observations suggest that both the Kelly and Cactus fault zones probably impede the movement of ground water. Other subsurface data in the vicinity of the Bundy fault indicate that this structure probably behaves as a conduit for ground water flow (Montgomery & Associates 1992). The calculated hydraulic conductivity values for the bedrock complex are highly variable, spanning five orders of magnitude; this wide range of hydraulic conductivity indicates the bedrock complex is heterogeneous and anisotropic.

In addition, as described later in this section, the chemical composition of the ground water sampled is highly variable between different bedrock wells. This variation is noted even where wells are completed in the same primary geologic formations. The composition of the ground water is dependent on the time of contact between the water and the host rock and reactivity of the host rock. The variation in ground water composition presumably reflects that water within the bedrock complex is evolving through different flow pathways and lithologies and that there is poor mixing (or interconnection) between different hydrochemical water types.

The water level data, pump test and recovery data, drilling observations, and chemical composition of the ground water all provide evidence that, with respect to hydraulic characteristics, there may be some degree of partitioning within the bedrock complex. Although poorly defined and presumably highly complex, this partitioning is likely to control ground water flow pathways, recharge and discharge, and

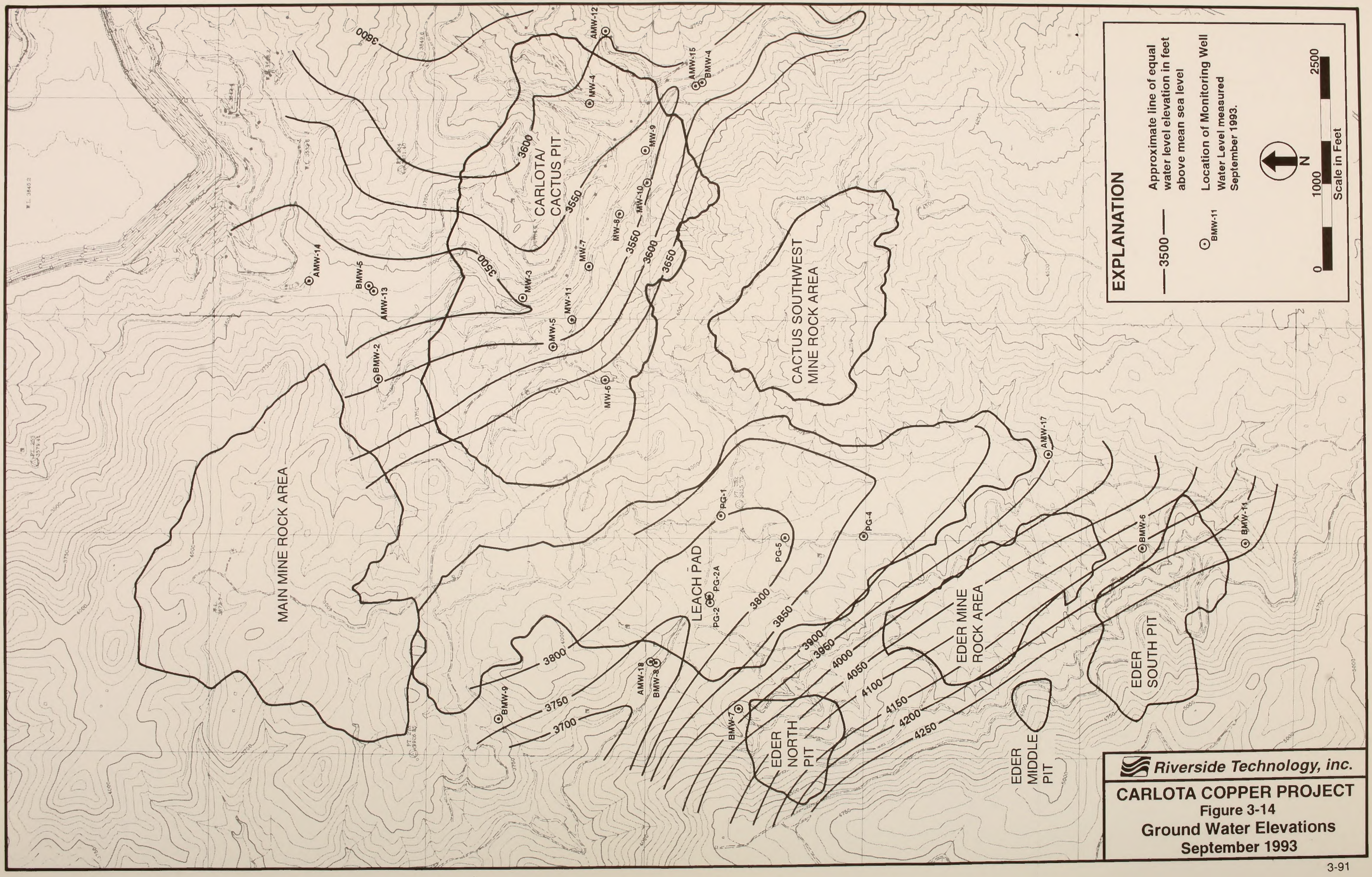

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Figure 3-14
Ground Water Elevations
September 1993

drawdown patterns resulting from ground water withdrawal.

Heap-Leach Pad and Rock Disposal Areas. The interpreted hydrogeologic conditions in the vicinity of the heap leach and Main mine rock disposal facilities are illustrated on a set of cross sections. The location of the cross sections are shown in *Figure 3-15*; cross sections through the heap-leach pad and Main mine rock disposal area are presented in *Figures 3-16* and *3-17*, respectively, and are discussed below. Ground water flow in the vicinity of the proposed heap-leach pad is controlled by movement through fractured bedrock units and along prominent faults. Also, minor amounts of ground water move through the thin alluvium present along the Powers Gulch drainage channel. The depth to ground water and distribution of bedrock units, faults, and alluvium in the vicinity of the heap-leach facility are illustrated on the geologic map (*Figure 3-3*) and cross sections (*Figure 3-16*).

The primary bedrock units beneath the leach pad area consist of Pinal Schist, Precambrian Diabase, and Apache Group. The major structural discontinuity trends northeast-southwest. Water level data from monitoring wells in the leach pad area indicate the potentiometric surface for the bedrock complex ranges from a few feet above land surface to greater than 30 feet below land surface. Monitoring wells installed in the bedrock adjacent to the creek in Powers Gulch (BMW-8, PG-2, PG-5,) record potentiometric conditions that seasonally are near (less than 5 feet below the surface) or above the existing ground surface. Seasonal water levels in the shallow wells completed in the alluvium (AMW-18, PG-2A) are within a few feet of the surface (less than 5 feet below the ground surface). In the late winter and early spring, an upward hydraulic gradient exists in the vicinity of PG-2, located in the creek channel in the southern half of the heap-leach pad. This upward hydraulic gradient caused this monitoring well to discharge at the surface in the spring of 1992. Ground water gradients range from approximately 200 feet per mile in the valley bottom to 800 feet per mile along the side slopes of Powers Gulch. Pump tests of the bedrock monitoring wells located in the southern portion of the leach pad indicate that the bulk permeability of the bedrock is low with hydraulic conductivities ranging from 0.03 to 1.3 gpd per square foot.

Subsurface conditions in the vicinity of the Main mine rock disposal area are illustrated in the cross sections in *Figure 3-17*. The principal rock unit types beneath the Main mine rock disposal area are the Tertiary Apache Leap volcanics and Paleozoic limestone. The Cactus Southwest mine rock area would be placed on the Precambrian Pinal Schist and Granite on Manitou Hill. The depth to ground water beneath these facilities is not known. However, the elevations of these sites suggest that, in general, the potentiometric surface of the bedrock is probably several tens of feet beneath the surface. One possible exception is Grizzly Bear Springs located in the southeast portion of the Main mine rock disposal area (see *Figure 3-9* for location). When these springs are flowing, the potentiometric surface of the bedrock is inferred to be above the ground surface. The Eder mine rock area would be constructed on slope deposits overlying Pinal Schist. Projecting water level data from the monitoring wells located immediately downslope of the Eder North and Eder South pits suggests that the potentiometric surface for the bedrock is probably 30 to 40 feet or more beneath the surface.

Springs. Major springs in the locale include Miller Spring, Mule Spring, Fifty Dollar Spring, and Coon Spring (*Figure 3-9*). Water quality analyses are summarized for selected springs in Table C4-3 of Appendix C, Water Resources Data. The first two springs are within the project area. Numerous other springs, adit flows, and seeps occur farther up the tributaries of Pinto Creek. Miller Spring and Mule Spring were monitored at approximately monthly intervals from the spring of 1993 through 1995 (GWRC 1996b). As shown in *Table 3-35*, the maximum measured flow at Miller Spring was 0.37 cfs (approximately 166 gpm); the spring was reported dry on 19 of the 33 monitoring dates. Mule Spring flowed throughout the monitoring period. Measured flows ranged from 2 cfs (approximately 898 gpm) to less than 1 gpm (GWRC 1996b).

The Grizzly Bear Spring (see *Figure 3-9* for location) consist of two small springs or seeps. On June 21, 1993, the reported discharge at each spring was less than 1 gpm (GWRC 1994). No other flow data are available for these springs.

Several springs, including 23db, 25ca, and 36ab (Miller Spring), are located near to and downgradient from an existing tailings facility owned by BHP Copper. The proximity of these springs and their relatively high electrical conductivity values indicate possible contamination of the spring water quality, but there is no substantiating evidence that the tailings facility is the contaminant source. However, Miller Spring was formerly used as an NPDES discharge point for the Pinto Valley Mine.

Ground Water Quality

Ground Water Quality Standards. Ground water quality standards for state aquifers have been established by the State of Arizona under *Arizona Administrative Code, Title 18, Environmental Quality, Chapter 11, Water Quality Boundaries and Standards, Article 4, Aquifer Water Quality Standards.* All aquifers in the state are classified for drinking water protected use except for aquifers that are reclassified to a non-drinking water protected use pursuant to A.R.S. § 49-224 and A.A.C. R18-11-503 Petition for Reclassification. The term "drinking water protected use" is defined in Section R18-11-401 to mean the protection and maintenance of aquifer water quality for human consumption. The term "non-drinking water protected use" is defined in Section R18-11-401 to mean the protection and maintenance of aquifer water quality for a use other than human consumption.

The bedrock and alluvial aquifers identified in the project area are classified for drinking water protected use. Water quality criteria to protect a drinking water protected use classification are prescribed in Section R18-11-405 (Narrative Aquifer Water Quality Standards) and Section R18-11-406 (Numeric Aquifer Water Quality Standards: Drinking Water Protected Use).

Narrative aquifer water quality standards restrict discharges that (1) cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration that endangers human health, (2) shall cause or contribute to a violation of a water quality standard established for a navigable water of the state, and (3) shall cause a pollutant to be present in an aquifer that impairs existing or reasonably foreseeable uses of water in an aquifer.

Numeric aquifer water quality standards are based on federal primary MCLs. federal MCLs include primary MCLs (health-based) and secondary MCLs (public welfare-based). Because Arizona aquifer standards are promulgated after federal primary MCL promulgation and because Arizona Aquifer Water Quality Standards do not include all federal primary or secondary MCLs, water quality criteria to protect drinking water protected aquifers in the Carlota Copper Project area will be based not only on Arizona Aquifer Water Quality Standards but on federal primary and secondary MCLs as well. Numeric water quality standards for aquifers in the project area are listed previously in *Table 3-44*.

General Ground Water Quality. The water quality data used to evaluate ground water conditions included data collected during 1992 (Montgomery and Associates, Inc. 1993) and 1993 to 1995 (GWRC 1994, 1996b). Data were available for areas in the Pinto Creek, Powers Gulch, and Haunted Canyon drainages. Bedrock and alluvial ground water quality were summarized separately for Pinto Creek, Powers Gulch, the well field area, springs, and private wells (*Tables C4-1, C4-2, and C4-3* in Appendix C, Water Resources Data). A condensed list of water quality constituents was selected from the detailed summary tables in Appendix C, Water Resources Data, to characterize and compare bedrock, alluvial, and spring water quality (*Table 3-46*).

Data from bedrock wells in each area were combined to summarize the water quality of the bedrock system. Water quality in individual rock types was not evaluated since few wells isolate specific rock types.

The monitoring wells are designated as either bedrock or alluvial monitoring wells. The bedrock monitoring wells are designed to prevent the interception of ground water contained in the overlying surficial material, such as alluvium or colluvium. Several of the alluvial monitoring wells, however, were designed to intercept ground water in both alluvium and shallow bedrock. This type of completion makes it difficult to characterize the background alluvial water quality. For this EIS, only alluvial wells that contained a minimum of 75 percent (by depth) of the open portion of the well in alluvium were considered in the water quality summary tables. The selection of the 75 percent cut-off was arbitrary. However, since the alluvium is typically several orders of magnitude greater in hydraulic conductivity than the bedrock, it seems reasonable to assume that

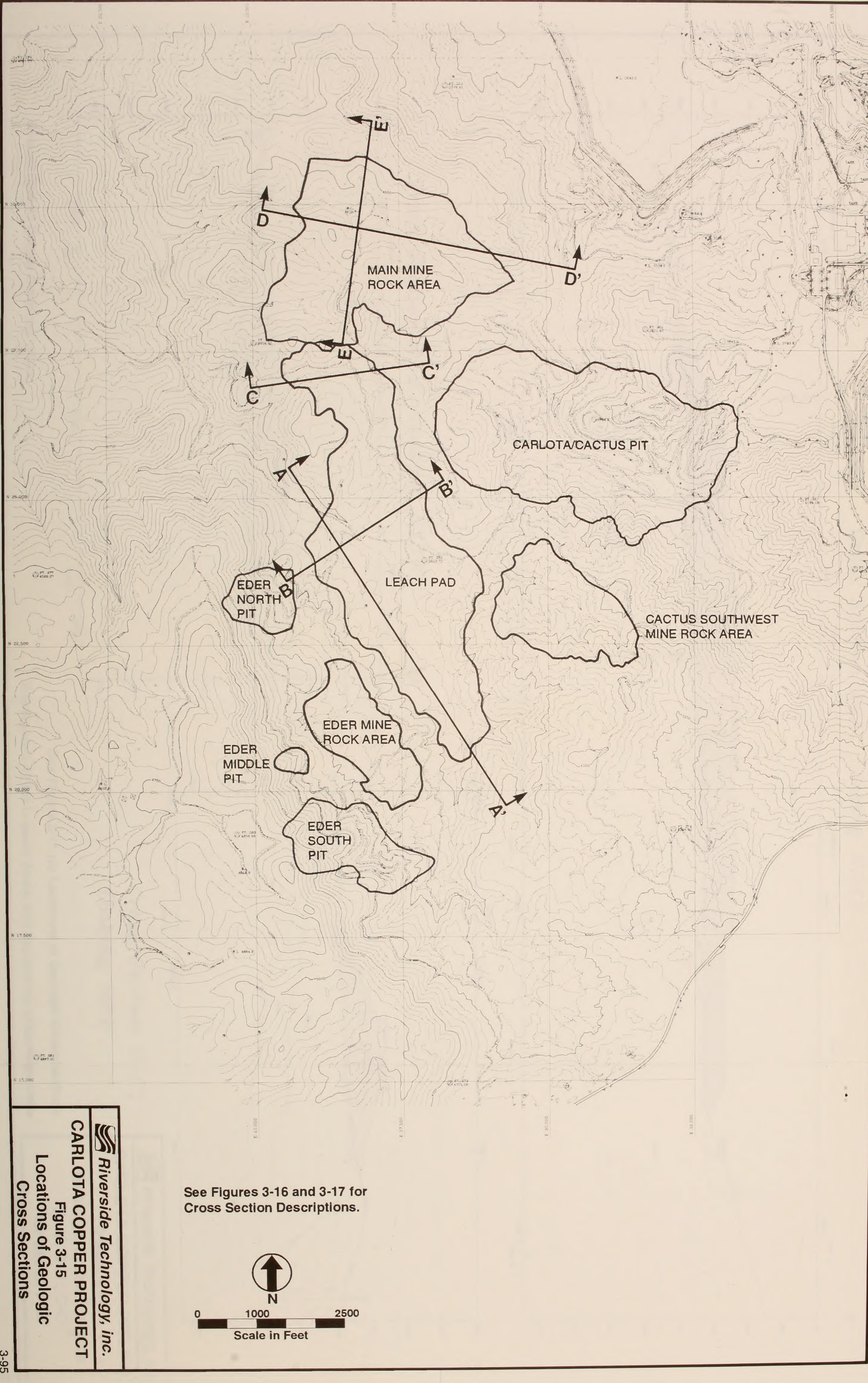

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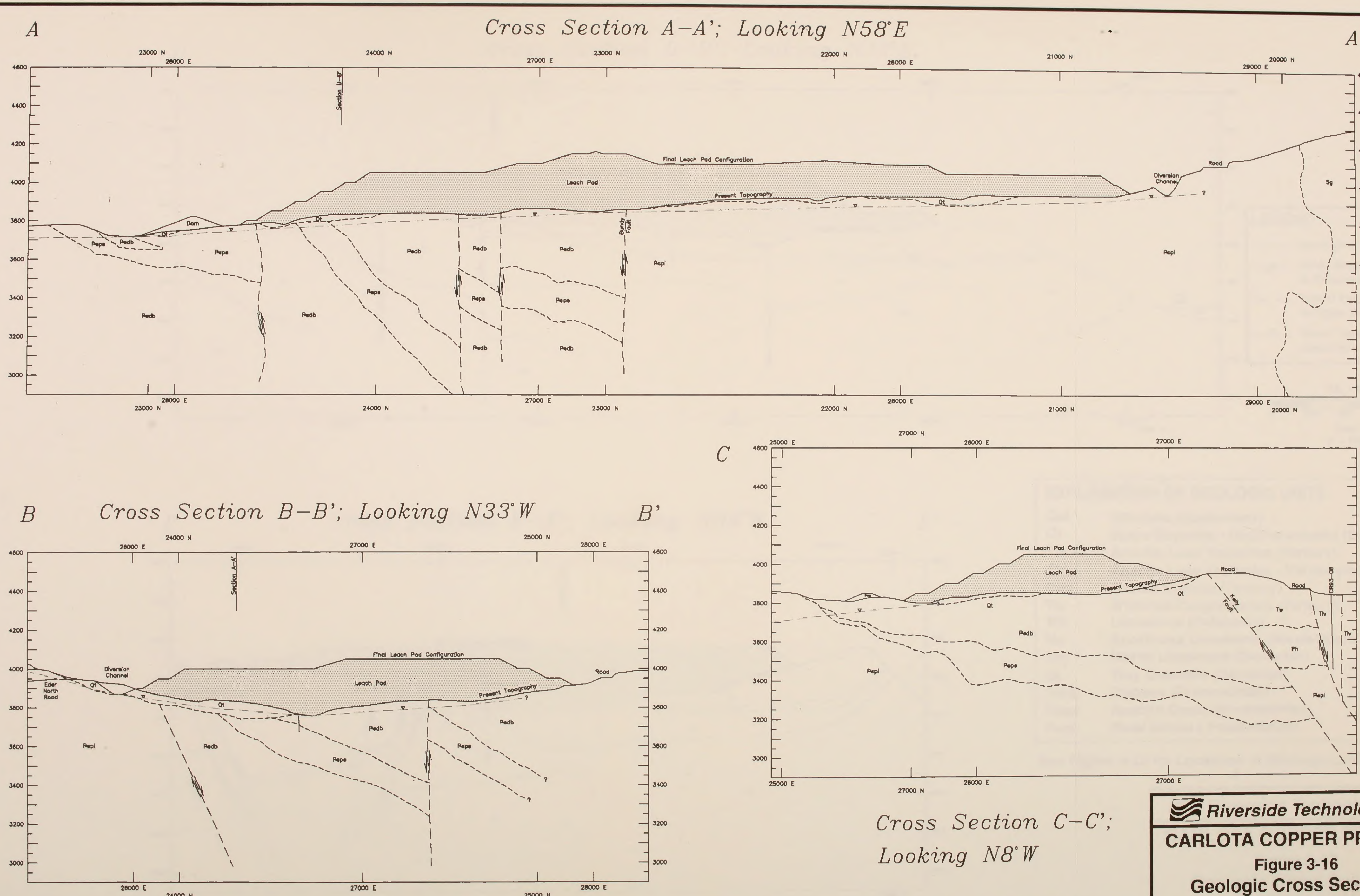
Figure 3-15

Locations of Geologic Cross Sections



Source: Carlota Copper Company 1994a

See Figure 3-15 for Locations of Geologic Cross Sections

See Figure 3-17 for Legend, Scale, and Explanation of Geologic Units

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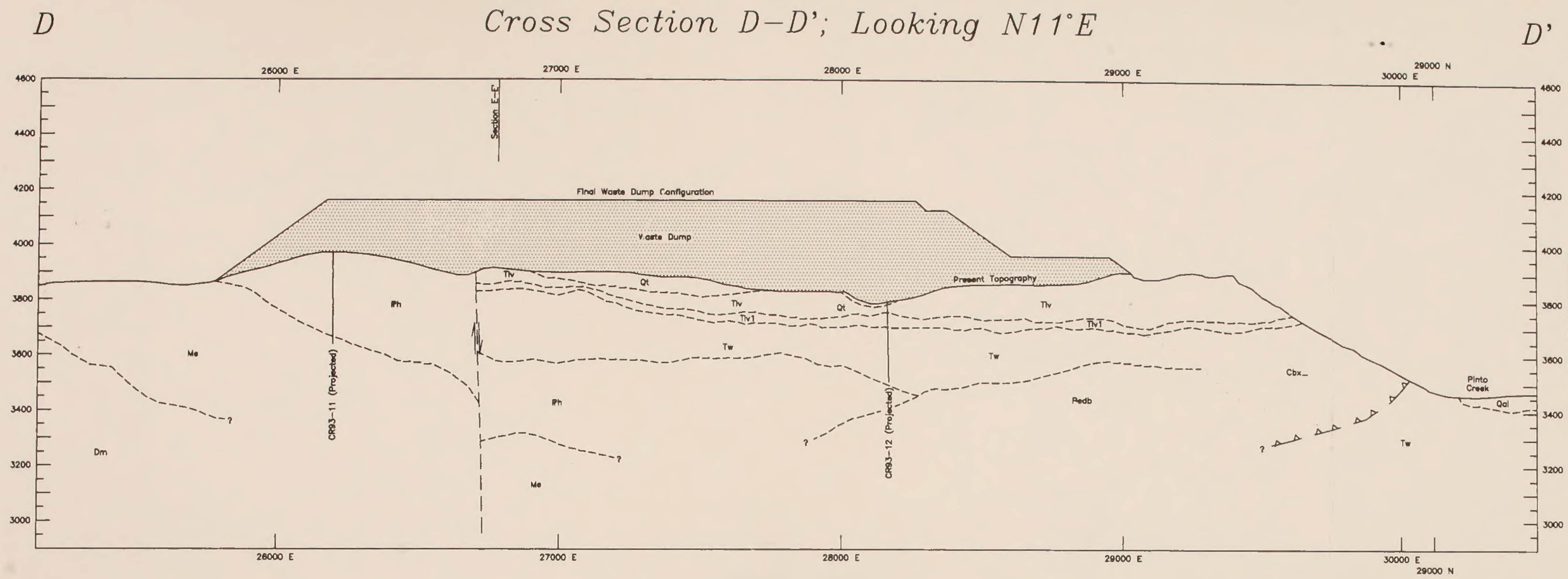
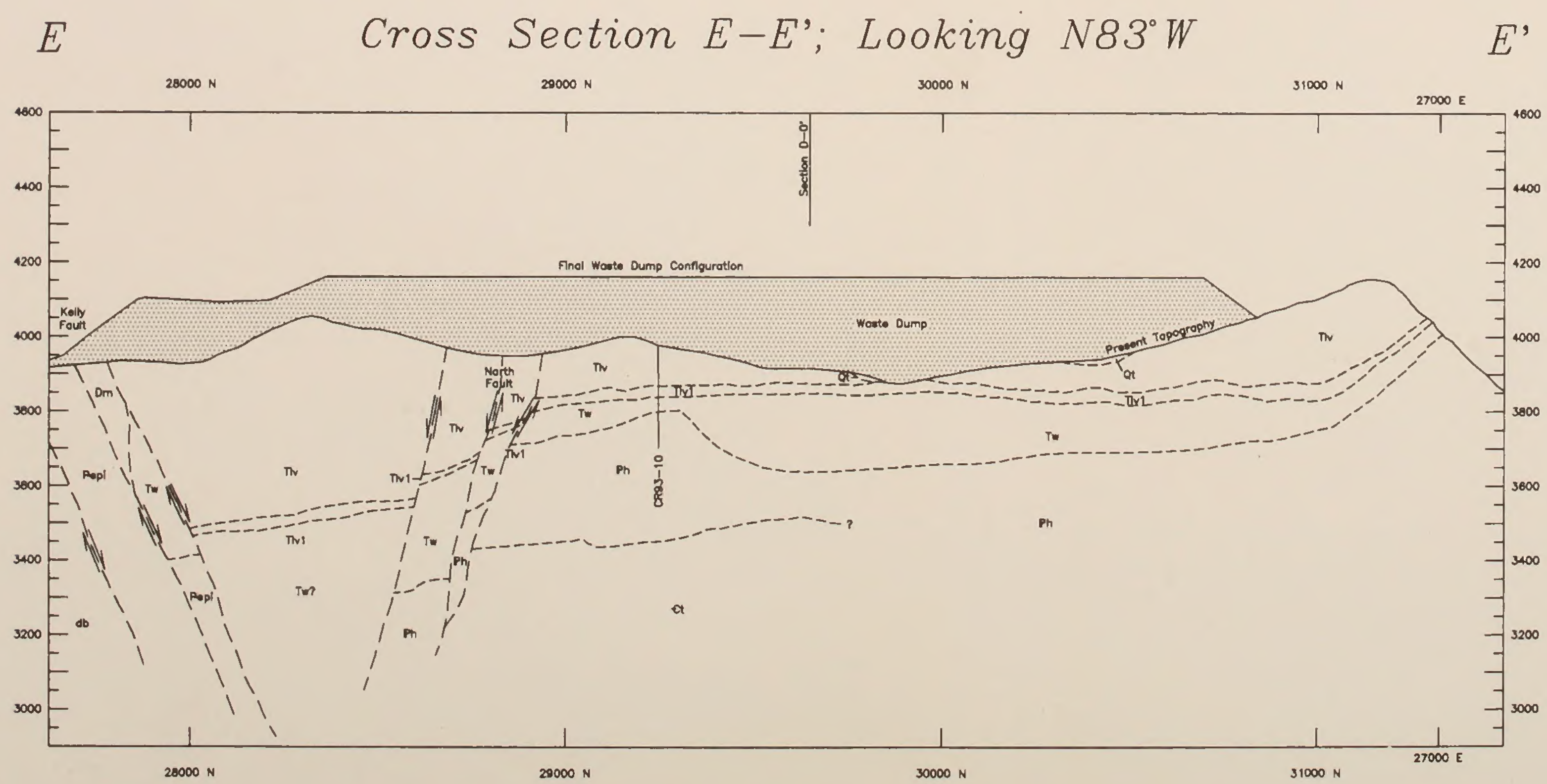
Figure 3-16
Geologic Cross Sections
A-A', B-B', C-C'
for Leach Pad





LEGEND

- Geological Contact
- Fault, Showing Direction of Movement
- Thrust Fault (Sawteeth in Upper Plate)
- Water Table Elevation (Approximate)

V.E. = 0

0 200 400 600 800

Feet

1" = 500'

EXPLANATION OF GEOLOGIC UNITS

Qal	Alluvium (Quaternary)
Qt	Slope Deposits - Undifferentiated (Quaternary)
Tiv	Apache Leap Volcanics (Tertiary)
Tiv_1	Apache Leap Volcanics - Vitrophyre (Tertiary)
Cbx	Cactus Breccia (Tertiary)
Tw	Whitetail Conglomerate (Tertiary)
ℙh	Limestone (Paleozoic)
Me	Escabrosa Limestone (Mississippian)
Dm	Martin Limestone (Devonian)
€t	Troy Quartzite (Cambrian)
P€db	Diabase (Precambrian)
P€ps	Apache Group (Precambrian)
P€pi	Pinal Schist (Precambrian)

See Figure 3-15 for Locations of Geologic Cross Sections

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Figure 3-17
Geologic Cross Sections D-D', E-E' for Main Mine Rock Area

Source: Carlota Copper Company 1994

Table 3-46. Summary of Ground Water and Spring Water Quality for the Affected Environment

Ground Water or Spring Water	Water Type	Mean ±1 Standard Deviation							Water Quality Criterion Exceedances[1]
		pH (s.u.)	Water Temperature (°C)	TDS (mg/L @ 180°C)	Sulfate (mg/L as SO_4)	Fluoride (mg/L as F)	Iron (mg/L as Fe)	Manganese (mg/L as Mn)	
Pinto Creek Drainage									
Bedrock	Ca, Na - HCO_3, SO_4	7.5 ± 0.3	19 ± 1	348 ± 106	49.6 ± 59.8	2.0 ± 2.5	0.5 ± 0.4	0.3 ± 0.28	TDS, F, Fe, Mn
Alluvium	Ca - SO_4	6.8 ± 0.1	17 ± 2.8	1428 ± 932	748 ± 545	0.7 ± 0.1	0.6 ± 0.4	0.7 ± 0.68	TDS, Sulfate, Cd, Fe, Mn
Powers Gulch Drainage									
Bedrock	Ca, Mg, Na - HCO_3	7.3 ± 0.3	17.9 ± 0.9	472 ± 247	107 ± 95.3	0.5 ± 0.2	0.2 ± 0.03	0.15 ± 0.19	TDS, Sulfate, Cyanide, Fe, Pb, Mn
Alluvium	Ca, Mg, Na - SO_4	7.1 ± 0.3	16 ± 2	2522 ± 665	1186 ± 335	3.6 ± 0.8	<0.3 ± 0.06	0.71 ± 1.18	TDS, Cl, Sulfate, F, Sb, Cd, Mn
Well Field									
Bedrock	Ca - HCO_3	7.3 ± 0.2	26.8 ± 2.6	309 ± 33	15 ± 8.5	0.28 ± 0.06	0.5 ± 0.4	0.05 ± 0.02	Fe, Mn, gross alpha activity
Alluvium	Ca - HCO_3	7.1 ± 0.1	16 ± 0.06	366 ± 78	80 ± 35	<0.5 ± 0.1	<0.3 ± 0.1	0.05 ± 0.02	TDS, Sb, Pb, Mn
Private Wells									
	Ca - HCO_3	6.8 ± 0.3	---	683 ± 298	108 ± 35	---	<0.05 0.0	0.01 ± 0.02	TDS, Zn
Springs									
Mule Spring	Ca-HCO_3	7.9 ± 0.2	15 ± 10	223 ± 31	6.8 ± 1.9	---	<0.1 ± 0.02	0.04 ± 0.02	Mn
Grizzly Bear Spring	Ca-HCO_3	8.0 ±0.0	---	470 ±0	86 ± 0	0.2 ±0.0	<0.05 ±0.00	<0.01 ±0.00	No Exceedances

[1]Constituents with values that exceeded a water quality criterion in at least one sample

the water quality of a well that contains 75 percent of its open interval in alluvium will be dominated by ground water input from the alluvium. The quality control data provided for field duplicates and blanks, generally near or below the applicable water quality standards.

Pinto Creek Drainage Ground Water Quality. Among the bedrock wells developed in the Pinto Creek drainage for water quality monitoring, BMW-1, BMW-2, BMW-4, and BMW-5 (GWRC 1996b) meet the selection criteria and were used in the analysis (well locations shown in *Figure 3-13*). Ground water from these wells is generally a calcium/sodium-bicarbonate/sulfate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Spatial variation in the water type of bedrock well samples was observed throughout the Pinto Creek drainage. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except TDS, fluoride, iron, and manganese (*Tables C4-1 in* Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: beryllium and thallium.

Two alluvial water quality monitoring wells were isolated within the Pinto Creek drainage; one in the Pinto Creek alluvium (AMW-15) and the other in the alluvium of Cottonwood Gulch (AMW-12) (*Figure 3-13*). Ground water from these wells is generally a calcium-sulfate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46.* A large variation in sulfate and TDS concentrations from these wells (GWRC 1994 and 1996b) and the close proximity of the wells suggest possible influences from mineralized areas and/or existing mining disturbance in the area. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except TDS, sulfate, cadmium, iron, and manganese (*Table C4-2 in* Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: antimony, beryllium, and thallium.

Powers Gulch Drainage Ground Water Quality. Among the bedrock wells developed in the Powers Gulch drainage for water quality monitoring, only BMW-6, BMW-7, BMW-8, BMW-9 and BMW-11 (GWRC 1996b) meet the selection criteria and were used in the analysis (*Figure 3-13*). Ground water from these wells is generally a calcium/magnesium/sodium-bicarbonate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except pH, TDS, sulfate, cyanide, iron, lead, and manganese (*Table C4-1* in Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: beryllium and thallium.

One well was isolated in the Powers Gulch alluvium (AMW-17) (*Figure 3-13*). Ground water from this well is generally a calcium/magnesium/sodium-sulfate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. The high TDS and sulfate concentrations displayed by samples from this well may not be representative of the entire alluvium in this reach of Powers Gulch. Summaries of other surface water (*Table 3-45*) and bedrock ground water (*Table 3-46*) samples within Powers Gulch do not reflect the same relative TDS and sulfate concentrations. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except TDS, chloride, sulfate, fluoride, antimony, cadmium, and manganese (*Table C4-2* in Appendix C, Water Resources Data). Reported detection levels were too high to evaluate water quality standard exceedances for the following constituents: beryllium and thallium.

Well Field Area Ground Water Quality. Three bedrock test production wells (TW-1, TW-2, and TW-3) in the well field area were sampled for water quality (*Figure 3-13*). Ground water from these wells is generally a calcium-bicarbonate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except iron, manganese, and gross alpha activity (*Table C4-1* in Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: antimony, beryllium, and thallium.

Two water quality monitoring wells (AMW-21 and AMW-23) were isolated in the alluvium within the well field area (*Figure 3-13*). A third monitoring well (AMW-22) did not isolate the alluvium, and therefore water quality sample results from this well were not included in the alluvial water quality summary. Ground water from these wells is generally a calcium-bicarbonate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except TDS, antimony, lead, and manganese (*Table C4-2* in Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: beryllium and thallium.

Spring Water Quality. Two springs (Grizzly Bear and Mule springs) within the project area were sampled for water quality (Montgomery & Associates 1993 and GWRC 1996). Water samples from these springs are generally a calcium-bicarbonate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Analyses of water quality samples collected for Grizzly Bear Spring showed no water quality standard exceedances, while Mule Spring only exceeded the manganese water quality standard (*Table C4-3* in Appendix C, Water Resources Data). Laboratory analytical detection levels were not sufficiently sensitive to evaluate ambient water quality with respect to applicable water quality standards for the following constituents: antimony (Mule Spring only), beryllium, and thallium (Mule Spring only).

Private Well Water Quality. Data were available from 4 private wells (Montgomery & Associates 1993) in the upper reaches of the Powers Gulch drainage (Top-of-the-World). Ground water from these wells is generally a calcium-bicarbonate type. The pH, water temperature, TDS, sulfate, fluoride, dissolved iron, and dissolved manganese are summarized in *Table 3-46*. Analyses of water quality samples collected consistently met applicable Arizona Aquifer Protection Standards and federal primary and secondary MCLs for all constituents tested except TDS, and zinc (*Table C4-1* in Appendix C, Water Resources Data).

Ground Water/Surface Water Interactions

Interpretations regarding ground water/surface water interactions are based on measurements of surface flow at surface stations, ground water levels in bedrock and alluvial wells, and comparison of the chemical character of the surface water and ground water. In the project area, possible ground water/surface water interactions include (1) infiltration of streamflow as recharge to the alluvial and bedrock aquifers, (2) discharge of ground water stored in the alluvium to streams and bedrock aquifer, (3) discharge of ground water from the bedrock aquifers into the alluvial aquifer, and (4) discharge of bedrock ground water directly into streams (where the stream channel is incised into bedrock).

Pinto Creek. During periods of high streamflow, the porous alluvium is recharged by the infiltration of streamflow. As the streamflow declines, water drains from the alluvium into the stream. This process probably plays a significant role in sustaining baseflow along some reaches of Pinto Creek (based on the distribution of alluvium along the Pinto Creek drainage), particularly in the perennial reach extending downstream from PC-10 and the discontinuous flowing reaches that occur between PC-5 and the Haunted Canyon confluence. As the dry season progresses, the water level in the alluvium may drop to the point where it falls below the bottom of the stream channel. At this point, the streamflow in the channel reach ceases. However, some flow is still moving downstream beneath the channel as alluvial underflow. Where the saturated alluvium pinches out in a downstream direction, this alluvial underflow will re-emerge for some distance as surface flow through a bedrock channel. As a result, during baseflow, stream segments with intermittent alluvium and bedrock reaches are typically characterized by discontinuous dry (alluvium) and flowing (bedrock) reaches. These processes are probably responsible, at least in part, for the discontinuous flow reported (GWRC 1996b) between PC-3 and PC-6, and downstream from PC-7 along Pinto Creek. Discharge of ground water from the bedrock complex into the stream channel or into the alluvium and then into the stream channel could contribute to or control the location of flowing reaches between PC-5 to PC-7. However, there are insufficient data to quantify the contribution from these different sources. A portion of the flows in Pinto Creek downstream of the Haunted Canyon confluence appear to be controlled by discharge from the bedrock complex in Haunted Canyon (see Haunted Canyon Area well field discussion below).

In the vicinity of the Carlota/Cactus pit, Pinto Creek flows through a reach that is mantled with alluvium. The water chemistry data, as illustrated in *Figure 3-18*, indicate that surface water and ground water in the alluvium are very similar calcium-sulfate type waters with moderate to high TDS (see *Table 3-45* and *3-46*). The similarity between these two waters suggests that there is interaction between the surface flows and ground water in the alluvium. Water level data from monitoring wells in the vicinity of the Carlota/Cactus pit indicate that there is a potential for ground water flow between the alluvium and bedrock. This potential, measured as a difference in head between the two aquifers, varies seasonally and from location to location. As shown in *Figure 3-18*, water quality data from numerous bedrock wells in the Carlota/Cactus pit area reflect a wide variation in ground water chemistry, being dominated by combinations of calcium, sodium, bicarbonate, and sulfate. The major influence of sodium and bicarbonate in the bedrock ground water (not seen in

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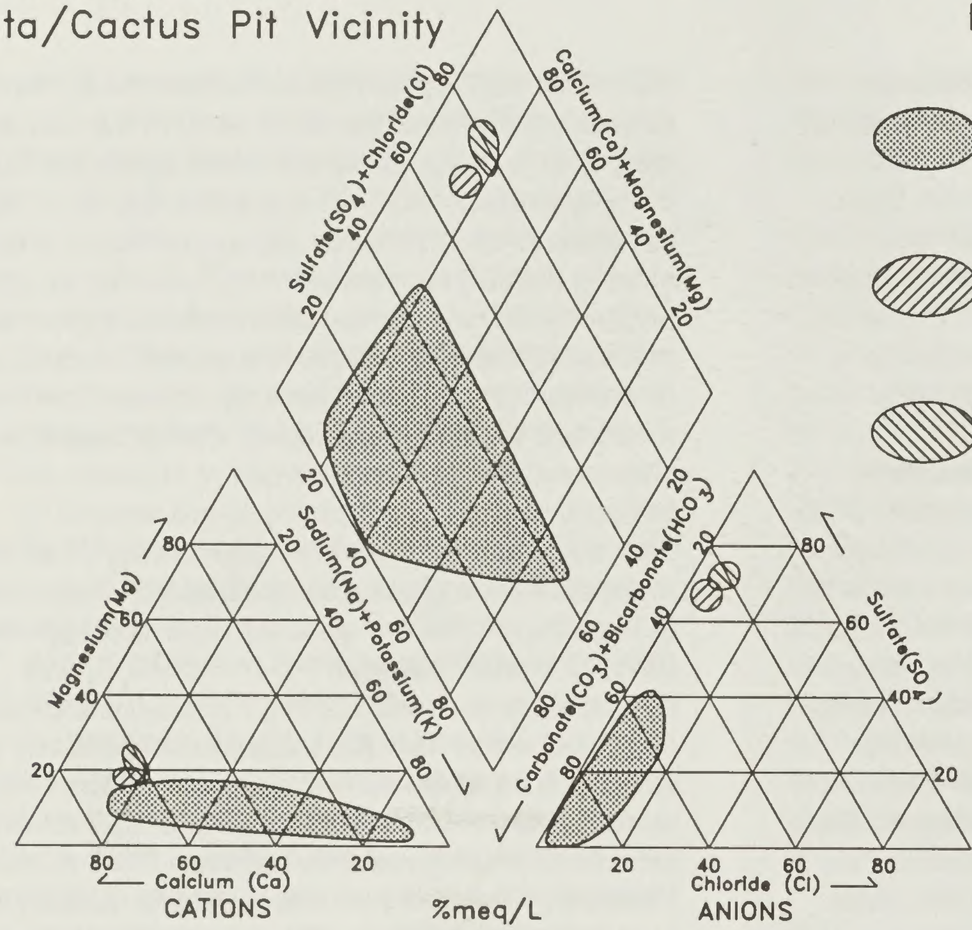
Pinto Creek Area
Carlota/Cactus Pit Vicinity



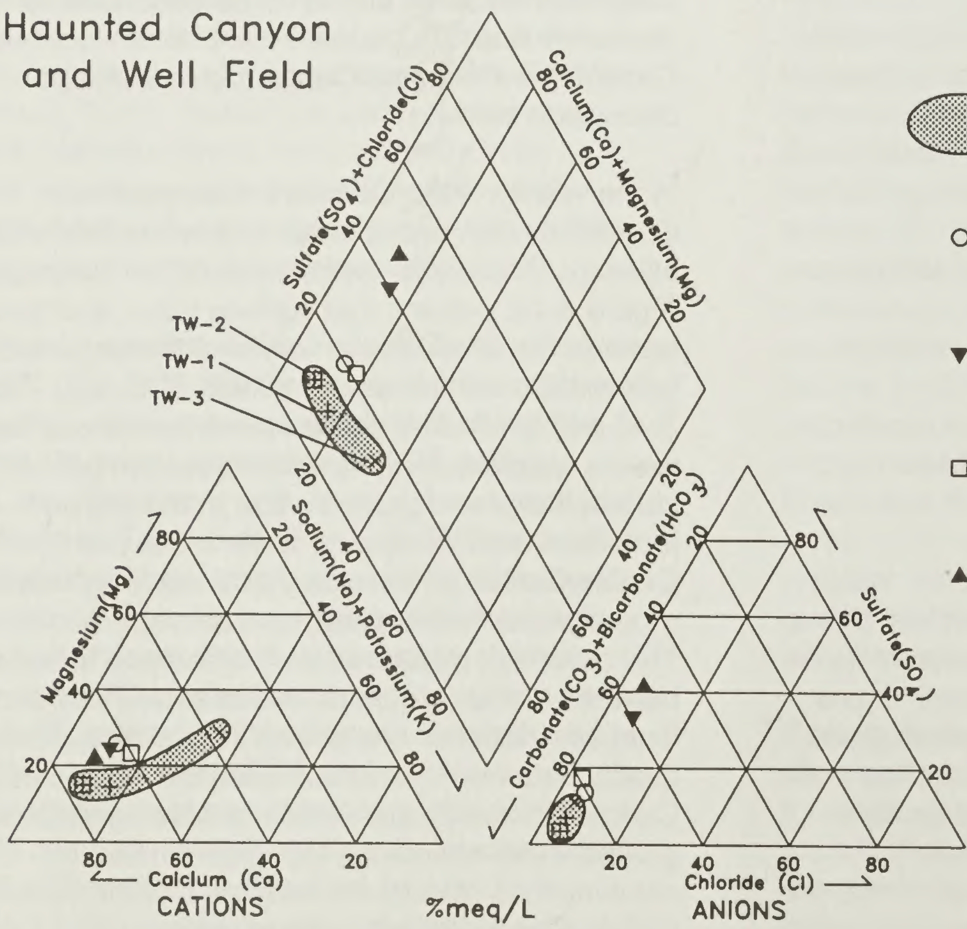
Legend

Bedrock Wells (BMW-1, -2, -4, and -5)

Alluvial Wells (AMW-13 and -15)

Surface Water Stations, Pinto Creek (PC-3 and PC-5)

Haunted Canyon and Well Field



Legend

Bedrock Wells (Test Production Wells)

○ Alluvial Well in Haunted Canyon (AMW-21)

▼ Alluvial Well in Pinto Creek (AMW-23)

□ Surface Water Station, Haunted Canyon (HC-2)

▲ Surface Water Station, Pinto Creek (PC-7)

Notes: Data plotted was restricted to represent water quality data collected at the selected monitoring points during low stream flow (or baseflow) periods. The composition of the alluvial and surface water would vary at higher stream flows as the contribution from runoff increases.

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Figure 3-18

Ground Water/Surface Water Trilinear Diagrams the calcium-sulfate dominated alluvial and surface waters of the area, as shown in *Figure 3-18*) suggests that the chemical composition of the bedrock and alluvial waters are dissimilar. This dissimilarity suggests that there is only minor interaction between the two aquifers, and that flow from the bedrock complex is relatively small and may not contribute significantly to the alluvial or surface flows in Pinto Creek in the vicinity of the proposed Carlota/Cactus pit.

Water quality data collected during low flow from station PC-7, located 3,000 to 4,000 feet downstream from the Haunted Canyon confluence, are presented in *Figure 3-18*. This sample was collected at a time when no surface water flow was observed upstream from Haunted Canyon at surface water stations PC-1, PC-2, PC-3, PC-4, PC-5, and PC-6. These water quality data indicate that at low flows, the flow in Pinto Creek below the well field (PC-7) is distinct from water quality in Haunted Canyon (HC-2) and upstream in Pinto Creek (PC-3 and PC-5). On the Trilinear plot (*Figure 3-18*), the PC-7 sample falls between the Haunted Canyon and the upstream Pinto Creek water samples. Therefore, the water at PC-7 during low flow is interpreted as a mixture of these two distinct water types. One possible explanation is that baseflow in Pinto Creek, below Haunted Canyon, is a mixture of discharge from Haunted Canyon and underflow in Pinto Creek that is not visible at the surface at PC-6, located upstream from Haunted Canyon.

Powers Gulch. Water level data from wells in the Powers Gulch area indicate that at certain times of the year, there is a potential for flow from the bedrock to the surface; at other times there is a potential for flow from the surface into the bedrock. A bedrock monitoring well, located in the creek bed in Powers Gulch (PG-2) within the footprint of the proposed heap-leach pad, had recorded water levels above the ground surface in April and May 1992, March 1993, and March through May 1995. Other bedrock monitoring wells indicate that at times the depth to the potentiometric surface for the bedrock complex is very near the surface (PG-1, PG-2, and PG-5) over a portion of the heap-leach site (particularly adjacent to the stream channel). Mule Spring, located in a tributary to Powers Gulch west of the heap-leach pad, apparently represents discharge of ground water from the bedrock complex.

Haunted Canyon Area. In the well field area, recorded water levels for the three alluvial monitoring wells range from a few feet beneath the surface to approximately 12 feet beneath the surface. Pressure measured in the shut-in water supply wells indicates that the potentiometric surface for the water supply wells ranges from approximately 40 to 65 feet above the surface. These head differences indicate that the bedrock aquifer is confined, and there is a large vertical hydraulic gradient between the bedrock aquifer system and the alluvial/surface water system. Monthly water level data from AMW-21 indicate that the alluvial water levels fluctuate up to approximately 3 feet per year. The water table fluctuation corresponds to recharge (rise) from the stream during periods of increasing runoff and discharge (drop) as streamflows decrease. However, because of the limited extent of saturated alluvium in Haunted Canyon, the contribution of alluvial discharge to streamflow is estimated to be very small. The results of the seismic surveys support the assumption that the baseflow component of the hydrograph for streamflow (or low flow) in Haunted Canyon is sustained by water leaking upward from the bedrock complex.

As illustrated in *Figure 3-19*, there is a correlation between the flows in Haunted Canyon (at HC-2) and alluvial water levels (at monitor well AMW-21, located near HC-2). The correlation between the streamflows and alluvial water levels indicates that there is a close interconnection between the streamflow and alluvial water levels. This correlation is also supported by a diurnal study conducted to evaluate daily fluctuations in streamflow and alluvial water levels (GWRC 1995b). During the diurnal study, flows at station HC-2a varied from 2 gpm to 56 gpm, and the water level in the nearby alluvial well (AMW-21) varied 0.64 foot over the 24-hour observation period. Again, the maximum and minimum flows correlated with the maximum and minimum water levels in the alluvium, although the response in the alluvium lagged behind the stream fluctuations by approximately 2 hours. The streamflow and alluvial fluctuations recorded during the diurnal study suggest close interconnection between the stream and alluvial systems. In addition, the diurnal study indicates that evapotranspiration can result in significant daily streamflow and alluvial water level fluctuations, particularly in the late spring, summer, and early fall. The chemical data, as shown in *Figure 3-18*, indicate that during low-flow periods, c:\projects\a210\fig3-19.doc 3/6/97

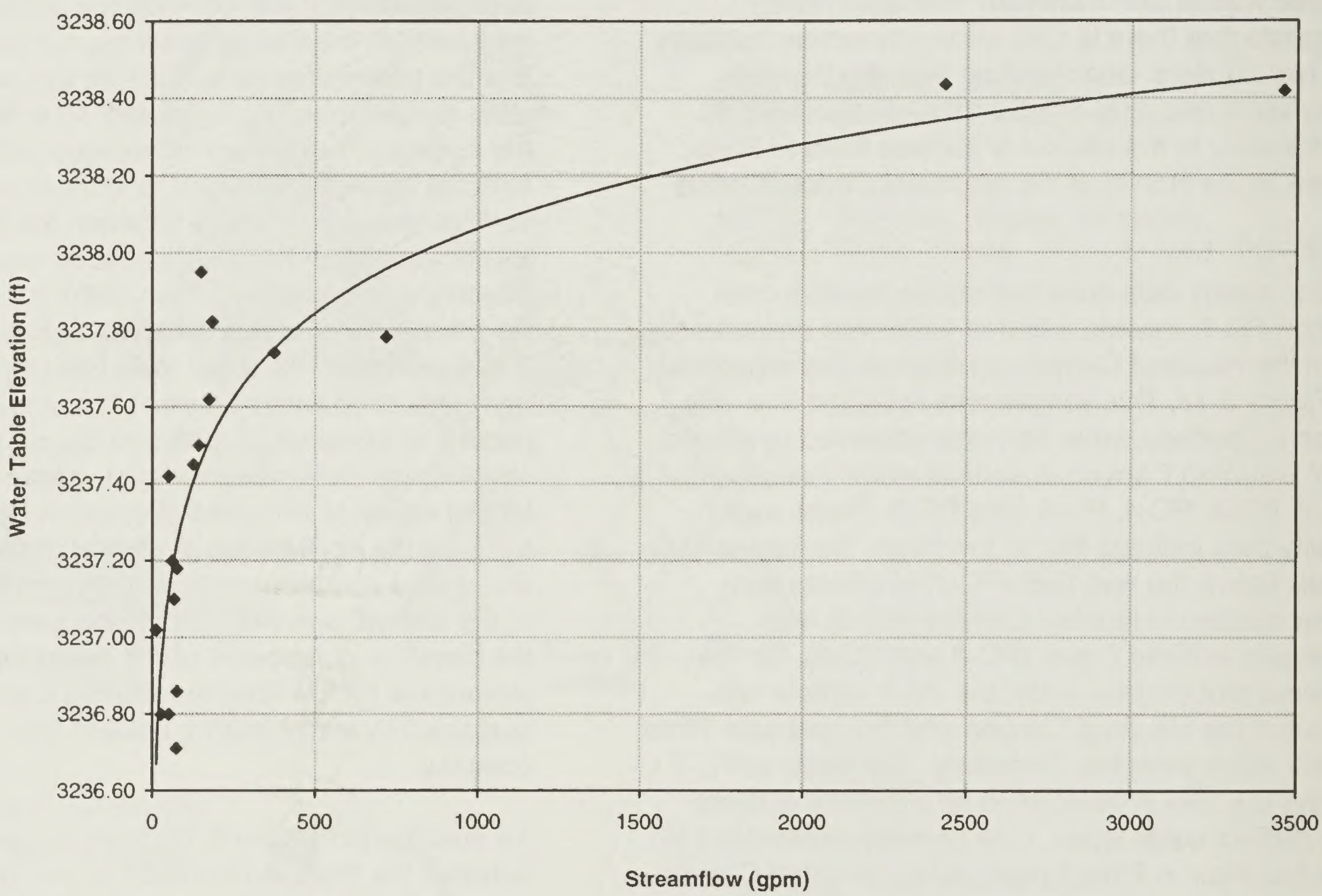

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Figure 3-19

AMW-21 Mean Water Table Elevation Versus HC-2 Streamflow the general composition of water in the bedrock test production wells, in the alluvium, and in the stream in Haunted Canyon are similar. These data suggest that the perennial flow in Haunted Canyon and the water level in the alluvium are sustained during baseflow periods by the discharge of ground water from the confined bedrock system.

3.3.2 Environmental Consequences

The primary water resource issues include the following: (1) reduction in surface and ground water for current users and water-dependent resources upstream, within and downstream of the project area, (2) impacts to ground water and surface water quality, (3) physical or chemical impacts caused by discharging dredged or fill material, (4) impacts to floodplains within and downstream of the project area, (5) changes in channel dynamics caused by diverting Pinto Creek and Powers Gulch, and (6) impacts related to the water quality and elevation of the postmining Carlota/Cactus pit lake. Potential impacts to waters of the U.S., wetlands, and riparian areas are addressed in Section 3.5, Biological Resources.

Evaluation criteria that were used to analyze water resource impacts included the following:

Surface Water

- Alteration of streamflow quantities
- Degradation of surface water quality constituents based on Arizona standards for designated beneficial uses
- Acres of floodplains affected
- Alteration of channel geometry or gradients sufficient to produce increased aggradation, degradation, sidecutting, channel migration, or sedimentation as measured by flow velocity and sediment transport
- Water quality of postmining Carlota/Cactus pit lake

Ground Water

- Change in water supply available to existing wells in the area because of project operations
- Change in elevation of ground water level in streamside alluvium and bedrock aquifer system
- Degradation of water quality within a given aquifer caused by the introduction of foreign substances based on the Arizona Aquifer Protection Standards.

3.3.2.1 Proposed Action

Pit Construction and Dewatering Impacts

Permanent withdrawal of the Carlota/Cactus pit area would result in a reduction of approximately 0.4 square mile of contributing watershed area. This would equal roughly 1 percent of the watershed area at the confluence of Haunted Canyon and Pinto Creek and would reduce mean annual runoff downstream by approximately 56 acre-feet based on average annual watershed runoff above the Pinto Valley weir of 2.62 inches. This reduction represents approximately 1 percent of the mean annual runoff at the PC-7 gage site.

The Eder pits would occupy a combined area of approximately 83 acres (0.1 square mile) of the Powers Gulch watershed area (5.5 square miles). During mining operations, this part of Powers Gulch would be withdrawn from the area contributing surface runoff to the watershed, which would reduce surface runoff by approximately 18-acre feet per year. This volume represents approximately 2 percent of the runoff from the Powers Gulch watershed and less than 0.4 percent of the runoff at the PC-7 gage site. This impact would occur primarily during storm events. The impact would end after reclamation and closure since the Eder Pits would be returned to an area that contributes surface runoff to the watershed. Reclamation would be accomplished by partially backfilling the Eder pits with mine rock and recontouring the backfilled surface so that precipitation falling over the reclaimed area would be free to exit the area as stormwater runoff.

The results of ground water monitoring and pump tests indicate that water-bearing rocks in the vicinity of the Carlota/Cactus, Eder North, and Eder South pits contain fractures that would likely yield ground water to the pits during the mining operation. As a result, dewatering would be required to limit the amount of inflow into the pits and to maintain pit wall stability. Dewatering would be designed to maintain water levels below the floor of the pit as mining progresses. Pit dewatering activities would result in the drawdown of water levels in the bedrock complex during operation. The maximum drawdown, which corresponds to the ultimate pit depth, would be approximately 750 feet in the immediate vicinity of the Carlota/Cactus pit, 230 feet in the Eder South pit area, and 200 feet in the Eder North pit area. After dewatering ceases, the water level in the Carlota/Cactus pit would rise, responding in part to ground water inflow. The Eder pits would be backfilled to above the premining water level to prevent postclosure ponding.

Ground water in the bedrock complex is stored and transmitted along interconnected fracture networks within the rock mass. Since the rock mass is actually composed of several different rock types of different ages, it is suspected that the orientation and interconnection of fractures is not uniform within the bedrock complex. This variability in fracture characteristics from one area to the next is indicated by the broad range in hydraulic conductivity (less than 0.005 to 9.5 gpd per square foot of aquifer [gpd/ft^2]) for pump tests conducted in the monitoring wells (*Table C3-1* in Appendix C, Water Resources Data). The geologic characterization data and pump test results indicate that the hydraulic properties of the rock mass are generally heterogeneous (different from one location to another) and at least locally anisotropic (different in different directions). Considering the complexity of the hydrogeologic setting, it is not possible to predict the precise boundaries of the area that will be affected by drawdown resulting from the mine dewatering activities.

The general dewatering requirement and the area of influence have been evaluated using MODFLOW, a finite difference numerical model (GWRC 1994).

The bedrock complex aquifer was modeled as a single, continuous, homogenous and isotropic aquifer with a hydraulic conductivity of 0.1 gpd/ft^2. Sensitivity analyses were performed by varying the hydraulic conductivity from 0.05 to 0.2 gpd/ft^2. The alluvial aquifers were not considered in construction of the layering and zonation within the model. In addition, no attempt was made to calibrate the model to steady state conditions. These assumptions and model procedures limit the usefulness of the model to predict maximum drawdown from pit dewatering.

Using the numerical model MODFLOW (GWRC 1994) and the assumptions stated previously, the maximum computed rates of ground water inflow/pit dewatering requirements predicted by the model ranged from 85 to 280 gpm for the Carlota/Cactus pit, 15 to 47 gpm for the Eder North pit, and 33 to 102 gpm for the Eder South pit, depending on the hydraulic conductivity value used for the bedrock complex.

The low transmissivity for the bedrock complex indicates that the amount of drawdown would decrease rapidly away from the pit. However, the extent of the cone of depression in any direction depends on the hydraulic properties of the water-bearing rocks. For example, the drawdown effects would be much greater along transmissive fracture zones and would be limited in the directions of low-permeability bedrock. For the purposes of analyses, the maximum extent of the 10-foot drawdown contour (predicted using MODFLOW) was selected as the general area of drawdown impacts. Although some drawdown could occur outside of the 10-foot drawdown contour, these changes would probably be indistinguishable from natural fluctuations in the ground water levels that occur seasonally and from year to year. Based on the hydrogeologic conditions, as well as pump test data, it appears that the impacts from drawdown would generally be restricted to areas immediately surrounding the pits. The drawdown associated with the Carlota/Cactus pit would affect a considerably larger area than the drawdown from the Eder pits. Based on available hydrogeologic data, pump test data, analytical modeling, and numerical modeling, it appears that the drawdown impacts (defined as greater than 10 feet of drawdown) would not extend farther than 1 to 2 miles from the perimeter of the Carlota/Cactus pit. Locally, drawdown could affect water supply wells, spring or seep discharge, and streamflows.

As stated previously, there is uncertainty regarding the configuration and aerial distribution of the maximum extent of the 10-foot drawdown contour resulting from mine dewatering efforts. A comprehensive ground water and surface water monitoring program is proposed as part of the monitoring and mitigation measures (Section 3.3.4, Water Resources - Monitoring and Mitigation Measures). Under this program, the monitoring data would be used to track the extent and rate of expansion of the cones of depression resulting from mine dewatering. The results of the MODFLOW modeling was used to select the boundary of the initial area to be included within the monitoring area. The monitoring would be used to trigger the implementation of mitigation measures for individual wells, springs, and streams on National Forest System lands and to make information available to the public with regard to changes in environmental conditions.

Impacts on Wells. The drawdown of water levels in the bedrock complex caused by dewatering activities could potentially affect some wells located in the vicinity of the project. Water supply wells located within the drawdown area could experience a noticeable drop in their pumping water levels. Where alterations in directions of ground water flow are experienced, changes in well water quality are also possible. The magnitude of the water level decline and degree of water quality variation would depend on the location of the well and the actual hydrogeologic conditions. Impacts to wells from lowering the water level could increase pumping costs and possibly decrease production. In addition, individual wells could become unusable if the water level was lowered to below the pump setting or below the bottom of the well. Given the complex hydrogeologic conditions, it is not possible to determine with certainty which wells (if any) will be affected by the mine dewatering efforts. However, using conservative estimates, any well located within the 10-foot drawdown contour, which is estimated to extend no further than 1 to 2 miles from the Carlota/Cactus Pit could potentially be affected.

The Top-of-the-World community is dependent on ground water derived from pumping private water supply wells. Most of the wells are constructed in fractured bedrock consisting of the Schultze Granite and Apache Leap Dacite units, and reported yields range from less than 1 gpm to 40 gpm. Apparently in recent years some of these wells have had problems with declining water levels and decreased yields (scoping comment letters). These problems may be the combined result of (1) decreased recharge of the bedrock aquifer during periods of below-normal precipitation, (2) depletion of the aquifer by overpumpage, and/or (3) well interference between adjacent wells. Based on the aquifer characteristics and the distance to active mining projects, it is unlikely that any wells in the community have been affected by existing dewatering at currently operating mines in the area.

The northern margin of the Top-of-the-World community is located approximately 10,000 feet south of the Carlota/Cactus pit and 4,500 feet south of the Eder South pit. Since the northern portion of the Top-of-the-World wells are located within 2 miles of the open pits, there is some potential for dewatering to affect these wells. Because of the hydrogeologic conditions found in this area, these effects are not anticipated to include water quality impacts. Results from pump tests indicate that, in general, the bedrock complex has a low transmitting and storage capacity. In addition, water quality, water level, and pump test data also suggest that there is some partitioning within the bedrock aquifer. These factors would tend to limit the maximum extent of the cone of depression caused by pit dewatering. However, there is uncertainty regarding actual hydraulic communication between fractures in the vicinity of the pits and the Top-of-the-World community. Considering these uncertainties and the importance of ground water as the sole source of water to the Top-of-the-World community, monitoring is proposed in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

The Pinto Valley Mine has several water supply wells located within a 1- to 2-mile radius of the Carlota/ Cactus pit. Little information exists to evaluate the potential for interaction between the ground water on the project site and the Pinto Valley Mine. However, because of the level of uncertainty involved, the Pinto Valley Mine wells, may potentially be affected and are also addressed in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

Impacts on Seeps and Springs. Drawdown from mine dewatering could potentially affect natural springs in the project vicinity. The magnitude of the impact would depend on the relationship between the spring location and the zone of influence (or cone of depression) caused by dewatering. Potential impacts could range from a minor reduction to a complete elimination of flow. Depending on the origin of the ground water that discharges at the surface as a spring, a reduction in flow could be accompanied by a change in water quality. However, where the source of the spring discharge is a single hydrostratigraphic unit (or aquifer) with relatively constant water quality, lowering the water level within the unit, and thereby reducing spring discharge rates, should not result in a significant change in water quality. It is likely that flows and water quality conditions in affected springs would return to premining conditions once ground water levels recover after the cessation of mining.

Identified springs within a 2-mile radius of the Carlota/Cactus pit include (1) natural springs (developed and undeveloped), (2) springs created by discharge from abandoned mine workings (adits), and (3) springs from existing tailings facilities. Mule Spring, located approximately 2,000 feet from the Eder North pit and 4,000 feet from the Carlota/Cactus pit, and spring 35dd, located approximately 2,500 feet from the Carlota/Cactus pit, could potentially be affected. The Grizzly Bear Springs and two small springs with reported discharge rates of less than 1 gpm (GWRC 1994) located within the Main mine rock disposal area are anticipated to be affected by pit dewatering and the placement of mine rock material. Springs that discharge from caved mine adits or near other mine workings within or near the pits would either be eliminated by mining (36ca, 36dd) or affected by dewatering (06ab, 01bb, 12ab). Miller Spring and other springs with high specific conductance that appear to be controlled by seepage from existing tailings facilities (25ca) should not be affected by pit dewatering since these springs are not related to or controlled by discharge from the bedrock complex ground water system. Yo Tambien spring flows out of an adit above Pinto Creek approximately 2,000 feet south of the Carlota/Cactus Pit. Based on the proximity of the spring to the pit, it is possible that the flows could be reduced. Therefore, monitoring and mitigation for reduced spring flow are addressed in Section 3.3.4, Water Resources - Monitoring and Mitigation.

Impacts on Shallow (Alluvial) Ground Water and Streamflows. Dewatering the Carlota/Cactus pit could potentially deplete some ground water stored in the alluvium in both the upstream and downstream reach of Pinto Creek adjacent to the Carlota/Cactus pit. The length of the reach that would be affected could potentially extend up to a few thousand feet from the perimeter of the pit. Montgomery & Associates (1993) estimated that the length of reach affected would probably be on the order of 2,000 feet upstream and downstream from the pit. Assuming an average alluvial width of 300 feet, a saturated thickness of 10 feet, hydraulic conductivity of 50 feet per day, and an approximate gradient of 100 feet per mile, the estimated rate of flow through the alluvium in this reach is on the order of 16 gpm.

Following the Montgomery & Associates report (1993), alluvial and bedrock monitoring well nests were established in Pinto Creek upstream and downstream from the Carlota/Cactus Pit (AMW15, BMW4, AMW13, BMW5; see *Figure 3-13*). One purpose of these wells was to provide information on the interactions between the bedrock and alluvial aquifer systems. Monthly water levels recorded from mid-1993 through 1995 indicate that the water levels in the alluvium are generally several feet higher than water levels in the bedrock. This indicates that at these locations there is separation between the alluvial and bedrock aquifer systems. The water quality data for these wells (GWRC 1996b) indicates that the alluvial water contains high sulfate (205-491 mg/L) and high TDS concentrations (508-934 mg/L) compared to the bedrock water quality (sulfate 11-157 mg-L, TDS 288-504 mg/L). Therefore, the alluvial and bedrock waters are chemically distinct. Under the existing condition, there is a potential for some seepage from the alluvium into the bedrock aquifer. Furthermore, these data suggest that at these locations, the streamflows in Pinto Creek are not sustained by or controlled by discharge from the bedrock system. Based on these monitoring data, pit dewatering is not anticipated to significantly affect the alluvial flows or streamflows in Pinto Creek. However, interaction between the bedrock and alluvial system may vary further upstream or downstream from the pit within the area that may be affected by drawdown of the bedrock system. Therefore, there may be some potential for pit dewatering to capture alluvial flows above and below the existing well nests.

Excavation of the Carlota/Cactus Pit would expose the Pinto Creek alluvium in the north and south walls of the pit upstream and downstream of the proposed diversion channel. As part of the proposed action, the potential removal of water from the alluvial system would be reduced by constructing an alluvial cutoff wall upstream from the pit. Because of the reversal of gradients near the pit, there may also be the potential for some of the ground water in the alluvium downstream from the pit to flow into the pit, where the alluvium would be daylighted in the north pit wall. However, as estimated above, these flows are anticipated to be on the order of 16 gpm or less. Daylighting the alluvium in the North pit wall could result in capturing some alluvial interflow in Pinto Creek. Therefore, monitoring and mitigation for potential inflow into the pit are addressed in Section 3.3.4, Water Resources - Monitoring and Mitigation.

Alluvial water quality in Pinto Creek near the proposed Carlota/Cactus pit is variable, possibly because of previous mining activities or other natural mineralization. Depending on the specific alluvial flows intercepted and the extent of dewatering, impacts to remaining alluvial flows are possible. Capturing water in the alluvium would reduce alluvial flow and could reduce surface flows in Pinto Creek upstream and downstream from the Carlota/Cactus pit.

Pit Water Recovery Impacts

There are three proposed pits for the Carlota Copper Project: two Eder pits (North and South, including the small Eder Middle pit) and the Carlota/Cactus pit. The Eder pits would be located on the west hillside of Powers Gulch and would be partially backfilled with mine rock material. The pit bottom elevations prior to backfilling would be 3,880 ft-amsl for the Eder North pit and 4,080 ft-amsl for the Eder South pit. The final backfilled pit elevations would range from approximately 4,000 to 4,200 ft-amsl. Approximately 4 million tons of mine rock would be placed in the Eder pits. The backfilled material would be contoured so that no ponding of water would occur within the pits; any precipitation captured by the pit highwalls and fill areas would exit the pit as stormwater runoff. This situation would be similar to premining conditions; therefore, long-term impacts to surface or ground water are not anticipated in the Eder area.

The Carlota/ Cactus pit would be partially backfilled. Water balance calculations have determined that water would be impounded in the pit after the cessation of mining (and pumping); the backfill material would only be partially submerged by the final pit lake. Surface water runoff, direct precipitation to the lake, and ground water seepage would contribute as inflow to the pit lake. The following discussion refers to pit water recovery impacts for the Carlota/Cactus pit.

A water balance approach was used to determine the final pit lake elevation once mining operations cease. The water level in the lake would depend on the amount of water entering the pit through ground water inflow, surface runoff from the pit walls, direct precipitation onto the lake surface, and the amount of water lost from the lake surface through evaporation. The pit lake water balance for the EIS analysis used conservative (high) estimates for initial ground water inflow and conservative (high) estimates for surface water runoff, both of which increase the predicted final lake level. Even using these conservative assumptions, the relatively high evaporation rates result in a final pit lake level that is estimated to stabilize at approximately 3,345 ft-amsl, which is approximately 150 feet below the premining ground water level in the alluvium beneath Pinto Creek, and several hundred feet below the premining water level in the bedrock slopes adjacent to Pinto Creek. Since the elevation of the lake surface is predicted to be considerably below the surrounding water levels in the bedrock and alluvial systems, the pit lake is anticipated to behave as a sink whereby the ground water gradient in all directions would be toward the pit. Ground water gradients sloping down toward the pit in all directions should effectively prohibit any significant ground water outflow from the pit lake.

From the water balance calculations, it is estimated that the equilibrium water level (defined as less than 0.1 percent change in water level annually) in the Carlota/Cactus pit would be achieved approximately 125 years after the pumping stops and would be approximately 505 feet above the pit floor (3,345 ft-amsl). At this level, the pit lake surface would be 135 feet below the Pinto Creek diversion's lowest point (3,480 ft-amsl) and would hold approximately 17,100 acre-feet of water. After the lake fills, an estimated 480 acre-feet per year (300 gpm) would be lost through evaporation off the lake surface.

Water quality standards prescribed by the ADEQ for surface water do not apply to open pits associated with the mining of metallic ores (Title 18, Section R18-11-102). Since water balance modeling indicates that the pit should behave as a sink, outflow from the pit lake to ground water is not anticipated. Therefore, Arizona Aquifer Protection Standards would also not be applicable to pit water quality.

Dissolved and suspended materials would be transported to the pit lake by ground water inflow, by direct precipitation and runoff, and through natural leaching of the wall rock exposed in the pit; the pit water would then be concentrated by evaporation. The contribution of TDS from ground water was estimated by averaging water quality data from bedrock wells near or in the Carlota/Cactus pit that were determined to be representative of rock types and ground water flows present at closure (BMW-1, BMW-2, MW-4, MW-5, MW-6, MW-9, MW-10). An average precipitation rate of 20.37 inches per year was used (GWRC 1994). Available precipitation chemistry data from Graham County, Arizona (National Atmospheric Deposition Program 1994) was used to estimate the dissolved solids contribution to the pit lake from precipitation. It was assumed that 50 percent of all precipitation that fell on soils and rock within the pit watershed would end up in the pit lake, and that 100 percent of the precipitation that fell directly on the pit lake surface would be added to the lake volume. Total evaporation from the pit lake was proportional to the lake surface area at a rate of 5.554 feet per year (GWRC 1994).

In addition, meteoric water mobility test results and acid generation/neutralization test results were used to estimate wall rock and backfill contributions to the pit lake final water chemistry. Wall rock and backfill materials were predicted to be non-acid generating and therefore the meteoric water mobility test results were assumed to be an accurate estimation of dissolved constituent contributions from these materials. It was assumed that precipitation runoff and water in the pit lake would leach metals, sulfate, and other major ions from pit wall rock and backfill, increasing the TDS load to the pit lake.

Mass balance calculations were performed on the pit water to determine the concentrations of constituents of interest when the water level reaches equilibrium. Processes such as precipitation and adsorption slow the concentration process by diluting dissolved constituents from the water when thermodynamic conditions are favorable. The EPA computer model MINTEQA2 is designed to predict these processes. The MINTEQA2 model was applied to the equilibrium pit water chemistry to predict the anticipated water quality. The geochemistry of the pit wall rocks and partial backfill material were included in this analysis.

The MINTEQA2 model predicted that a pit water TDS concentration of 687 mg/L (*Table C5-1* in Appendix C, Water Resources Data) would occur 125 years after the cessation of pumping. The predicted pH of the pit water would be 8.4 standard units, within the full body contact and agricultural livestock water quality standard range of 6.5 to 9.0 standard units. No data were available for predicted concentrations of beryllium, but significant levels of this constituent would not be expected because of the high pH and oxidizing nature of the pit lake water chemistry. The inflow data for constituents reported as below the minimum reportable level were not included in the mass balance calculations or modeled for final pit water quality. As shown in *Table C5-1*, the concentrations of metals for the inflow data were low and either remained unchanged or decreased in concentration over the 125-year model period. Although mass balance calculations and modeling were performed for 125 years after the cessation of mining (predicted time for the water level to reach equilibrium), the pit water chemistry would not be anticipated to be at equilibrium at this point in time. The predicted zero outflow scenario means that the concentrations of most constituents would continue to increase. Natural systems provide sinks (sources of removal) for many dissolved constituents, but many of the major ions (sodium, chloride, sulfate) and TDS would continue to increase in concentration to levels many times greater than those modeled at 125 years.

Regardless of the final pit lake water quality, no impacts to other surface or ground water resources surrounding the pit would be expected, since no outflow of water from the pit lake is predicted to occur. Potential impacts to wildlife are discussed in Section 3.5, Biological Resources.

Well Field Impacts

The location of the proposed water supply well field would tap into the bedrock aquifer in the vicinity of the confluence of Haunted Canyon and Pinto Creek. GWRC (1994) conducted a series of pump tests to determine the long-term sustainable yield of a well field located in this area. Three bedrock wells (TW-1, TW-2, and TW-3) were drilled, and a series of pumping and recovery tests were conducted between October 1993 and January 1994. The locations of these three bedrock wells (proposed water supply wells) and the geology of the area are shown in *Figure 3-4*. The pumping periods of the tests ranged from 5 days (TW-1 and TW-3) to 24 days (TW-2). The pump tests indicated that production wells located in this area could supply the general water requirements of the mine (GWRC 1994) (see Section 2.1.6.1).

To evaluate the potential impacts to surface water flows and shallow alluvial ground water from the well field development, several streamflow stations, and three shallow wells were monitored during the pumping and recovery tests. The location of the streamflow stations (HC-2, PC-7, and PC-7A) and alluvial wells (AMW-21, AMW-22, and AMW-23) located near the well field and included in the pump testing are shown in *Figure 3-4*. Since TW-2 was pumped at the highest rate (604 gpm) for the longest time (24 days) and showed the largest impact on alluvial water levels and surface flows in Haunted Canyon, the results from this pump test provide the primary information to evaluate potential impacts to streams and ground water resources. Additional data collected during the 5-day pump tests of TW-1 and TW-3 provide supplemental information to predict impacts.

The results of the TW-2 pump test are presented in *Figure 3-20*. During the pump test, there was a slight decrease in pressure recorded in bedrock observation well TW-1 located 1,700 feet south of TW-2, but no response in TW-3 located 2,300 feet northwest of TW-2. The pressure in TW-1 recovered to near prepumping conditions after the TW-2 pump test was completed. The response in these wells indicates that the bedrock aquifers tapped by TW-1 and TW-2 are interconnected. The several-day pump test in TW-1 and TW-3 did not affect water levels or pressure conditions in the other bedrock wells. From these results, it appears that the cone of depression in the bedrock complex caused by well field extraction would extend out in some irregular fashion up to a distance of a few thousand feet from the well field. The water level in the alluvium also declined during the TW-2 pump test. AMW-22 (located 200 feet from TW-2) appeared to decline approximately 2.0 feet; AMW-21, located in Haunted Canyon (1,550 feet south of TW-2), declined 1.0 feet; and AMW-23, located along Pinto Creek (2,200 feet northwest of TW-2), was not affected by the pumping. It is important to note that drawdown in the alluvial wells appeared to reach equilibrium during the TW-2 aquifer test (i.e., the water levels did not lower further) after approximately 14 days in AMW-22 and 21 days in AMW-21. Water levels in these wells recovered slowly after the pumps were shut off.

During the TW-2 pump test, streamflows were monitored in Haunted Canyon at station HC-2, located approximately 3,200 feet south of TW-2, and in Pinto Creek at station PC-7A, located approximately 2,300 feet north of TW-2. The measured flows at the Haunted Canyon (HC-2) station during the pump test are presented in *Figure 3-20*. During the pump test, the Haunted Canyon flow decreased from approximately 45 gpm at the start of the test to 5 gpm at the end of the test. The flow progressively increased to approximately 27 gpm within a few days of shutting off the pump. The decrease in flow recorded in Haunted Canyon during the TW-2 pump test suggests that pumping the TW-2 well would reduce the flow in Haunted Canyon. No decrease in flow was observed during the TW-2 pump test at the PC-7A station in Pinto Creek.

The pump tests of TW-1 and TW-3 did not appear to affect streamflow in Haunted Canyon. However, while pumping TW-3, the streamflow in Pinto Creek at station PC-7, located 1,400 feet downstream from the pumping well, decreased from approximately 350 gpm to 250 gpm. After the pump was shut off, the flow at this station increased steadily over the next several days to approximately 290 gpm. These data suggest that pumping the TW-3 production well would reduce the flows in Pinto Creek.

The pump and recovery tests indicated that there is a hydraulic connection between water pumped from the bedrock complex, water stored in the alluvium, and surface flows. This connection is also supported by the fact that the chemistries of the surface water,

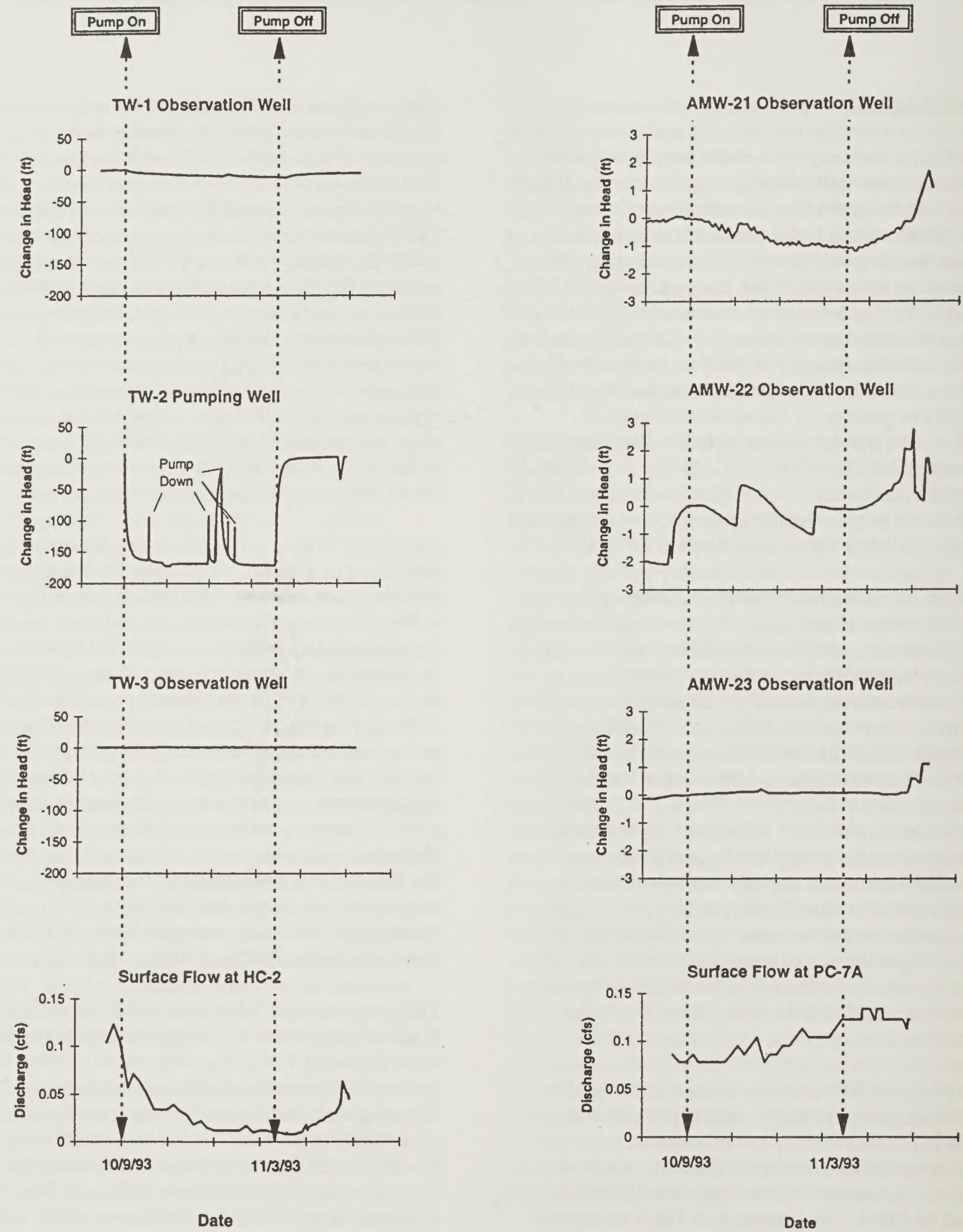

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Figure 3-20
Water Level and Flow Response to the TW-2 Pump Test

ground water in the alluvial wells, and ground water in the bedrock test wells in the well field area were similar (see discussion under Ground Water/Surface Water Interactions in Section 3.3.1). This chemical similarity suggests that during low-flow conditions, the surface flows and water levels in the alluvium are sustained primarily by discharge from the bedrock system. Pumping the bedrock wells would reduce the amount of discharge from the bedrock into the alluvium and creek bed.

Impacts on Wells. Based on the localized drawdown pattern observed in the bedrock during the three pump tests, it appears unlikely that wells located more than 1 mile from the well field production wells would be affected by long-term pumping. There are four BHP Copper wells located within a 1-mile radius of the well field: Peak 26, Peak 29, #3 Seep Caisson, and well PV-SX. However, only Peak 26, Peak 29, and PV-SX are completed into the bedrock aquifer. Water levels in these wells would be lowered if (1) the bedrock aquifers tapped by Carlota's well field production wells were hydraulically interconnected with the bedrock aquifers intercepted by these three bedrock wells, and (2) if the cone of depression caused by pumping the Carlota production wells overlaps with the cone of depression caused by pumping any of these three BHP Copper bedrock water wells. Given the complex hydrogeologic conditions, it is not possible to determine if the BHP Copper wells would be affected. Possible impacts include a noticeable change in pumping water levels.

Impacts on Seeps and Springs. There was no measurable decrease in discharge in either of the two springs (Fifty Dollar Spring and Mule Spring, see *Figure 3-9* for location) monitored during the pump tests. Although no impacts were observed during the pump tests, it is conceivable that long-term pumping of multiple wells in this area could affect natural spring discharge in the vicinity of the well field. The magnitude of the impact would depend on the relationship between the spring location and zone of influence (or cone of depression) caused by the well field extraction. Based on the localized drawdown pattern observed in the bedrock during the three pump tests, it appears unlikely that springs located more than 1 mile from the well field production wells would be affected by long-term pumping.

Five springs and seeps have been identified within a 1-mile radius of the well field (*Figure 3-9*). These include Fifty Dollar Spring, Coon Spring, and three unnamed springs. The flow rate in June, 1993, was 2 gpm at Fifty Dollar Spring, and 1 gpm or less at the other four springs. Most of these springs discharge in areas where bedrock is located, or very near the surface. Therefore, ground water extraction could potentially reduce the discharge at any or all of these springs. It is unlikely that other springs located outside this area would be affected by the well field. Monitoring and mitigation measures are proposed to minimize impacts to springs in Section 3.3.4-Water Resources, Monitoring and Mitigation Measures.

Impacts on Shallow (Alluvial) Ground Water and Streamflows. The distance-drawdown relationships, as well as the establishment of static water levels in the alluvium after pumping in TW-2, were used to estimate the decline in alluvial water levels that may occur as a result of pumping from the well field. The estimates, presented in *Table 3-47*, suggest that at a distance of 1,000 feet from the pumping well, the drawdown is anticipated to range from 1 to 3 feet, depending on the pumping rate. However, it should be noted that because of the complex structure of the bedrock in this area, as well as the uncertainties regarding the combined effects of several wells pumping in this area, the actual drawdown in the alluvium may be more or less than estimated.

As stated previously, water quality data provided from the well field suggest a similar water chemistry in Haunted Canyon surface waters and the local alluvial and bedrock ground water. The water chemistry of Pinto Creek, however, is significantly different from the Haunted Canyon water chemistry (see *Figure 3- 19*). The water chemistry of Pinto Creek below the Haunted Canyon confluence suggests a mixing effect of upper Pinto Creek and Haunted Canyon water chemistries. Therefore, decreasing the contribution of Haunted Canyon flows would have the potential to alter the downstream water quality of Pinto Creek.

In summary, based on the TW-2 pump test, pumping the well field would have a direct impact on streamflows in Haunted Canyon and water levels in the alluvium in Haunted Canyon and Pinto Creek

Table 3-47. Anticipated Drawdown in the Alluvial Aquifer as a Result of Pumping Well TW-2

Production Rate	Estimated Drawdown in the Alluvial Aquifer[1] at Various Distances from the Pumping Well(s)		
	100 feet	1,000 feet	5,000 feet
600	2.3	1.3	0.7
800	3.0	1.8	1.0
1,000	3.8	2.3	1.2
1,200	4.6	2.7	1.4

[1]Based on extrapolating measured drawdown in AMW-21 and AMW-22 during 24-day pump test of TW-2 at 604 gpm.

immediately downstream of the confluence of Haunted Canyon and Pinto Creek. These impacts would be most noticeable during periods when streamflow consists primarily of baseflow. Although these data indicate that the streamflows and water stored in the alluvium would be affected by the proposed well field, it is not possible to determine with certainty the magnitude and areal extent of the impacts. It appears that most or all of the perennial reach in Haunted Canyon (between Powers Gulch and Pinto Creek) would be affected to some extent. Streamflows and water stored in the alluvium in Pinto Creek could also be directly affected for several thousand feet up and downstream from the water supply wells. A direct reduction in flow in the vicinity of the Pinto Creek and Haunted Canyon confluence would incrementally reduce flow for some distance downstream in Pinto Creek. See Section 3.10 for a discussion of impacts to the downstream section of Pinto Creek that is eligible for Wild and Scenic River designation. The Pinto Creek water quality downstream from the Haunted Canyon confluence could also be affected. Reductions in flow for Haunted Canyon would increase the TDS concentration in Pinto Creek below the confluence of these streams because Haunted Canyon has a lower TDS concentration, which acts to dilute the relatively higher TDS of Pinto Creek. Additional pump testing and monitoring, as recommended in the mitigation section (Section 3.3.4), would be required to further refine the boundaries of the affected area and the magnitude of the impacts. Mitigation is proposed in Section 3.3.4 (Water Resources, Monitoring and Mitigation Measures) to mitigate potential flow reductions in Haunted Canyon and Pinto Creek resulting from well field pumpage.

Impacts from Well Field Access Roads. The construction of the well field service road from the south and the main access road from the north would create cut and fill slopes that would be susceptible to erosion if BMPs are not employed. However, Carlota has committed to implementing BMPs to minimize erosion and sedimentation. The potential for erosion and sedimentation and the effectiveness of BMPs are analyzed in more detail in Section 3.2, Geology and Minerals, and Section 3.4, Soils and Reclamation.

The proposed undeveloped service road crossing of Haunted Canyon (Carlota 1994c) would create channel and bank instability because of traffic on unprotected surfaces. This would contribute to sediment yield, an adverse impact for which additional monitoring and mitigation measures are recommended (Section 3.3.4, Water Resources - Monitoring and Mitigation Measures).

<u>Heap-Leach Impacts</u>

The heap-leach pad, ponds, and process plant area would occupy approximately 342 acres (0.5 square mile) of the Powers Gulch watershed area (5.5 square miles). During mining operations, this part of Powers Gulch would be withdrawn from the contributing watershed area. Based on a mean annual watershed runoff of 2.62 inches above the Pinto Valley weir, removal of this contributing watershed area would reduce surface water runoff by approximately 75 acre-feet per year. This volume represents approximately 10 percent of the runoff from the Powers Gulch watershed and less than 2 percent of the runoff at the PC-7 gage site downstream of the confluence of Haunted Canyon and Pinto Creek. This impact would occur primarily during storm events and would end after reclamation and closure of the heap facilities since the area would be returned to the area that contributes surface runoff to the watershed. Reclamation would be accomplished by creating a low-permeability recontoured heap surface that would continue off the pad and into the diversion channels. Final grading would ensure that all surface runoff would be diverted efficiently to the Powers Gulch and east diversion channels and conveyed downstream to Powers Gulch.

A substantial amount of water consumption would be associated with the heap-leach process. However, Carlota proposes to minimize the consumptive use of water by designing dominantly in-pad ponds to reduce evaporation and by using pit water to fulfill a portion of the project water needs. Some consumptive use of water would occur as a result of evaporation on the pad surface, adsorption by the ore, and the use of water in dust suppression. Mitigation has been proposed to maximize water conservation (Section 3.3.4 - Water Resources Monitoring and Mitigation Measures).

The proposed process water management system, including the main and north PLS embankments and ponds and the raffinate and plant PLS/SX ponds, would be designed to contain the maximum operational water storage requirement occurring during a wet month in a wet year, in addition to runoff from a 1/2 PMF event occurring on the pad, plant, and contributing watershed area. All pond pump systems would include emergency backup pumps and diesel-powered electrical generators. Water balance and flood hydrology analyses have been conducted by Carlota and its consultants (Knight Piésold 1995a, 1995e, 1996e, 1996f, 1996g, 1996h) to determine the volumes of water to be contained under these conditions. Scenarios that produced the largest combined volume (the maximum operational volume plus the 1/2 PMF stormwater volume) were analyzed for each month of the year. The main heap-leach embankment/PLS pond, the north heap-leach embankment/PLS pond, and the raffinate and plant PLS/SX ponds were evaluated separately to determine the scenario for each individual component within the heap-leach facility. Hydrologic modeling to estimate 1/2 PMF peaks and volumes assumed that heavy rainfall had occurred the 5 days previous to the given storm event (antecedent moisture condition [AMC] III), and that soils were nearly saturated. Therefore, these estimates were considered to be very conservative. Additionally, the heap water balance conservatively estimated the monthly maximum operational volumes.

The maximum combined operating and stormwater volume for the main heap-leach embankment and pond occurs from the 72-hour February 1/2 PMF stormwater volume (80.1 million gallons) and an operating base pool of 82.2 million gallons (Knight Piésold 1997). The main heap-leach facility, operating in conjunction with the Powers Gulch inlet control structure and diversions, would receive approximately 80.1 million gallons of the total direct precipitation and flood runoff volume of 367.4 million gallons from the pad, the upper watershed, and the west side of Powers Gulch (Eder area) (Knight Piésold 1997). The remaining 287.3 million gallons would be routed through the Powers Gulch Diversion around the facility. This facility, as designed (main embankment crest height of 3,830 ft-amsl), would completely contain the combined volume of 162.3 million gallons without decanting any solutions to the north heap-leach pad or any other location, since the facility has approximately a 190.2-million-gallon solution storage capacity (or 170.2 million gallons with 3 feet of freeboard). To better accommodate a situation where back-to-back heavy precipitation events might occur, mitigation has been specified that would require this component facility to have the capability of pumping, within a 10-day or less period, the entire volume of solution generated by the 100-year, 24-hour storm out of the main heap-leach PLS pond into a suitable location available for emergency containment (Section 3.3.4, Water Resources - Monitoring and Mitigation Measures).

The maximum combined operating and stormwater volume for the north heap-leach embankment and pond (35 million gallons) occurs from the 72-hour October 1/2 PMP volume (direct precipitation on the north pad with zero runon) with a base pool operating volume of 14.8 million gallons. Not only would this facility, as designed, contain the 1/2 PMP volume (20.2 million gallons) on top of the maximum October operating base pool, it would also contain the entire PMP volume of approximately 40.5 million gallons (combined containment volume of 55.3 million gallons) without overtopping (Knight Piésold 1997), since the solution capacity of the north embankment and PLS pond at the top of the embankment is approximately 58.4 million gallons.

The maximum combined operating and stormwater volume for the raffinate and plant PLS/SX ponds coincides with the 72-hour August 1/2 PMP (maximum base pool operating volumes of approximately 1.79 million gallons and 1.59 million gallons, respectively). The maximum combined stormwater and operating volume for the raffinate pond is approximately 3.46 million gallons as compared to a total solution capacity of approximately 4.54 million gallons at the embankment crest elevation of 3,900.5 ft-amsl (or approximately 3.46 millions gallons with 3 feet of remaining freeboard) (Knight Piésold 1997). The maximum combined stormwater and operating volume for the plant PLS/SX pond is approximately 2.31 million gallons as compared to a total solution capacity of approximately 3.18 million gallons at the embankment crest elevation of 3,925 ft-amsl (or approximately 2.31 million gallons with 3 feet of freeboard). Under these conditions, the potential for impacts from process water overflow is considered minimal.

The 1/2 PMP has a very low probability of occurrence. Since the flood hydrology and water balance analyses considered other conservative variables (AMC III conditions, operational data based on the wettest year on record, and the availability of additional storage capacity within the 3 feet of embankment freeboard), the estimated solution volumes are conservative, and would tend to decrease the probability of occurrence even further. Additionally, the heap-leach facility embankments would be designed to adequate safety standards for operational and closure conditions, and would be constructed and lined to prevent instability from seepage. In the postmining configuration, process water impoundments would be recontoured and related embankment locations would be incorporated into the postmining topography. Therefore, the potential for overtopping or failure of process water embankments is considered minimal. Mitigation is proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures) specifying that, at a minimum, the above-referenced pond volume capacities must be maintained in the final facility design.

The quality of surface water and/or ground water would be impacted if process solutions seeped or were accidentally released from the heap-leach facility. Although Powers Gulch would be permanently diverted around the heap, process solutions that seep or are accidentally released from the facility could enter Powers Gulch immediately downstream from the facility. Ground water in the vicinity of the heap is controlled by movement through fractured bedrock units and along prominent faults. Also, minor amounts of ground water move through the thin alluvium present along the Powers Gulch drainage bottom. Depending on the time of year, the elevation of the ground water potentiometric surface under the heap-leach pad varies from a few feet above land surface to more than 30 feet below land surface. This indicated that, in the absence of engineering controls, a high potential exists for intercommunication between process solution and ground water from seepage or release of process water.

The potential for uncontained seepage or the release of process water would be minimized during operations because of Carlota's proposed facility design (see Section 2.1, Proposed Action, for design details). The heap would be constructed as a valley fill with internal solution storage. A single synthetic liner would be installed in heap areas where no solution storage is planned. In areas where perpetual solution storage would occur during operation, a double-lined system with an internal LCRS would be constructed to detect leaks and provide for the collection and recovery of solution should seepage occur through the primary liner. Near-surface ground water beneath the pad would be collected and transmitted away from the heap base via a central spine drain located in the topographic low of Powers Gulch augmented by dedicated finger drains. This underdrain system would minimize the potential for hydrostatic uplift in the heap-leach pad area and would facilitate the isolation of ground water from process solutions. The heap would be designed as a zero-discharge facility. As summarized in Section 2.1.3.1, during operation, surface runoff would be diverted around the heap, and direct precipitation would infiltrate and be contained within the heap.

Although an accidental release of process solutions from the heap-leach facility is unlikely during operations, any release to the environment would result in significant impacts to localized surface water and ground water quality. The ore would be leached with a dilute sulfuric acid solution that would result in process water with low pH and high heavy metals concentrations. The process water chemistry was estimated (Knight Piésold 1993a) to have a pH of 1.4, a TDS of 29,600 mg/L, and elevated levels of heavy metals (e.g., 2,190 mg/L copper, 44.8 mg/L manganese, 3,560 mg/L iron, and 16.5 mg/L zinc). The severity of any water quality impacts resulting from a release of process water from the heap would depend upon the size and timing of the release, the time required to detect the release, and the measures implemented to remedy the situation.

Local surface waters and bedrock ground waters in Powers Gulch and Haunted Canyon (well field area) are generally low in TDS (less than 500 mg/L) and are of a calcium, sodium-bicarbonate water type. Metals concentrations in the surface waters and ground waters are mostly low or below detection limits. Although the local waters would be expected to provide a certain amount of buffering capacity due to moderate concentrations of carbonate and excess acid-neutralizing potential in underlying rock, the low pH process solution would be expected to lower surface water pH values to below levels set by Arizona to protect designated uses if released in amounts significant to flow. Releasing high TDS, high metals concentrations, and sulfate-dominated process solution could potentially impact the quality of the local surface and ground waters. Potential impacts to Powers Gulch and Haunted Canyon would include exceedances of stream water quality standards and would change the overall stream water chemistry.

Downstream water quality impacts are influenced by the intermittent nature of the regional surface waters. A surface release of process solutions would most likely be transported downstream from the project area by ephemeral flows. Pinto Creek below the project area has a sulfate water chemistry with most metals concentrations low or below detection limits and TDS concentrations of approximately 500 mg/L. Potential impacts would include exceeding stream water quality standards or changing the overall stream water chemistry. Potential impacts to ground water downgradient of the project area would depend on the specific area geology, ground water flow, and hydraulic conductivity.

Carlota has proposed a monitoring, spill protection, and spill containment program (SCHMM Plan) to minimize the probability of releasing process solutions into the environment during operations, and to provide for the rapid detection and control of process solution seepage or accidental spills. The ground water and surface water monitoring plan (GWRC 1996a) includes several alluvial and bedrock monitoring wells and surface water sampling stations located downstream from the heap leach/PLS pond facility as part of a comprehensive monitoring network. Regular sampling of water collected in the underdrain collection pond is also included in the plan. The monitoring locations and sampling frequency included in the plan are summarized in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures. The monitoring network would provide for early detection of a release to ground water or surface water. In addition, the monitoring plan has been accepted by the ADEQ and required as part of the State of Arizona Aquifer Protection Permit (ADEQ 1996).

The SCHMM Plan proposed by Carlota (1996a) considers the potential flow paths of accidental process solution spills; these flow paths would provide locations for water monitoring and sampling, rapid detection, and treatment or capture of accidental process water discharges before they migrate into the Powers Gulch surface and ground water system. Automatic pumps with standby diesel power and electronic metering, monitoring, and control systems would be provided. Dedicated backup pumps are included in the process solution pond designs (Knight Piésold 1995a).

The primary focus of the SCHMM would be to prevent process water discharges. Should a discharge occur, the emergency response objectives of the plan would be to minimize and address potential immediate health or safety hazards, to limit potential spill impacts to the smallest possible area, and to facilitate subsequent cleanup and disposal activities. If an accidental process water discharge or spill were to reach surface or ground waters, the plan emphasizes methods to quickly contain and remove contaminants from the water to minimize water quality impacts, avoid downstream transport of contaminants, and minimize damage to aquatic life (Carlota 1996a). However, because of the quantity and hazardous nature of the PLS and raffinate solution, a release would have the potential to degrade surface and ground water quality. Therefore, monitoring and mitigation measures are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

Carlota has proposed a heap closure plan (Carlota 1994a) that would drain as much process solution as possible from the heap, and would recontour and reclaim the heap to minimize infiltration, enhance surface runoff and evapotranspiration, and prevent the build-up of water at topographic lows within the heap. The postclosure water balance for the heap was estimated using the Hydrologic Evaluation of Landfill Performance (HELP) model (Carlota 1994a). The results of the modeling do not indicate a significant change in moisture content in the heap over the 20-year model period.

The Powers Gulch diversion channel would be reshaped as necessary to convey large flood events without impacting the stability of the heap or allowing flood waters to infiltrate. Ground water would remain separated from the heap by the permanent spine and finger drain system under the liner. Several years before closing the main leach pad area, Carlota would begin closure of the stand-alone north pad area to conduct full-scale testing of closure and reclamation options.

Leaching characteristics and the static and kinetic behavior of the leached ore from the proposed project were determined using metallurgical tests (PINTAIL Systems, Inc. 1994). An Acid-Base Accounting (ABA) test was conducted to define the balance between potential acid-producing minerals and acid-consuming minerals. Results of the ABA test indicated that the oxide spent ore, representing approximately 80 percent of the total ore body, did not possess the potential to produce acid. The mixed-zone spent ore, representing approximately 20 percent of the total ore body, produced results falling in an intermediate range (ANP [Acid Neutralization Potential]:APP [Acid Producing Potential] ratios between approximately 1 and 3), indicating a limited potential for acid generation. Kinetic humidity column testing was used to model the processes of geochemical weathering of the spent ore. Results indicated that leachate from the oxide spent ore type and the mixed zone spent ore would have pHs of less than 6 and less than 3, respectively. Both would contain elevated metal concentrations — conditions expected from an acid leached ore. The Meteoric Water Mobility Test (MWMT), which was used to evaluate the spent ore for its potential to release contaminants into meteoric water, indicated that concentrations of regulated metals from the oxide ore were below the standards and that concentrations of regulated metals from the mixed-zone ore exceeded the standards for copper, iron, and magnesium. Metals exceeded Arizona surface water quality standards for Powers Gulch and downstream receiving waters, Arizona aquifer standards, and Federal Primary and Secondary MCLs. The Toxicity Characteristic Leaching Procedure (TCLP) was used to test for leaching of eight TCLP-specific toxic metals from the spent ore rock matrix. All metals analyzed from the TCLP-leached oxide and mixed-zone ores were below the regulated standards. Based on these test results, a release from the heap to surface waters following closure would potentially impact stream water quality, which could impair the stream's resident aquatic life, including habitat for the desert sucker, long fin dace, and the potential Pinto Creek Scenic River segment (see Sections 3.5, Biological Resources, and 3.10, Wilderness and Wild and Scenic Rivers).

Although the spent ore would be primarily non-acid-generating because the acid leaching would have occurred for approximately 20 years, the current proposed closure plan recognizes the possible presence of acid in the spent ore. The plan is designed to minimize any release of water originating from the internal portion of the leach pad by retarding infiltration into the spent ore. At closure, Carlota would consider the most current technology to improve upon heap closure options already identified (see Section 3.4, Soils and Reclamation), including but not limited to, injecting milk lime directly into the heap to chemically and physically fix residual acidity, applying various soil compaction techniques, and using sealants, such as clay or lime, to reduce permeability. Water monitoring would continue following heap closure until the success of heap closure could be verified by the ADEQ and the Forest Service. As improved closure technologies are identified throughout the life of the project, the reclamation bond required by the Forest Service would be adjusted accordingly.

The severity of water quality impacts would depend on the size and timing of the release, the rapidity of detection, and the remediation measures. Although, a release from the heap after closure is not anticipated due to the proposed draindown and capping processes at closure, any possible release would have the potential to degrade surface and ground water quality because of the quantity and hazardous nature of the spent ore; therefore, monitoring and mitigation measures are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

There are several state and federal water quality permits that would be secured by Carlota before project construction. These permits would require that the heap leach be built, operated, and closed to comply with BADCT with regard to environmental protection. An Aquifer Protection Permit would be required by the ADEQ to protect ground water quality. A CWA Section 402 Permit would be required by the EPA to protect surface water quality from storm water runoff from the heap-leach facility. A CWA Section 404 Permit would be required by the COE to protect and mitigate losses of waters of the U.S., including wetlands; the ADEQ would require Section 401 certifications for both of the CWA Section 404 and 402 permitting process. The water monitoring and compliance requirements in these permits would be designed to protect surface and ground water quality.

A discussion of potential impacts to riparian areas and wetlands is presented in Section 3.5.1, Biological Resources - Affected Environment.

Stream Diversion Impacts

Permanent diversions would be planned around the Carlota/Cactus pit in Pinto Creek and the heap-leach facility in Powers Gulch. The following sections describe the anticipated changes to the respective watersheds and channels.

Pinto Creek Diversion. For the proposed action, the Pinto Creek diversion would be constructed along the edge of the Carlota/Cactus pit. The alignment of the Pinto Creek diversion in the pit area during operations is shown in *Figure 2-3.* The proposed operational design would, at a minimum, provide conveyance for all flows up to the 500-year flood peak (approximately 10,100 cfs). The proposed diversion channel alignment would be similar to the existing channel and would not cause a major change in the slope of the channel. The hydraulics of the diversion channel were determined over a range of potential channel widths in order to select a preliminary cross-sectional geometry that would provide acceptable sediment transport conditions (SLA 1993). At the end of operations, the diversion would be reconfigured as necessary for long-term postclosure functioning (Carlota 1994a).

With adequate hydraulic design and implementation, the diversion hydraulics would remain similar to existing conditions as would the sediment transport capacity (SLA 1993). In this case, which has been shown to be feasible in preliminary design, the channel dynamics would remain relatively unaffected by the proposed diversion on Pinto Creek both upstream, downstream, and within the diverted reach (SLA 1993). Bed material size distributions and channel cross sections would not be significantly affected by the project either upstream or downstream of the diversion channel. Detailed diversion designs and maintenance during operations would ensure that channel depths would be adequate to contain flows, and that the stability of upstream and downstream channels and banks would be maintained.

With BMPs to control erosion and sediment as proposed, the increase in sediment produced by the project would be negligible. Any small increase in sediment supplied by the watershed to Pinto Creek would be transported by the channel, since the sediment transport capacity of Pinto Creek, including the diverted section, is much greater than the supply (SLA 1993). Watersheds similar to Powers Gulch and the upper reaches of Pinto Creek often have sediment transport capacities larger than the actual quantity of sediment supplied. This is caused by such characteristics as steep channel gradients, hillslopes protected by dense vegetation, and a lack of erodible material under normal runoff conditions. In some areas, this would encourage streambed degradation; however, in the project area, the processes of sediment sorting and bedrock exposure have naturally armored many channel reaches against further degradation. Consequently, diversion designs can be conceptually oriented to sediment supply, rather than attempting to match future sediment transport capacities to existing capacities.

Although overtopping of a properly designed diversion is unlikely, overtopping could occur if flows greater than the 500-year flood were experienced. However, the probability of the 500-year flood occurring is 0.2 percent during any year of the operation. Diversion overtopping would create minor adverse impacts to the environment if it occurred during operations and damage to the diversion was rapidly repaired. For the postmining configuration, the diversion would be stabilized by a large bench with a backfill berm in the upstream area where flow momentum is toward the pit. These features would add considerable long-term protection and stability to the diversion area. In addition, the flow path and meander configuration of the proposed diversion around the remainder of the pit would encourage flow momentum away from the pit and onto channel sections reinforced by bedrock. When these attributes are considered and a postmining design for an adequate recurrence interval is implemented, diversion overtopping and subsequent failure would be highly unlikely. Mitigation is proposed that would require the postclosure channel design to accommodate an event of the magnitude prescribed by the appropriate agencies.

Powers Gulch Inlet Control Structure and Diversion. For the proposed action, Powers Gulch is to be diverted around the heap-leach pad and associated facilities. In addition, an inlet control structure would be constructed to attenuate storm runoff flows before they entered the main diversion. Storm runoff from the hillside to the east of the leach pad would be collected by the east diversion channel and routed through the inlet control structure. The channel alignments for this action is shown in *Figures 2-1a and 2-1b*. The bed of the diverted channel would follow a flatter gradient than the natural channel in a longer path around the heap-leach pad on the watershed sideslope; once it passes the north end of the heap-leach pad, it would be directed back to the existing Powers Gulch channel by constructing a flume drop.

The primary purpose of the inlet control structure is to operate in conjunction with the heap-leach facility and the Powers Gulch and east diversions to attenuate flood peaks, thereby reducing the size and associated disturbance required for the Powers Gulch diversion. As an example of this effect, the 6-hour 1/2 PMF peak in Powers Gulch immediately downstream from the location at which the Powers Gulch diversion re-enters Powers Gulch would be approximately 12,838 cfs without the inlet control structure and heap-leach facility in place. During the operational phase of the project with these facilities in place, the peak would be attenuated to approximately 3,047 cfs (Knight Piésold 1996h). The Powers Gulch and east diversions would be sized to pass the peak flows from the 6-hour 1/2 PMF.

At mine closure the inlet control structure would be removed and the peak flows entering the Powers Gulch diversion would no longer be attenuated. Since the natural runoff hydrograph would be passed directly through the diversion, no long-term impact would occur to the quantity of downstream flow in Powers Gulch, Haunted Canyon, and Pinto Creek. Although Carlota has proposed to reshape the Powers Gulch and east diversion channels to convey large flood events without impacting the stability of the heap or allowing flood waters to infiltrate the leach pad, the magnitude of "large flood events" has not been defined. Therefore, monitoring and mitigation are proposed that would require the monitoring and postclosure channel design to accommodate the full PMF event or an event as otherwise specified by the Forest Service (Section 3.3.4, Water Resources - Monitoring and Mitigation Measures).

The existing slope of Powers Gulch in the vicinity of the proposed heap-leach pad is approximately 4.3 percent, while the flatter portion of the diverted channel is approximately 1.5 percent, and the slope of the steeper flume drop portion is approximately 22.2 percent in the upper section and 11.8 percent in the lower section. With the proposed change in alignment and gradient through the diverted reach, Powers Gulch would flow at a lower velocity in the flatter section and at a higher velocity in the steeper section. In the section with reduced gradient and velocity, the sediment transport capacity of the channel would be reduced below the existing transport capacity, decreasing the ability of the channel to transport the sediment load. In the section with the increased gradient and velocity, there is an increased potential for scour. However, bedrock controls in the channel bed would minimize this scour potential in the steep gradient reach. Some high energy flow effects could occur on the flatter reach of Powers Gulch immediately downstream of the steep gradient depending on the channel characteristics, flow state, and the nature of flow transitions. Potential impacts would include local scour and bank erosion, with subsequent sedimentation in the Powers Gulch and Haunted Canyon reaches immediately downstream. These would be adverse impacts requiring monitoring and mitigation.

Regarding the reach with the flatter gradient, SLA (1993) states that "lesser slopes than the long-term slope would be adequate (from both a hydraulic and sediment-transport standpoint), provided the channel is periodically maintained to remove any accumulated sediments." Much of the sediment produced by the watershed is composed of finer-sized particles that would continue to be transported through the diversion channel. However, the coarser fraction of sediment, primarily consisting of bedload, may deposit on the bed of this portion of the diversion channel. While some accounting for sediment deposition was included in the freeboard calculation in the form of bed waves, no direct analysis of bedload deposition was conducted. It is unknown if the freeboard for sediment would adequately compensate for the actual deposition that may occur. To account for this uncertainty, SLA (1993) recommends observing hydraulic conditions and sediment deposition during the life of the project before developing and constructing a final postclosure design for the diversion channel. Therefore, monitoring and mitigation are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

Overtopping of the Powers Gulch and east diversions would be very unlikely since the diversions, operating in conjunction with the inlet control structure and the heap-leach facility, would be designed to convey the 1/2 PMF event. Although overtopping of a properly designed and constructed diversion is unlikely, the possibility of overtopping would remain if flow exceeded the design capacity or if there were inadequate inspection and maintenance activities. Overtopping could also result from landslides or debris flows affecting the integrity of the diversion, particularly with the additional loading and slope steepening associated with the Eder mine rock disposal area. Overtopping could create adverse impacts to the environment even with rapid repair of the diversion. During operations, diversion overtopping would cause water quality impacts if the stormwater storage capacity of the heap-leach facility was exceeded and process solution escaped over the main PLS embankment. Overtopping could also increase the potential for erosion of the toe of the heap adjacent to the Powers Gulch diversion channel. Therefore, mitigation is proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

The inlet control structure is designed to attenuate peak storm flows and is not designed to retain water for future use. The structure would be dry except during or immediately following storm events. Therefore, the potential for water temporarily detained by the inlet control structure to seep into the bedrock system and significantly affect or increase the hydrostatic heads in the bedrock system beneath the heap leach pad should be minimal.

Water quality impacts to Powers Gulch, Haunted Canyon, and Pinto Creek from a potential surface release of process solution have been outlined in the discussion of heap-leach impacts earlier in this section. Overtopping of the Powers Gulch diversion and erosion of the heap-leach pad would have similar impacts on surface water quality. Eventually, the excess transport capacity in the system would likely disperse the deposited material downstream. However, the leach pad would remain exposed to channel flows and accelerated erosion. This major adverse impact would be avoided by Carlota's commitment to ensuring long-term diversion functions, as identified in the proposed action.

Downstream of the proposed heap-leach pad, a short section of steep gradient would occur along the diversion alignment. Channel slopes in this area would be on the order of 15 to 20 percent. The higher flow velocities in this downstream reach may require some form of energy dissipation if it is determined that the natural channel section cannot withstand the associated hydraulic forces. Although the natural Powers Gulch channel contains exposed bedrock and is armored by coarse gravel and boulders for much of its length, an unacceptable amount of local scour and site instability may occur in the area immediately downstream of the steep reach, creating an adverse impact. Therefore, mitigations are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

Erosion and Sedimentation Impacts

With regard to the overall project effect on erosion and sedimentation, the predicted changes in sediment yields from the Pinto Creek and Powers Gulch watersheds would be expected to be minimal. The results of modeling by SLA (1993) indicate that, without BMPs, disturbances related to mining operations would result in an increase of approximately 0.12 acre-foot in the average annual amount of sediment volume delivered to point SPC4 (see *Table 3-43*), which is located immediately downstream of the Pinto Creek/Haunted Canyon confluence (SLA 1993). At that point, the increase in sediment yield would be approximately 2 percent. It should be noted that these estimates refer to sediment yielded on a watershed basis, and are not directly related to site-specific erosion rates discussed in Section 3.4, Soils and Reclamation. As indicated in Section 3.4, localized increases would be more significant. Not all eroded material ends up as streamborne sediment. Upstream of the Pinto Creek/Haunted Canyon confluence, the sediment yield would be increased approximately 2.5 percent. Thus, even without BMPs, the overall increase in sediment yield as a result of the project would be minimal. As part of the proposed action, the incorporation of BMPs at key locations during and after operations would minimize long-term sediment yield impacts. However, temporary impacts to aquatic habitat may occur until fine sediments are flushed through the channel system. These effects are discussed in Section 3.4, Soils and Reclamation, and Section 3.5, Biological Resources.

Floodplain Impacts

Under the proposed action, the mine components would directly affect approximately 39 acres of alluvial deposits by earthmoving. Of this area, an estimated 35 to 50 percent (approximately 14 to 20 acres) would be composed of alluvial soils on terraces along Pinto Creek and lower Powers Gulch. The remaining area would be composed of gravel- to boulder-sized alluvial deposits in channels and bars. A small stock pond would be removed by constructing project components. Additional acreage would be disturbed by road and pipeline crossings and well pads associated with water supply and power facilities for the project. This area would be small relative to the overall extent of floodplains and channels in the Pinto Valley watershed, and would not constrict flow areas to the point where flood flow hydraulics would be adversely affected. BMPs, including controlling erosion and sedimentation, would be combined with hydraulic design and construction of diversions and sediment controls to minimize the potential for additional impacts in floodplain areas. A discussion of wetlands and waters of the U.S. is presented in Section 3.5, Biological Resources.

Other Project Components

Impacts from the Mine Rock Disposal Areas. Five separate areas for the disposal of mine rock have been proposed: the Main, Cactus Southwest, and Eder rock disposal areas; Carlota/Cactus pit backfill; and backfill of the Eder pits (*Figures 2-1a and 2-1b*). Potential impacts from the Carlota/Cactus pit and Eder pits backfill are addressed previously in the section on pit water recovery impacts.

Construction of the Main mine rock disposal area would eliminate Grizzly Mountain Tank (a small stock pond).

Surface runoff from the Cactus Southwest mine rock disposal area would be permanently directed toward the Carlota/Cactus pit during mining and after mine closure. Therefore, approximately 74 acres of watershed would be permanently removed from the watershed contributing runoff to Pinto Creek. Average annual runoff would be reduced by approximately 16 acre-feet, based on a mean annual watershed runoff of 2.62 inches above the Pinto Valley weir. This volume represents less than 0.4 percent of the runoff at the PC-7 gage site downstream of the confluence of Haunted Canyon and Pinto Creek. This impact would occur primarily during storm events

Based on conclusions and recommendations from previous investigations (Knight Piésold 1993a), mine rock for the proposed project would be disposed of without special treatment. Mine rock would be deposited directly upon untreated soils and rock and would be exposed to precipitation events. Carlota proposes to prepare the mine rock disposal areas to minimize surface water runoff, erosion, and sedimentation from the disposal sites (CWA Section 402 Permit Application 1994). As described in the SWPP plan and the NPDES permit application, the mine rock disposal areas would have upgradient interceptor ditches to convey runoff from undisturbed areas to natural drainages. The tops of the mine rock disposal areas would be graded away from the embankment crests to prevent surface runoff from flowing down the rock face. Storm runoff from the tops of the mine rock disposal areas would be temporarily detained on the tops of the disposal areas. Sediment basins and/or the sediment-control BMPs constructed downgradient of the mine rock disposal areas would control excess sediment runoff originating on the disposal areas. An NPDES permit would be required for any water discharged from the sediment basins as a result of precipitation events less than the 100-year, 24-hour recurrence. The permit application would require approval by the EPA and ADEQ via a 401 certification. Discharge from the basins would be required to comply with the water quality limits set in the NPDES permit, and therefore would not violate any water quality standards in Pinto Creek or Powers Gulch.

MWMT results (Knight Piésold 1993a) on rock types to be deposited in the mine rock areas reflect TDS concentrations below or comparable with present ground and surface water concentrations (less than 250 mg/L). In general, most metals analyzed were low in concentration or not detectable. Reportable lower detection values for most metals were near or below applicable surface water quality standards. For weight percent adjusted MWMT results (*Table C5-2* in Appendix C, Water Resources Data), the Cactus Southwest mine rock area copper value was 0.0514 mg/L (exceeding the aquatic and wildlife [warm water fishery] acute and chronic stream standards of 0.034 mg/L and 0.021 mg/L, respectively); the Eder mine rock area manganese value was 0.08 mg/L (exceeding the federal secondary drinking water standard of 0.05 mg/L), and the aluminum values of all three rock areas exceeded the federal secondary drinking water standard for aluminum (0.005-0.2 mg/L). The potential impact associated with these results would still be low since MWMT results are not normally compared one-to-one with water quality standards (a typical comparison is 10 to 1). Stream water quality standards exist for thallium, but analyses for thallium on the MWMT were not performed. All metals analyzed were below Arizona aquifer protection standards.

Increased leaching and contaminant mobility could occur if surface or ground water pH were lowered because of runoff from the mine rock areas. The results of acid-neutralizing potential and acid-producing potential indicate that even under the most conservative estimates, composite waste rock material would have an excess of acid-neutralizing potential (Knight Piésold 1993a). Under these circumstances, the potential to lower present pH values below standard levels (6.5 standard units) in surface or ground water is low. Since the source of the acid-neutralizing potential is generally believed to be carbonate (Knight Piésold 1993a), the potential for increased pH values above standard levels (8.5 standard units) would also be low.

The proposed action reduces the potential for impacts to surface and ground water quality under normal circumstances. Although the leaching of metals from mine rock is anticipated to be low, the variability of rock material being mined creates the potential for acid-generating conditions to exist in some materials. Acid generation generally increases the mobility of metals and would produce a source of contamination for surface and ground water degradation. As part of the ADEQ's Aquifer Protection Permit, Carlota has committed to continual characterization during active mining as specified by ADEQ (Carlota 1995a). The waste rock from mining activities would be sampled and analyzed at a frequency of 1 sample for every 1 million tons of waste rock using the EPA's Method 1312. Synthetic Precipitation Leaching Procedure. Provided that these measures are followed, potential impacts to surface or ground water quality are not anticipated. In addition, as part of the Aquifer Protection Permit, if geochemical testing indicates that some of the material has the potential to generate acid or leach metals. Carlota would develop a materials handling plan to prevent impacts to surface or ground water and submit it to ADEQ for approval.

Impacts from SX/EW Plant and Associated Facilities. The SX/EW plant would be upgradient of the proposed plant PLS/SX and raffinate ponds, and any spills or leaks from the plant would flow to the pond. The plant PLS/SX and raffinate ponds would be upgradient of the heap and PLS ponds. Raffinate pond overflows or other releases would be retained in downgradient project components, which have been sized to contain extreme events. Spills infiltrating into the ground would likely be captured by the dewatering wells. Under normal operating conditions, potential impacts to water quality from the SX/EW plant and associated facilities would be minimal because of the procedures to be followed in the Stormwater Pollution Prevention plan (CWA Section 402 Permit Application 1994) and the SCHMM (Carlota 1996a). If deviations from these plans occurred, the potential for affecting both ground and surface water quality would increase. As presented in *Table C5-3* in Appendix C, Water

Resources Data, the PLS and raffinate solutions would be maintained at pH values below 2 and would contain TDS, sulfate, and metals concentrations at orders of magnitude above any applicable ground or surface water quality standards. In the event of an operational deviation (i.e., spill, leak, or procedural error), potential impacts to water quality could be greatly reduced by having response teams and procedures, cleanup and remediation teams and procedures, and secondary containment structures in place before they are needed. However, because of the quantity and hazardous nature of the PLS and raffinate solution, any possible release would have the potential to degrade surface and ground water quality. Measures for spill control, cleanup, and remediation are directly associated with the potential to affect ground waters. The low pH of the solution would minimize metals attenuation capabilities of soil material. Although potential contaminant loads would generally be localized, the process solutions would provide an extremely mobile source of dissolved constituents to ground water. Therefore, monitoring and mitigation measures are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

Impacts from Support Facilities. Construction and operating conditions for supporting operations have been outlined in the CWA Section 402 Storm Water Pollution Prevention Permit Application (1994), the COE CWA Section 404 Permit Application (1994), the Arizona Aquifer Protection Permit Application (1994), and the SCHMM (1996). Supporting operations would include the maintenance shop and warehouse facilities; the crushing, conveying, and stacking operations; and access and haul roads. Other proposed disturbances would include storage facilities, power distribution lines, pipelines, and the administration building. Potential impacts to water quality, surface water quantity, and erosion and sedimentation from supporting operations would not be anticipated if BMPs and plans for spill prevention, control, and remediation were appropriately applied. However, because of the quantity and hazardous nature of the materials used at the maintenance shop and warehouse (oils, lubricants, solvents), any possible release would have the potential to degrade surface and ground water quality. In addition, the effects from erosion and sedimentation from access roads and haul roads after initiating the proposed final reclamation and closure practices would have the potential to degrade surface water quality. Therefore, monitoring and mitigation measures are proposed in Section 3.3.4 (Water Resources - Monitoring and Mitigation Measures).

3.3.2.2 Alternatives

<u>Mine Rock Disposal Alternatives</u>

Alternative Mine Rock Disposal Sites. Two additional sites (Cactus South and Cactus Central) have been identified for mine rock disposal (*Figure 2-12*). Potential water resource impacts from the Cactus Central site are generally similar to those for the proposed mine rock disposal sites. However, the Cactus South site lies in the drainage area of Cottonwood Gulch. Analyses of surface water from Cottonwood Gulch (*Tables C1-1* and *C1-2* in Appendix C, Water Resources Data) indicate elevated levels of TDS (2,380 mg/L) compared to Pinto Creek (360 mg/L). Associated with the higher TDS concentration is a concentration of dissolved copper (0.40 mg/L) that exceeds the Pinto Creek surface water quality standard for aquatic and warm water fisheries. Total iron and manganese concentrations of 0.45 mg/L and 0.09 mg/L, respectively, exceed federal secondary MCLs. Although increased leaching from mine rock caused by low pH would not be expected (surface water pH=7.5), the quality of the surface water that would come in contact with the Cactus South disposal site would be dramatically different than that seen at the other mine rock disposal sites. Since the rock would essentially fill the drainage, the potential exists for this relatively low-quality surface water to move through and discharge from the rock disposal facility. Because of the background water quality of the surface water, it is likely that the discharge from the mine rock would violate water quality standards.

Surface water quantity impacts would be minimal since both alternative sites would likely consist of relatively free-draining rock materials. However, if restricted drainage were to occur within the rock materials over the long term, the potential exists for ponding to occur behind the Cactus South alternative. In addition, buildup of a saturated zone would compromise slope stability in either rock disposal area, but this is unlikely given the coarse nature of mine rock on the site. Ponding would necessarily be avoided during operations at the Cactus South location because of the need for access to an existing well.

After closure, if ponding were to be built up behind the Cactus South location, poor water quality could present a seasonal hazard to wildlife. In addition, if ponding occurred, approximately 42 acres would be withdrawn from the contributing watershed area. Using estimates derived from Pinto Valley weir data, this withdrawal would represent a surface water loss of approximately 9 acre-feet per year. Most of the water probably would be lost through evaporation during the year. Overall, this would be a negligible effect on surface water yields. Potential impacts on surface water from other project activities and components would remain the same as for the proposed action.

Additional Backfill of the Carlota/Cactus Pit. Under this alternative, the Carlota/Cactus pit would be backfilled up to the approximate premining elevation of Pinto Creek (3,520 ft-amsl). The surface of the partially backfilled pit would be above the premining elevation of the water table. As a result, no pit lake would develop. Since there would be no pit lake, pit lake water quality, or evaporative losses from the pit lake surface would not be a concern. Based on the geochemistry of the proposed backfill material and the ambient ground water quality, interaction between the backfill and the ground water is not anticipated to degrade ground water quality. Potential impacts to water resources associated with this alternative as compared to the proposed action are summarized in *Table 3-48.*

Additional backfill of the Carlota/Cactus pit would potentially have similar types of impacts on surface water quantities and erosion and sedimentation considerations as the proposed action. However, the additional backfill would restore the contributing watershed area to near its premining state. Reducing the size of the Main mine rock disposal area would create beneficial effects by reducing the erosion potential on that component. This evaluation is based on the assumption that the Pinto Creek diversion would remain in place in an adequate postmining configuration. Restoration of the Pinto Creek channel through the additional backfill would not be a reasonable reclamation alternative because of the additional disturbance related to diversion removal and losses of Pinto Creek surface flows into the porous backfill for an unknown length of time.

Additional Backfill of the Eder South Pit. Additional backfill of the Eder South pit would not create further potential impacts beyond those previously described under the proposed action. The removal of rock from the Eder mine rock disposal area would reduce lateral earth loading and would increase the sideslope stability and reduce the risk of mine rock migrating or sliding downslope and potentially affecting the Powers Gulch diversion integrity regarding water conveyance and sediment transport. This would be a potential benefit of this alternative.

<u>Leach Pad Alternative</u>

Eder Side-Hill Leach Pad Alternative. The alternative of constructing the heap-leach facility on the side slopes of the Powers Gulch watershed while leaving the channel in the valley floor would have less potential for impacts from an erosion and channel stability perspective. In the description of this alternative (Knight Piésold 1993a), it is assumed that the toes of the heap-leach pad and embankment could be placed high enough to be out of the floodplain for some given magnitude of event. With the channel left as it is, its sediment transport characteristics and sediment regime passed downstream would remain as they are now. However, some erosion protection would be required if the base of the embankment were to be inundated during large flow events in Powers Gulch. Although the need for the Powers Gulch diversion would be eliminated with this alternative, approximately 1,000 feet of Powers Gulch could require realignment through the pad area so that flows would not impinge on the embankments. The possible need for an energy dissipation structure downstream on Powers Gulch would be eliminated. This alternative would temporarily remove approximately 458 acres (0.7 square mile) from the contributing Powers Gulch watershed (approximately 5.5 square miles). Based on mean annual watershed runoff of 2.62 inches above the Pinto Valley weir, removing this contributing watershed area would reduce surface water runoff by approximately 98 acre-feet per year. This volume represents approximately 13 percent of the runoff from the Powers Gulch watershed and approximately 2

Table 3-48. Comparison of Potential Postmining Water Resource Impacts Associated with the Proposed Carlota/Cactus Pit and the Additional Backfill of the Carlota/Cactus Pit Alternative

	Proposed	Additional Backfill
Pit Lake Development	An approximately 500-foot deep lake would eventually develop postclosure.	No lake will develop.
Ground Water Flow	Ground water in the vicinity of the pit would flow towards and discharge into the pit.	Ground water gradient should be re-established to near premining conditions.
Potential Water Quality Concerns	The pit lake would become more saline with time due to concentration by evaporation and lack of outflow.	Interaction of ground water with backfill is not anticipated to degrade ground water.
Estimated Water Loss from Evaporation Once Pit Water Level Reaches Steady State	Approximately 480 acre-feet per year (300 gpm) would be lost once the lake level reaches equilibrium.	No loss of water from pit lake evaporation.
Pinto Creek Diversion	Diversion channel would be maintained postclosure.	Diversion channel would be maintained postclosure.
Area Withdrawn from Contributing Watershed Area	Approximately 0.5 square mile of contributing watershed area would be withdrawn.	No loss of contributing watershed area.

percent of the runoff at the PC-7 gage site downstream of the confluence of Haunted Canyon and Pinto Creek. This impact would occur primarily during storm events.

In addition, this alternative would involve substantially less disturbance to the Powers Gulch stream channel during operations than the proposed action. As with the valley fill option (proposed action), the side-hill alternative would incorporate solution storage within the pad itself. However, this alternative would require six different PLS ponds behind three embankments as compared to two PLS ponds behind two embankments for the proposed action. The solution retention embankment length would be approximately 14,640 feet, almost 11 times the total embankment length in the proposed action. As a result of the increased embankment length, the required base pool solution storage capacity would be 214 million gallons as compared to 104 million gallons for the proposed action. Therefore, the potential for the accidental release of process solutions is significantly greater with this alternative than with the proposed action. Additionally, slope stability in this alternative would require relatively large toe berms (in excess of 50 feet in height) to generate marginally acceptable factors of safety and accommodate internal solution storage. The minimum factors of safety for this scenario were 1.3 and 1.0 for static and pseudostatic, respectively, which are less than the minimum factors of safety generally acceptable for dam design. The lower factors of safety are largely a result of the lack of buttressing at the toe of the pad. Therefore, the steep side-slope configuration could increase the potential for heap slope failure into Powers Gulch, and for a heap-leach solution release.

Under this alternative, the reclaimed leach pad would occupy more acreage, with longer slopes and less flat surfaces, than under the proposed action. Erosion and sediment yield would be expected to increase from this alternative, creating more adverse impacts than the proposed action.

Seasonally high ground water conditions would not be a potential problem for this alternative. Potential impacts to surface water and ground water quality would be similar to those for the proposed action because the low pH and toxicity of the heap-leach solution would be identical.

Water Supply Alternatives

Low-Quality Water, Water Supply Wells, and Dewatering Wells. This alternative consists of using low-quality water that may have been degraded by previous mining activities in the region to supply a large portion of the water requirements of the project. The low-quality water would be piped from one or more of the following sources: Pinal Creek, BHP's Cottonwood Storage Pond, BHP's Copper Cities Pit Water, and Cyprus' Oxhide Pit. These potential water sources range from 1 to 14 miles from the Carlota Copper Project site as shown in *Figure 2-18.* Carlota estimates that these low-quality sources could provide up to 59 percent of the project's water requirements. The remaining water requirement would be supplied by pit dewatering wells and water supply wells in the well field. This alternative would substantially reduce the amount of water withdrawn from the well field. For example, this alternative would reduce the maximum ground water withdrawal from 850 gpm (proposed action) to approximately 350 gpm (this alternative). Reducing ground water pumping from the well field area should substantially reduce, but not eliminate, anticipated impacts to surface flow and water levels in the alluvium in Haunted Canyon and Pinto Creek.

Pinal Creek Water. One potential supplemental source of water would be the low-quality, shallow ground water from Miami Wash, a tributary of Pinal Creek. The Pinal Creek Remediation Group (BHP Copper Company, Cyprus Miami Mining Company, and Inspiration Consolidated Copper Company) have developed and implemented a remedial program along Pinal Creek that involves pumping and reclaiming or using the acidic alluvial water degraded from past mining operations. The locations of the Miami Wash, Diamond H Pit, existing BHP Copper pipeline, and proposed pipeline route are shown in *Figure 2-18.* The proposed pipeline would transport untreated water from a pump station or storage reservoir to the project site. Untreated or partially treated water from this same source is reportedly being piped to several other mining projects, including BHP Copper's Pinto Valley Mine and the Cyprus Miami Mining Company. It is proposed that Pinal Creek water would be used as process makeup water; therefore, the proposed alternative does not include treatment for use by the Carlota Copper Company.

In this region of Pinal Creek, the surface flows are ephemeral. The contaminated aquifer consists of unconsolidated to consolidated alluvial sediments composed of interbedded fine sand, coarse gravel, and cobbles with occasional boulders up to several feet in diameter. Clay interbeds of up to 40 feet thick occur in the alluvium and may or may not be calcareous in nature. The Pinal Creek and tributary channels are incised into the Gila Conglomerate, which crops out along much of the Miami Wash area. The Gila Conglomerate is composed of clay- to boulder-sized material cemented primarily by calcite.

Water quality data compiled from the Miami Wash alluvium (*Table C5-4* in Appendix C, Water Resources Data) indicate wide ranges of elemental concentrations, possibly caused by variations in the local geology and past mining practices. The overall water quality of the Miami Wash, however, would violate water quality criteria for most domestic or industrial uses. Elevated concentrations of TDS (average concentration = 4,640 mg/L) and sulfate (average concentration = 3,400 mg/L) are reported. The average pH was 4.8 standard units. Fluoride concentrations averaged 12.7 mg/L. Elements with concentrations below laboratory detection limits or with sporadic trace concentrations included arsenic, boron, barium, bromine, chromium, mercury, molybdenum, selenium, and silver. Dissolved metals concentrations with clearly elevated average concentrations included aluminum, beryllium, cadmium, cobalt, copper, iron, manganese, nickel, strontium, vanadium, and zinc. The Miami Wash alluvial water exceeds Pinto Creek stream water quality standards for beryllium, cadmium, copper, manganese, nickel, and zinc, and is below the minimum allowable pH value of 6.5 standard units. Federal primary and secondary MCLs for drinking water and Arizona Aquifer Water Quality Standards are exceeded by concentrations of TDS, sulfate, fluoride, cadmium, copper, iron, manganese, and zinc.

BHP Copper's Cottonwood Storage Pond. The water that would be supplied from the Cottonwood storage facility is a calcium-sulfate water with moderately high TDS and a neutral pH; sulfate and TDS concentrations are greater than their respective federal secondary MCLs. The Cottonwood tailings water generally has lower dissolved metal concentrations than those found in Pinal Creek, the BHP Copper Cities Pit, and Cyprus' Oxhide Pit water sources because some of the water is low-quality water that has been treated. Because of the neutral pH and lower metals concentrations, water from the Cottonwood storage facility would be considered a higher-quality water source than the other low-quality alternative sources described in this section.

BHP Copper's Copper Cities Pit and Cyprus' Oxhide Pit Water. Low-quality water may be available from either BHP Copper's Copper Cities Pit or Cyprus' Oxhide Pit (see *Figure 2-18*). Water quality analyses for these pit waters are not available. For the purpose of this EIS, these waters are anticipated to be similar to the Pinal Creek water with low pH and high metals concentrations.

Potential Impacts. The pipeline to any of these sources, except for the Cottonwood Storage Pond, would traverse several miles of mountainous terrain and would cross the Cottonwood tailings facility and roadways. Information on the existing soil and geologic conditions along the route are not available. However, considering the length of the route and the terrain, it appears that there would be a low to moderate risk that the pipeline could be damaged during the life of the project. Potential threats could likely include rock falls, landslides, flooding, settlement (tailings impoundment), fire, and vandalism. Water released from a failure of a pipeline would be a potential pollutant to ground and surface waters.

Potential localized impacts to springs and stream channels could occur as a result of construction activities and operation related to the alternative pipelines. Excavation and increased traffic would contribute to erosion and sedimentation. If released, seepage of low-quality water could affect the quality of flow at springs, such as Vigor of Life Spring, Webster Spring, and Prince Charming Spring. These potential surface water impacts would be of a localized nature since existing open pits downgradient of the rights-of-way would inhibit potential impacts from migrating very far along the surface drainages. The potential degree of seepage and migration of spills in the ground water system is unknown. If use were restricted to the heap-leach operation, monitoring and mitigation measures for the water alternative would be covered by the monitoring and mitigation program established for the heap-leach facility.

Alternative Water Supply Well Field Access Roads

Potential surface water impacts related to these alternatives would be increased erosion and sedimentation of the Pinto Creek drainage as a result of construction and operation of the access roads. The actual impacts from these activities would be minimized by Carlota's commitment to employ BMPs to control erosion and sedimentation under the proposed action. It is assumed that such a commitment would extend to either of the access road alternatives, since the need for a well field access road is an integral part of the project water supply.

Without such drainage and erosion controls, either road alternative would create substantial sediment yield from disturbance in the immediate vicinity of stream channels, which would be an adverse impact. However, the potential for impacts from such considerations would be minimized by Carlota's commitment to implement an approved Stormwater Pollution Prevention Plan and appropriate erosion and sedimentation controls, including BMPs.

Alternative A would require that Pinto Creek be forded three times, with much of the road located within the Pinto Creek floodplain. These conditions would restrict access to the well field via this road during periods of higher flow in Pinto Creek. These conditions would not apply to Alternative B. Further discussion of these alternatives is presented in Section 3.2, Geology and Minerals, and Section 3.4, Soils and Reclamation.

No Action Alternative

Ground water pumping would not change from current conditions. No pumping and resultant drawdown and reduction in surface flows would occur in association with the Carlota Copper Project.

This alternative would result in no adverse water quality impacts on ground water or surface water resources other than those already associated with current mining operations and abandoned mine operations in the Pinto Creek (and its tributaries) basin. Past releases of tailings and process solutions to surface waters have been documented by ADEQ and the EPA.

3.3.3 Cumulative Impacts

For water resources, the cumulative effects area consists of the Pinto Creek watershed and adjoining areas included in the Top-of-the-World community. The Pinto Valley Mine is the only large-scale mining project currently operating in this area. The Gibson

Mine and historic placer mining activities also occur in the Pinto Creek watershed. Pinto Valley Mine operations cover large portions of the eastern flank of the Pinto Creek watershed, extending from near the project site north to Layton Ranch. The general location of these mines is presented in Chapter 1.0, *Figure 1-2*.

Past, present, and future activities at Pinto Valley Mine have the potential to impact ground water and surface water quantity and quality. The location of the primary mine facilities and water supply wells associated with these operations are illustrated in *Figure 3-21*. The overall consumptive use of ground water and surface water at BHP Copper's Pinto Valley operations is approximately 10,200 acre-feet per year (Arizona Department of Water Resources 1992). A portion of BHP Copper's production water is pumped from the alluvial system in Pinal Creek and stored in the Cottonwood Reservoir. Additional water is supplied from 10 production wells located in the Pinto Creek watershed (Hargis and Associated, Inc. 1995). Pumpage from the wells varies according to demand and recovery of water levels between pumpings. Based on data supplied by Magma (now BHP Copper) for the years 1980 through 1991, the average annual pumpage rate for the well field is approximately 1,630 gpm (Hargis & Associates, Inc. 1995). Ground water is used to supplement available surface water so that ground water pumpage is generally reduced during wet years.

The ground water production wells are located in Eastwater Canyon and Ripper Spring Canyon (*Figure 3-21*). Well construction information, along with static depths to ground water, and pumpage drawdown rates for BHP Copper's production wells are presented in *Table 3-49*. Recorded water level drawdowns range from 5 feet at well Peak 48 to 355 feet at well Peak 51 (*Table 3-49*) (Hargis & Associates, Inc. 1995). The cumulative change in water levels throughout the area resulting from ground water pumpage is not known.

The open pit at the Pinto Valley Mine, which is located in the southeastern portion of the Gold Gulch drainage basin (*Figure 3-21*), does not appear to influence ground water elevations in the area. Hargis & Associations (1995) state that only minimal and sporadic seeps are present along the perimeter of the walls of the pit. In addition, wells located near the pit have significant differences in depths to water and water level elevations.

Mining and ore processing facilities at BHP Copper's Pinto Valley Mine include low-grade ore leaching facilities, the open pit, mine rock disposal area, the concentrator and SX-EW plants, and No. 1, No. 2, No. 3, No. 4, and the Cottonwood Canyon tailings impoundments (*Figure 3-21*). Seepage from some of the tailings facilities has the potential to degrade ground water in the area.

Ground and surface water studies conducted by Hargis & Associates, Inc. (1995) indicate that seepage from the No. 1, No. 3, No. 4, and the Cottonwood Canyon tailings impoundments is affecting the ground water quality. Downgradient of the No. 1 tailings facility, water quality data from monitoring wells indicates that migration of seepage containing elevated concentrations of sulfate, TDS, iron, and manganese has occurred (Hargis & Associates, Inc. 1995). Studies also indicate that ground water quality downgradient of the Cottonwood tailings facility may also be affected. Elevated concentrations of sulfate and TDS in the ground water adjacent to the southeastern margin of the tailings impoundment area has been detected. The studies also indicate that seepage from the No. 3 and No. 4 tailings impoundments has locally effected ground water quality beneath and, for some distance, downgradient of these facilities. Several monitoring wells located downgradient from the facility indicate that the concentrations of calcium, sulfate, and TDS have increased over time. However, because of the dilution processes, Hargis & Associates, Inc. (1995) concluded that the eventual migration of seepage from these tailings impoundments should have minimal impact on the alluvium system in Pinto Creek.

The proposed action could potentially increase cumulative impacts to the quantity of ground water available and to local surface water discharge. However, the proposed action is anticipated to have minimal impacts on the quantity of ground water available to the Top-of-the-World community or surface flows below the Pinto Valley weir.

Although little is known about the premining water quality of the watershed, it appears that existing mining-induced impacts include increased TDS and

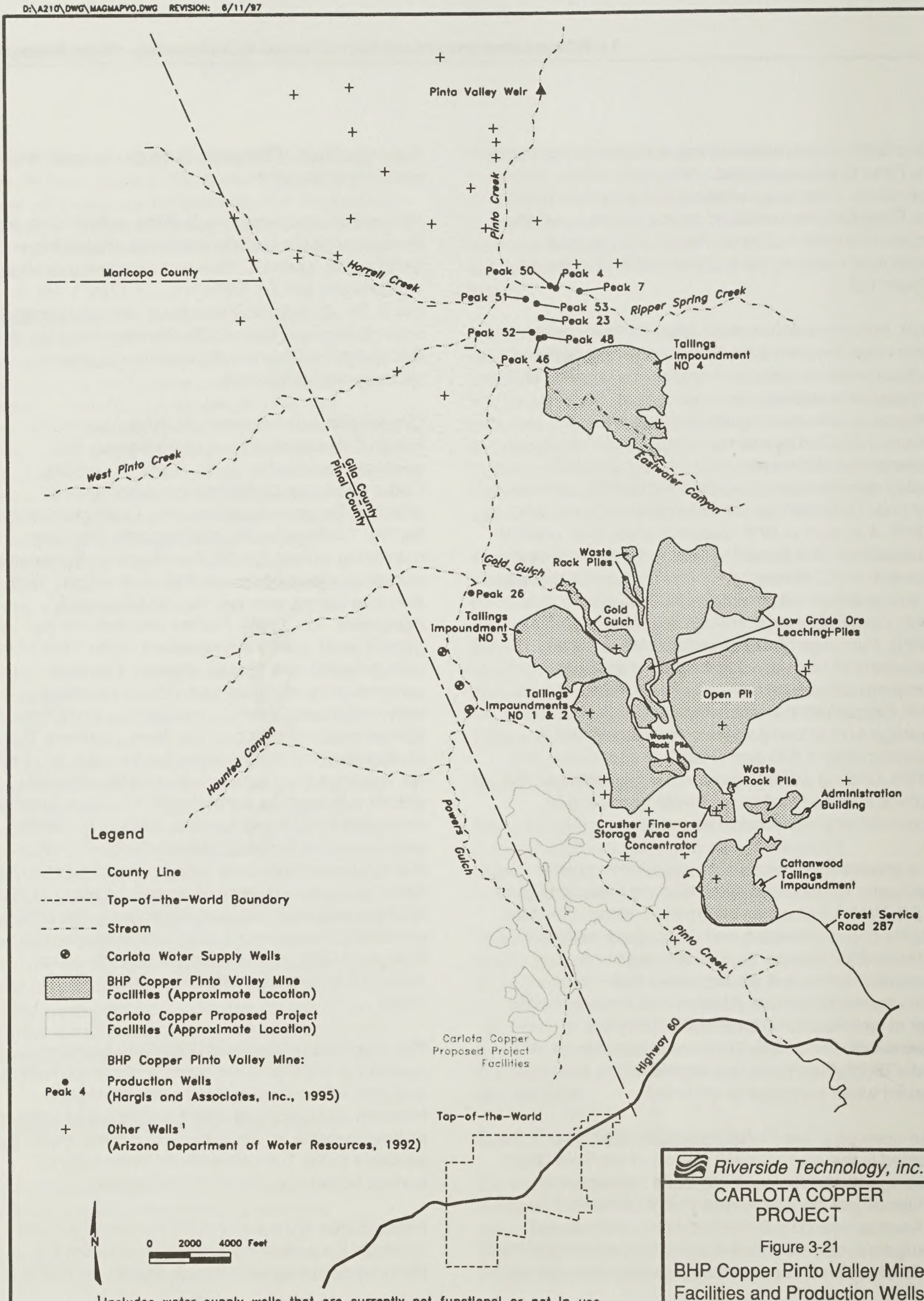

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Figure 3-21
BHP Copper Pinto Valley Mine Facilities and Production Wells

Table 3-49. BHP Copper's Pinto Valley Mine Production Wells

Well Number	Borehole Depth (feet)	Open Interval (feet)	Static Depth to Water (feet)	Pumpage Drawdown (feet)
Peak 46	760	215-515, 595-695	NA	NA
Peak 48	1200	840-1200	580	5
Peak 4	512	80-512	130	60-110
Peak 7	656	166-655	NA	160-460
Peak 52	620	90-590	17	10-20
Peak 23	765	open hole	145.5	NA
Peak 51	620	170-765	133	225-355
Peak 52	740	360-700	213.5	NA
Peak 53	840	300-800	253	NA
Peak 26	550	465-505	37	NA

See *Figure 3-22* for well locations.
Source: Hargis & Associates, Inc. (1995).
Well Peak 26 has been observed by the Forest Service as an active pumping well. Peak 26 was not listed as a production well by Hargis & Associates (1995).

sulfate and copper concentrations in surface water and shallow ground water along stream reaches downstream from some active and historic mining properties. Periods of higher than average runoff and flooding have caused breaching of tailings impoundment facilities in the watershed. The released materials subsequently flowed into Pinto Creek near the proposed project area. Some of the tailings material was deposited along the floodplain in Pinto Creek. The tailings deposits, and possible seepage from the existing tailings facility, could potentially degrade the water quality in Pinto Creek. The existing placer mining that occurs in the Pinto Creek drainage is limited to small-scale operations, and the relatively small size of these activities would suggest minor additional effects on water quality in the drainage.

After reclamation and closure, approximately 310 acres (0.5 square mile) would remain withdrawn from the watershed area contributing to runoff volume. This would be approximately 0.5 percent of the contributing watershed above the Pinto Valley weir and 0.3 percent of the contributing watershed above Roosevelt Lake. Approximately 2.8 percent of the contributing watershed area above the Pinto Valley weir has already been withdrawn in the locale by operations at the Pinto Valley Mine. By implementing monitoring and mitigation measures, negligible adverse impacts to surface runoff and flood flows are anticipated from the Carlota Copper Project.

With mitigation measures implemented, the long-term sediment transport conditions and related stream channel stability of the overall Pinto Creek watershed would not be adversely affected to a significant degree by the Carlota Copper Project. Although the potential for increased erosion rates may affect on-site surface stability, most eroded fine-grained materials would be flushed through the channel system by high sediment transport capacities. This has been demonstrated previously by the distribution of tailings spilled by the existing adjacent mine operation. Coarser eroded materials may be initially deposited in channels near the project area, but would eventually be dispersed downstream. Implementation of the identified monitoring and mitigation measures and the commitment by Carlota to stabilize and reclaim the site according to BMPs and to implement postclosure diversion designs would mitigate the potential for additional cumulative water resources impacts from erosion and sedimentation beyond what has already occurred in the Pinto Creek watershed and nearby areas from existing exploration, mining, and grazing operations.

3.3.4 Monitoring and Mitigation Measures

3.3.4.1 Monitoring and Mitigation for the Proposed Action

The proposed project could potentially impact wells and surface water resources in the vicinity of the proposed project. The recommended monitoring and mitigation measures for the proposed action are summarized below. Monitoring of the riparian aquatic communities is addressed in Section 3.5, Biological Resources.

Monitoring and reporting would enable impacts on water resources directly attributed to the Carlota mining operation to be anticipated so that mitigation measures could be implemented to reduce the potential impacts. The monitoring data would also provide valuable information to help determine if individual water resources, such as private water supply wells, had been impacted whenever complaints were registered.

Monitoring and maintenance to control erosion and sedimentation would occur throughout the operations phase and would extend into the postmining phase. As proposed by Carlota, BMPs would be employed to control erosion and sedimentation on the project area. These practices would be inspected periodically during operations and for a selected period of time after reclamation. The frequency of inspection and the duration of the monitoring program would be determined by the Forest Service and Carlota personnel during project permitting and construction, with annual reviews to assess the needs and success of the program.

Monitoring would include the locations of erosion and sedimentation controls, as well as overall project area inspections, to identify any evolving critical areas that may need attention. This would include areas and practices such as unimproved road crossings of stream channels, the leach pad revegetation, and the drainage control effort. Heap-leach pad embankments would be monitored for stability in the recontoured, reclaimed configuration. The Pinto Creek and Powers Gulch diversions would be monitored for stability and postclosure functioning. The methods, frequency of inspection, and duration of these monitoring programs would be determined by the Forest Service.

<u>Monitoring Program</u>

The *Groundwater and Surface Water Monitoring Plan, Carlota Copper Project, Gila and Pinal Counties, Arizona* (GWRC 1996a), a comprehensive ground water and surface water monitoring plan, has been prepared for the project. The monitoring plan (GWRC 1996a) is intended to satisfy ADEQ's requirements for an Aquifer Protection Permit, Section 401 certification by ADEQ for the EPA NPDES permit compliance, and the COE for CWA 404 permit compliance. The monitoring plan also includes the monitoring and reporting requirements of the Forest Service. The purpose of the monitoring plan is to monitor potential effects of project development, operation, and closure activities on water resources in the Pinto Creek, Haunted Canyon, and Powers Gulch basins. The monitoring plan includes the following activities: (1) tracking the rates, volumes, and quality of ground water extracted during pit dewatering and well field operation; (2) monitoring ground water hydraulic heads and ground water quality in both the alluvial and bedrock ground water systems; (3) monitoring surface flows and water quality in streams and springs; (4) monitoring water quality from ephemeral water courses and runoff detention basins located downgradient from the mine rock disposal areas; (5) monitoring sediment transport along the Powers Gulch diversion channel; (6) and monitoring meteorological conditions. The locations of proposed monitoring wells and surface water monitoring stations are presented in *Figure 3-22*. Details regarding all the monitoring stations, monitoring frequency, parameters for field and laboratory analysis, and quality assurance and quality control are provided in the ground water and surface water monitoring plan (GWRC 1996a).

The water monitoring program (GWRC, 1996a) includes the following principal components:

- Several wells or piezometers located between the Carlota/Cactus pit and Top-of-the-World and the Eder South pit and Top-of-the-World to monitor possible drawdown between the open pits and the Top-of-the-World water supply wells

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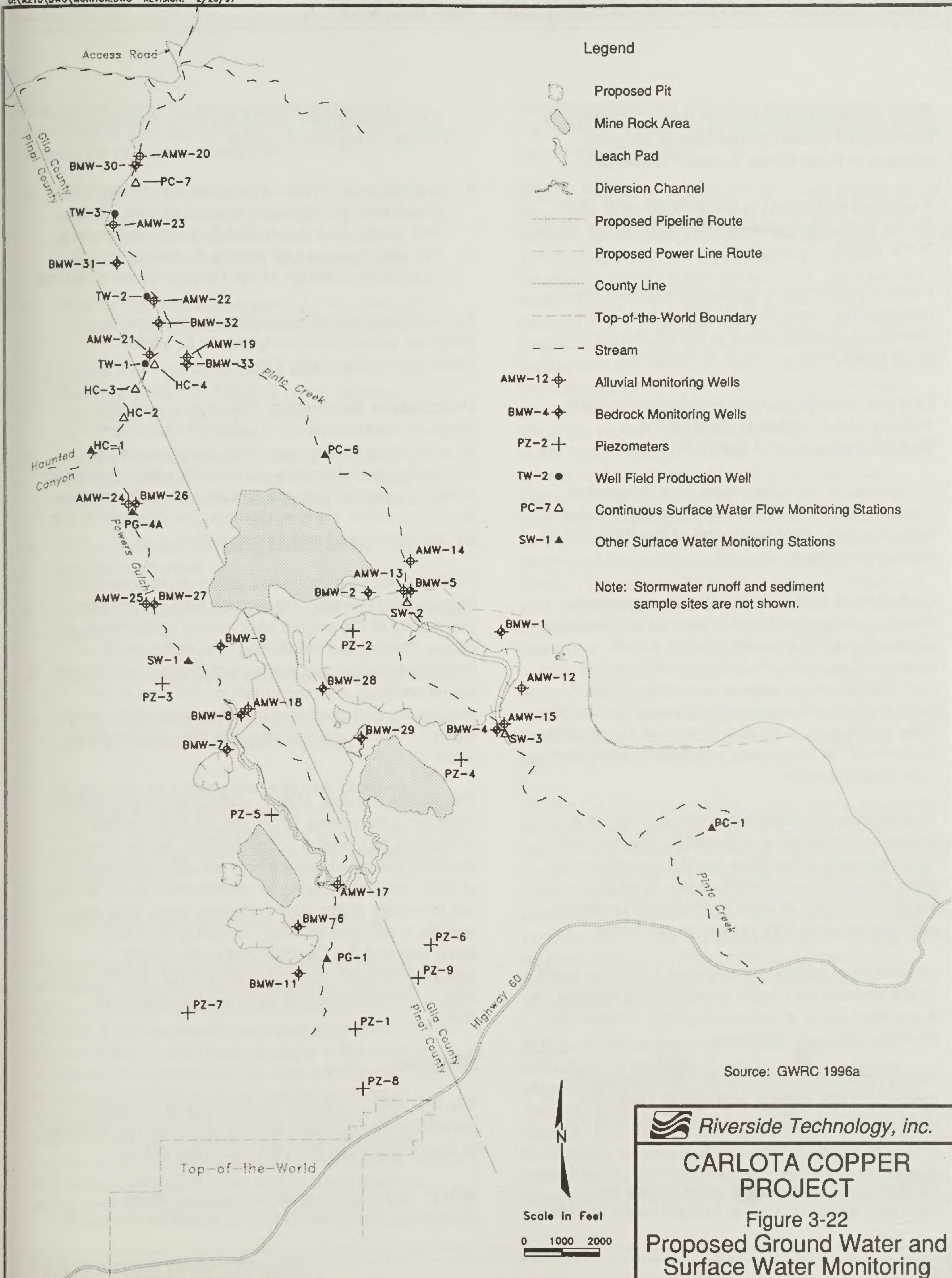

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Figure 3-22
Proposed Ground Water and Surface Water Monitoring

- Wells or piezometers located both upstream and downstream of the Carlota/Cactus pit in the alluvium in Pinto Creek to detect drawdown

- A piezometer located in the bedrock near Mule Spring to monitor possible drawdown in the vicinity of the spring

- Wells or piezometers located at selected sites in Haunted Canyon and Pinto Creek to monitor drawdown of water levels in the alluvium that could result from well field development

- Flow rate monitoring from well field production wells and pit dewatering wells for the Carlota/Cactus pit and Eder pits

- Continuous streamflow monitoring in Haunted Canyon and Pinto Creek in the vicinity of the well field and at the inlet and outlet of the Pinto Creek diversion channel

- Collection of water quality data on a quarterly frequency from a network of alluvial and bedrock monitoring wells, including wells located downgradient of the PLS impoundments, leach pad, SX/EW plant, raffinate and plant PLS/SX ponds, shop and warehouse, Carlota/Cactus pit, Eder North and South pits, Eder rock dump, and portions of the Main and Cactus southwest mine rock disposal areas

- Collection and analyses of water quality on a quarterly frequency at selected continuous and instantaneous streamflow monitoring stations in Pinto Creek, Powers Gulch (when flowing), and Haunted Canyon at sites located both upstream and downstream from project components

- Monitoring of spring discharge on a monthly basis (eight springs) and water quality (three springs) on a quarterly basis at selected springs located near the mine and well field areas

- Weekly collection and analysis of water quality data (pH, TDS, sulfate, and copper) from the underdrain collection pond associated with the main pad embankment

- Collection and analysis of water quality from sediment detention basins located below the Main, Cactus southwest, and Eder mine rock disposal areas during runoff events

- Collection of sediment samples during and after runoff events at stations located above, within, and below the Powers Gulch diversion to verify the assumptions and modify, if necessary, the post-closure design of the Powers Gulch diversion

For additional details regarding the monitoring program, please refer to Appendix C, Water Resources Data, *Table C6-1*,

Postclosure Monitoring. The water monitoring program would continue at selected sites following closure of the mining operation. Postclosure monitoring would include periodically measuring water levels in selected bedrock and alluvial wells and flow in springs within the drawdown cones affected by the pit dewatering and well field activities.

Facilities from the proposed action could potentially impact ground water and surface water resources in the vicinity of the project after mining operations cease. Postmining monitoring of specific areas or facilities would persist during reclamation efforts and would continue after reclamation until it could be reasonably demonstrated that the potential no longer exists for these areas to degrade the waters of the state.

The Forest Service, ADEQ, and Carlota would work together to determine when and for which areas or facilities this goal is accomplished. Some areas and facilities could require only an additional year of postmining monitoring to demonstrate that potential risk to waters of the state no longer exist. However, specific areas and facilities, including the heap-leach pad and the Carlota/Cactus pit, would require continued monitoring for a much longer time to demonstrate that potential risk has been minimized.

Mitigation

The following proposed monitoring and mitigation measures would lessen or eliminate potential impacts to water resources from the proposed action.

WR-1: The ground water and surface water monitoring plan (GWRC 1996a) would be revised to include the following specifications and would be submitted to and approved by the Forest Service prior to initiation of project construction:

- Provide the Forest Service with the location, well completion information, lithologic log, initial static water level, pumping rates, and cumulative volumes pumped for each dewatering well
- Monitor flow and water quality for the underdrain collection pond below the north embankment
- Locate PC-1 on Pinto Creek upstream of 005 Gulch as shown in Figure 3 of the existing monitoring plan (GWRC 1996a)
- Conduct surface water quality sampling at the identified stations in Powers Gulch quarterly (if there is sufficient flow) and during runoff events
- Add a sediment sampling station on the East diversion channel
- Add continuous recording gages at PC-6 and Mule Spring
- Add continuous water-level recording to BMW-31
- Add a monitoring well at the base of the raffinate pond to monitor the bedrock surface
- Within the well field area, add sets of alluvial monitoring wells near existing monitoring station HC-3 in Haunted Canyon and PC-7 in Pinto Creek or other appropriate locations approved by the Forest Service
- Add an alluvial piezometer near AMW-21

The purpose of the additional alluvial monitoring well sets would be to monitor the variations in ground water levels across the alluvium perpendicular to the stream channel. Each set would consist of a minimum of two shallow alluvial wells installed along a line perpendicular to the stream channel: one well located near the stream channel and one located a reasonable distance away from the channel (but still within the alluvium). Based on the results of the monitoring, Carlota, in conjunction with the Forest Service, ADEQ, and other appropriate state and federal agencies, would periodically evaluate the adequacy of the monitoring plan and mitigation measures and revise the plan and measures as deemed necessary by the regulatory agencies.

WR-2: Additional aquifer and well field testing would be performed during the mine construction phase but prior to well field production for operating the mine. This testing would not be performed until the necessary access roads, power lines, pipelines for water management, additional production and bedrock and alluvial monitoring wells, continuous streamflow stations, and water-level monitoring instruments are in place. The full-scale testing would be designed to simulate both average and peak ground water withdrawal rates expected during the life of the project, and would involve pumping the water supply wells concurrently and monitoring the effects on surface and ground water resources. The purposes of the testing are to (1) confirm the long-term sustainable yield from the well field, (2) further quantify potential effects to the alluvial water levels and streamflow in Haunted Canyon and Pinto Creek, (3) evaluate the most appropriate locations and methods (surface discharge, alluvial infiltration, and/or alluvial injection) for discharging mitigation flows (see WR-3), and (4) further evaluate the water quality of the well field for use in mitigating streamflows (see WR-3). A work plan for any additional well field testing would be submitted to the Forest Service and other appropriate agencies and approved prior to initiating testing.

During the life of the project, it may be necessary to conduct other aquifer or aquifer/stream interaction tests. The purpose of additional aquifer tests would be to refine the understanding of ground water/surface water interactions and adjust the mitigation program, if necessary, to protect water-dependent resources. The need for and scope of additional aquifer testing would be evaluated on a continual basis by the Forest Service in conjunction with Carlota and other appropriate agencies.

WR-3: A detailed plan to mitigate potential flow reductions in Haunted Canyon and Pinto Creek (Appendix E) has been agreed to by the Forest Service, ADEQ, ADWR, Salt River Project, COE, and Carlota. The wellfield mitigation program is designed to maintain aquatic and riparian resources at pre-project levels and specifies a mechanism to augment streamflows. In summary, the well field mitigation plan for Haunted Canyon and Pinto Creek includes (1) continuous flow measurements at stream gaging stations and at any required flow augmentation discharge point(s), (2) trigger flow rates that identify when flow augmentation should begin, (3) specific flow rates that would be maintained in the stream to sustain water-dependent resources at premining levels, and (4) specific discharge rates from the mitigation flow pipeline that would be required to maintain flow rates in the streams. Ground water pumped from the well field or water from other suitable source(s) approved by the Forest Service and other appropriate agencies would be discharged to the stream to maintain streamflows.

Continuous surface water flow data and ground water elevation data in bedrock and alluvial monitoring wells would be provided to the Forest Service in accordance with the ground water and surface water monitoring plan (GWRC 1996a). If the streamflows fall below the trigger flows identified in the Forest Service Wellfield Mitigation Program (Appendix E), then the Forest Service would be provided with weekly reports of well field extraction rates and volumes for each production well; water level elevations in each alluvial and bedrock monitoring well within the well field area; and streamflow measurements, including daily instantaneous minimum and maximum flows and daily mean and median flows (based on hourly measurements) and rates and volumes of water discharged to the stream systems at each discharge point. Details regarding the specific data, summaries and summary tables and graphs to be included in the weekly reports, and report format would be described in a revised ground water and surface water monitoring plan submitted to and approved by the Forest Service prior to project construction.

It is likely that over time the Wellfield Mitigation Program and the ground water and surface water monitoring plan would need to be modified, refined, or expanded as necessary. Additional testing may be required to improve individual components of the mitigation program. The components of this mitigation program that may require additional testing during the project life or closure period include the putback point locations, putback quantities, and putback methods to ensure that water discharged to the stream meets appropriate water quality standards. The Forest Service would be responsible for evaluating the adequacy of the monitoring program and mitigation plan and defining the need and scope of any additional testing that may be necessary on a continual basis throughout the life of the project and for some period after closure. The Forest Service would work closely with Carlota and other agencies to update the monitoring and mitigation plans as necessary.

Reductions in streamflow could occur both during the project operation and for some period following the cessation of all mine dewatering and well field pumping activities. If reductions in flow attributable to the project are recorded in Haunted Canyon and reaches of Pinto Creek, flows would be supplemented as specified in the Wellfield Mitigation Program until adequate natural stream conditions are restored.

WR-4: Any water discharged to the stream through the mitigation flow program (WR-3) would be required to meet the Arizona surface water quality standards established for the appropriate beneficial uses. If the well water does not meet water quality standards, then the water would need to be treated prior to discharge, or a variance would need to be granted by the EPA or ADEQ to allow discharge. Alternatively, Carlota would need to provide another source of supplemental water that met discharge permit requirements for flow augmentation.

Existing water quality data for potentially affected stream reaches and the well field alluvium, in addition to possible sources of supplemental water (well field bedrock ground water) are presented in *Table C5-5* in Appendix C, Water Resources Data. Analyses of samples collected from the three bedrock test production wells and Haunted Canyon (*Table C5-5)* are the best estimates of the water quality for the proposed supplemental water source and the anticipated receiving waters. It should be noted that a single maximum value for zinc (out of a total of six reported values) exceeded Arizona surface water quality standards for aquatic and wildlife uses. Information is not available to evaluate whether discharge of well field bedrock water would exceed the maximum allowable increase in the ambient water temperature of 3°C. Reported detection levels were too high to evaluate water quality standard exceedances or levels elevated above receiving waters for the following constituents: cyanide, total phosphorus, antimony, beryllium, cadmium, copper, mercury, selenium, and thallium. Blending different well field bedrock ground waters and selecting one well field bedrock well over another are two methods available to maintain constituent levels in the supplemental water below Arizona water quality standards. If the temperature of the water in the bedrock varies from the surface water quality standards for the stream, adjustments will be made prior to discharge.

WR-5: Significant impacts to Pinto Creek from pit dewatering activities are not anticipated. However, the proposed alluvial and surface water monitoring program would be used to help evaluate whether pit dewatering is partially lowering water levels in the Pinto Creek alluvium located upstream or downstream from the pit, and depleting Pinto Creek flows. If necessary, the monitoring plan would be expanded to track potential impacts. Mitigation for these impacts would depend on the ecological value of the affected stream corridor. The Forest Service would be responsible for evaluating impacts and determining the appropriate mitigation. Mitigation for impacts to Pinto Creek from pit dewatering activities could potentially include a cutoff wall on the downstream end of the Pinto Creek diversion and/or improvements to other nearby stream reaches, wetlands, or riparian corridors.

WR-6: A spring monitoring program is included within the ground water and surface water monitoring plan and consists of monitoring selected natural springs and wells near springs. Various mitigation measures would be used to effectively renovate or replace an affected spring or seep. The appropriate mitigation measure to be implemented on any affected spring would be based, in part, on the ecological value of the resource. Potential mitigation measures for affected springs include the following:

- Supplementing or replacing the flow from springs that support important wetland or wildlife habitat by discharging ground water from wells. The well water could either be piped from existing wells in the area or from a new well drilled into an underlying aquifer near the spring. Ground water discharge could either be from natural artesian flow or could be pumped using electric, solar, or wind power.
- Improving existing spring sites to enhance collection or water yield by (1) constructing catchment basins or ponds to capture runoff, (2) constructing tanks or troughs for storing the collected surface water, and (3) installing devices designed to provide water to wildlife or to discharge to the surface at a relatively constant rate.
- Developing or improving other nearby springs to offset the impact to springs or seeps that are difficult to repair or enhance.
- Replacing lost water from another water source (pipeline, trucking) if other mitigation measures are not practical.

WR-7: A comprehensive ground water monitoring program has been established (GWRC 1996a) to measure the extent and rate of expansion of the cone(s) of depression from drawdown due to mine dewatering activities. This monitoring plan is designed to make information about changes in environmental conditions available to the Forest Service, COE, ADEQ, and ADWR. Carlota has indicated its intent to assist affected parties by deepening existing wells, drilling new wells, or providing a replacement water supply of equivalent yield and general quality during any period of effect. However, the Forest Service does not have the authority to require mitigation of impacts occurring off National Forest System lands.

WR-8: Water conservation measures would be implemented to minimize the need for ground water pumping. These measures could include solution emitters (drip lines) to apply raffinate to the leach pad, dust palliatives for dust control on unpaved mine roads, and other measures for reducing evaporative losses. To prevent water quality impacts, the types of dust palliatives proposed must be approved by the Forest Service before being applied to roads. Carlota would prepare a water conservation plan that includes these measures for approval by the Forest Service.

WR-9: Failure to contain the leachate within the heap-leach pad could result in degradation of ground water and surface water resources. Because a release of solution with low pH and high metals concentrations from the heap-leach pad to surface waters could potentially be transported by streamflow to Powers Gulch, Haunted Canyon, Pinto Creek, and eventually Roosevelt Lake within a short time (less than a day), an alarm system (including electric dialing and personnel notification) would be installed in Powers

Gulch downstream of the heap-leach pad to provide real-time detection of a low pH release (e.g., less than a pH of 4.0).

The potential for leakage from the facility would be significantly reduced by installing the LCRS described in the proposed action. Carlota's construction quality assurance/quality control plan must be approved by the Forest Service before construction on the leach pad begins with regard to testing and placing subgrade materials. Prior to final construction of the heap-leach pad, Carlota would submit a report to the Forest Service evaluating competent borrow sources and estimating volumes of sources by material types. Source material with the capability of achieving a loaded permeability potential of 1×10^{-6} cm/sec would be targeted for preparing the subgrade in the most critical areas (double-lined areas of the main and north pads). Loaded permeability equates to demonstrating that on lower gradient slopes of the critical areas, a loaded permeability potential of 1×10^{-6} cm/sec can be achieved with the lowest ore lift heights. Corresponding ore lift heights would be determined from the laboratory analysis/modeling of competent borrow sources and displayed in the report. The most competent borrow sources would be used in the critical areas that would create the lowest possible ore lift heights prior to solution application.

Other portions of the leach pad would be consecutively targeted to receive subgrade material that would have a loaded permeability objective of 1×10^{-6} cm/sec, which equates to demonstrating that on lower gradient slopes of other portions of the leach pad, a loaded permeability objective of 1×10^{-6} cm/sec can be achieved with the lowest ore lift heights. Corresponding ore lift heights would be determined from the laboratory analysis/modeling of remaining borrow sources and displayed in the report.

In situations where a loaded permeability of 1×10^{-6} cm/sec for the critical areas cannot be achieved through conventional methods used to place subgrades, Carlota would submit a listing of BADCT alternative procedures to the Forest Service. The list would outline procedures that would be implemented to meliorate the less than ideal source material to achieve the targeted permeability potential. If all the BADCT alternative procedures fail to achieve the target permeability of 1×10^{-6} cm/sec, then source material with the higher permeability potential would be allowed depending on concurrence by the Forest Service. Other state and federal agencies, where applicable, would be advised if higher targeted permeabilities would be allowed and at which locations the higher permeabilities would be allowed.

As part of this mitigation, the spine drains beneath the main and north portions of the leach pad would be included as an integral part of the leak detection and removal system.

Both the LCRS and the spine drains would be monitored weekly for evidence of leakage, and results of the monitoring would be furnished to the Forest Service and ADEQ. Any leachate collected by the system would be pumped back onto the heap. In addition, process flow shutoffs and secondary containment for piping between components would be provided. The leach collection system and downgradient aquifers for the heap-leach pad would be regulated by an ADEQ aquifer protection permit. Alert levels for the underdrain system would be established after 12 months of ambient water quality have been collected. Mitigation of adversely affected surface or ground water quality or potential degradation from uncontained leachate would include identifying the potential contaminant source, correcting the source of release where possible, and remediating contamination, if necessary. The exact type of cleanup and remediation procedures would be approved by the ADEQ in coordination with the Forest Service, EPA and other state and federal agencies.

In addition to the above requirements, the main heap-leach reservoir must be equipped with pump systems with the capacity to remove the volume of solution generated by the 100-year, 24-hour storm event out of the reservoir and into a suitable location available for emergency containment within a 10-day or less period.

<u>WR-10</u>: The existing preliminary characterization data indicate that the waste rock material would be non-acid generating. However, considering that some sulfide-bearing material would be mined, there is some potential for acid-generating waste rock material to be produced. The waste rock from mining activities would be sampled and analyzed at a frequency of 1 sample for every 1 million tons of waste rock using the EPA's Method 1312, Synthetic Precipitation Leaching Procedure. As part of the ADEQ's Aquifer Protection Permit, Carlota has committed to continual

characterization during active mining as specified by ADEQ (Carlota 1995a). In addition, as part of the Aquifer Protection Permit, if geochemical testing indicates that some of the material has the potential to generate acid or leach metals, Carlota would develop a materials handling plan to prevent impacts to surface or ground water and submit it to ADEQ for approval.

WR-11: To control erosion, sedimentation, runoff, and surface drainage, the proposed erosion and sediment controls would be developed and implemented subject to Forest Service, EPA, and ADEQ approval. A Stormwater Pollution Prevention Plan would be developed and implemented subject to approval by the EPA. For the long term, a stable, free-draining postmining topography would be restored on the project area in the reclamation and closure phase. Effects of erosion and sedimentation from access roads and haul roads during and following reclamation activities (as currently proposed) would have the potential to degrade surface water quality; therefore, a mitigation measure has been added in Section 3.4.4.2, Soils and Reclamation - Reclamation.

WR-12: Although failure of a properly designed diversion is unlikely, the possibility of failure would remain if flows exceeded the design flow or if there were inadequate inspection and maintenance activities. The final design of the heap-leach embankments, inlet control structure, raffinate and plant PLS/SX ponds, and associated diversions must comply with the conditions specified in the Arizona Department of Water Resources Dam Safety permit. At a minimum, however, these facilities must comply with the Forest Service requirement that, operating in conjunction with one another, they must accommodate (at a minimum) the peak flows and volumes resulting from the 1/2 PMF in addition to the corresponding one-time maximum monthly operating volume of process solutions without any discharge of these solutions. The following measures must be met:

- The main PLS embankment crest must be maintained at a minimum height of 3,830 ft-amsl. The maximum elevation permissible for storing operational process solutions is 3,810 ft-amsl.

- The maximum elevation permissible for storing process solutions in the North heap leach pad embankment/PLS pond is 3,845 ft-amsl.

- The maximum elevation permissible for storing process solutions in the raffinate pond is 3,891 ft-amsl.

- The maximum elevation permissible for storing process solutions in the plant PLS/SX pond is 3,919 ft-amsl.

- The Powers Gulch diversion, operating in conjunction with the inlet control structure, the heap and the east diversion channel, must be able to safely convey the 6-hour 1/2 PMF peak flow and volume (at a minimum) as defined by Knight Piésold (1996f). The toe of the main ore heap behind the main heap-leach embankment where it parallels the Powers Gulch diversion must be armored with large rock riprap or other suitable material to prevent erosion of the heap in the unlikely event that the diversion is overtopped.

- The East diversion channel must be designed to safely accommodate the 6-hour 1/2 PMF peak flow and volume (at a minimum).

WR-13: The Pinto Creek, Powers Gulch, and East diversions are designed to safely convey the 500-year thunderstorm event (Pinto Creek) and 1/2 PMF storm event (Powers Gulch and east diversions) during the operational phase of the project. These diversions would be redesigned at closure to convey the full PMF storm event. The designs would incorporate detailed assessments of the range of hydraulic conditions and sediment transport characteristics likely within the channel systems. The need for energy dissipation structures for the reach immediately downstream of the proposed Powers Gulch diversion outlet would be analyzed for both the operational and postclosure phases.

Periodic inspections of the diversions are required for a number of years after closure and would include inspection of energy dissipation structures downstream of the proposed Powers Gulch diversion outlet, if such structures are necessary. The frequency of inspections and the duration of the monitoring program after closure would be set by the Forest Service and other appropriate agencies. Monitoring during the operational phase is described in the monitoring program (GWRC 1996a). Monitoring and review of the performance of the diversion channels and of the monitoring program would be conducted during the operational phase of the project. A consultant would be hired to evaluate the performance of the channels, particularly their sediment transport characteristics, to aid in developing a maintenance-free design for the postclosure period. Maintenance during the operational phase could include sediment removal and repairs to channel structures. Providing for long-term stability after closure could require altering the channel geometries such that the need for periodic maintenance and repair over a lengthy time could be avoided.

WR-14: The design of the central spine drain to be constructed beneath the main portion of the heap-leach pad would be modified to include an upstream access port. The purpose of the access port would be to provide an upstream opening that could be used for clean out, flushing, or inspection, if necessary. The access port would be located in the vicinity of Powers Gulch immediately upstream of the leach pad, and would be designed such that it would not penetrate the liner or compromise the integrity of the fluid containment system. The access port would include a locking cap at the surface.

WR-15: For closure of the heap-leach pad, Carlota has committed to investigating closure technology to improve upon closure options already identified. Carlota has also committed to experimenting with any identified techniques on the North portion of the leach pad since that portion would be closed before the main portion of the pad. To provide oversight for this research program, Carlota would prepare annual reports of its investigations and findings for submittal to the Forest Service. Submission of reports would begin 1 year after commencement of the operational phase of the project. Annual meetings would be conducted to discuss the annual report and work anticipated for the following year. One year prior to actual closure of the full facility, Carlota would submit a final proposal for closure of the heap leach pad to the Forest Service and other regulating agencies for approval. If a preferred closure technology, such as neutralizing the heap, is identified during the life of the operation the reclamation bond would be adjusted accordingly.

WR-16: The main and north embankments would have a seal zone keyed into bedrock. The need for alluvial monitoring wells upgradient of the embankments would be evaluated on the basis of site conditions and depth of alluvium below the spine drains.

Additional Mitigation Measure

The Forest Service would be responsible for determining that adequate monitoring and mitigation measures are implemented to protect water dependent resources. Carlota would contribute funding to the Forest Service, through a collection agreement, to monitor project construction activities. The funding would be used to finance a portion of the Forest Service specialist's salary, a portion of a specialist's salary from another agency, or a third-party contractor (under the guidance of the Forest Service) to monitor project construction and facilitate the implementation of operational monitoring programs.

3.3.4.2 Additional Monitoring and Mitigation for the Alternatives

Mine Rock Disposal Alternatives

Alternative Mine Rock Disposal Sites. Additional monitoring of ground water and surface water quality would be performed in the vicinity of the Cactus South mine rock disposal area. The monitoring would include upgradient and downgradient monitoring wells and surface sampling points. Surface water monitoring associated with this alternative would entail periodic sampling and analyses of any ponding or drainage outflow from the mine rock disposal areas.

Additional Backfill of the Carlota/Cactus Pit. Water quality monitoring of the pit lake quality for some unspecified period of time would not be required under this alternative. Periodic inspections of the diversion would be required for several years to ensure proper function. Additional mitigation measures would be the same as previously described for the proposed action.

Additional Backfill of the Eder South Pit. No monitoring or mitigation measures beyond those identified for the proposed action would be required for this alternative.

Leach Pad Alternative

Eder Side-Hill Leach Pad Alternative. Although monitoring points would change, no mitigation measures beyond those identified for the proposed action would be required for this alternative.

Water Supply Alternatives

Low-Quality Water, Water Supply Wells, and Dewatering Wells. A detailed plan would be developed to define appropriate measures to (1) reduce the potential for leaks or ruptures in the pipelines, (2) conduct periodic monitoring of the pipeline for integrity, and (3) implement remediation measures to reduce the potential for degradation of surface or ground water resources in the event of a release. This plan would be approved by the ADEQ. Pipeline integrity would need to be monitored throughout the operational life of the low-quality water supply alternative. This would occur as part of normal project operations since system reliability would be a major operational consideration. Monitoring would include an automated leak detection system. Automated control valves would be placed along the pipelines at locations or intervals as specified by appropriate agencies. The pipeline would be constructed before leaching operations on the main pad would begin. During construction, BMPs would be implemented as erosion and sedimentation controls. At the end of operations, the pipelines and appurtenances would be cleaned, drained, and removed. The rights-of-way would be revegetated, and erosion and sedimentation controls, such as water bars and riprap, would be installed as needed. Carlota would report the volume of water pumped through the low-quality water pipeline to the Forest Service quarterly.

Alternative Water Supply Well Field Access Roads

Monitoring would consist of periodic inspection of site conditions and erosion controls to ensure site stabilization along the access roads. Mitigation would consist of concurrent revegetation of roadside cuts and fills and stabilization of all stream channel crossings. Stabilization would consist of durable riprap in the stream channel and along road approaches.

3.4 Soils and Reclamation

3.4.1 Affected Environment

3.4.1.1 Soil Occurrence and Characteristics

A wide range of soil characteristics occurs in the proposed Carlota Copper Project area because of the complexity of geologic materials, slope and aspect, and climatic factors. Within the project locale, the soil features consist of shallow, very gravelly materials with thin, loamy topsoil and subsoil layers. Typically the soils are less than 20 inches deep over bedrock. Some areas, particularly toeslopes and north- and east-facing aspects, are overlain by deeper, more strongly developed soils. Rock outcrops and rubble are widespread in the project area. The occurrence of these features varies over the project area, but generally 15 to 40 percent of the land surface is occupied by such materials.

Cedar Creek Associates, Inc. has conducted soil mapping and has described the proposed project area; the results of this work are presented in the Soils Technical Memorandum for the project (Cedar Creek Associates, Inc. 1994d). Twenty-four mapping units were described and mapped; the major characteristics of these units are summarized in *Table 3-50. Figure 3-23* shows the occurrence of the soils within the project area.

For the purpose of general soil description, the project area may be divided into four major sections based on dominant soil units: north, central, southwest, and southeast. These sections were identified as the northern part occurring generally north of the Kelly fault zone from Manitou Hill toward Grizzly Mountain, the central part lying generally south of the Kelly fault and west-southwest of Manitou Hill, the southwestern part generally west of Powers Gulch, and the southeastern part as the remaining portion of the project area.

The northern section occurs north of the Kelly fault zone from the Manitou Hill area west toward Grizzly Mountain. Soils in this section of the project area have developed in colluvium and residuum from mixed sources, including dacite, breccia, conglomerates, and limestones. Gravelly and very gravelly loamy and sandy textures predominate.

In this northern section, dominant soil mapping units are A, C, D, L, and N (Cedar Creek Associates, Inc. 1994a). Much of the area consists of rubbleland and rock outcrop (Unit A) where soils are very thin or nonexistent. Where soils do occur, the surface layers typically consist of very gravelly loams or sandy loams, and underlying layers range in texture from very gravelly sandy loams to gravelly clay loams (Units C and D). Typically, bedrock occurs at depths shallower than 20 inches. Dark, organically-enriched surface layers occur on some north- and east-facing slopes as a result of climatic and vegetative influences. Mapping unit L consists of deep soils formed in residuum from conglomerate. Typically, the surface layer is gravelly loam. The subsoil is gravelly clay loam to a depth of approximately 8 inches. Underlying materials are extremely gravelly sandy loams weathered from conglomerate. Mapping unit N consists of very shallow and shallow soils weathered from igneous rocks. Textures range from very gravelly sandy loams in the surface layer to extremely gravelly sandy clay loams in the subsoil. Depth ranges from 4 to 20 inches over hard bedrock.

Soils in the central section of the project area have developed in colluvium, slope wash, and residuum dominantly from basaltic diabase and Pinal Schist. This section lies west and southwest of Manitou Hill and is generally separated from the northern section by the Kelly fault zone. Dominant soil mapping units include G, H, R, and S (Cedar Creek Associates, Inc. 1994a). Units G and H are deep and moderately deep soils that commonly contain gravelly loam surface layers and silt loam to gravelly sandy clay subsoils. Bedrock occurs at depths ranging from 22 to 55 inches or more. Mapping units R and S are typified by very gravelly to extremely gravelly sandy loam materials underlain by bedrock at depths less than 20 inches.

Soils in the southwestern section of the project area formed in colluvium and slope wash primarily from diabase and smaller occurrences of Pinal Schist. This section generally occurs west of Powers Gulch. Dominant soil mapping units include A, C, and V (Cedar Creek Associates, Inc. 1994a). Unit A consists of rubbly slopes and rock outcrops. Mapping unit C consists primarily of shallow, very gravelly sandy loams occurring under juniper on north and east aspects. Dark-colored, organically-enriched surface

Table 3-50. Typical Soil Characteristics

Soil Mapping Unit	Slope Range %	Surface Stoniness	Depth (inches)	Texture	Coarse Fragments (% vol.)	Approx. pH	Major Additional Component	Potential Salvage Depth (inches)	Approximate % of Unit Salvageable	Salvage Limitations	Typical Vegetation	Diagnostics of Interest
A	20-100+	30 % cobble, stones, and boulders	0-7	gravelly sandy loam	15	7.4	90% rubble land and rock outcrop	0	0	stoniness, rock outcrop, slope	dry-slope desert brush/ chaparral	mollic
			7-18	gravelly to very gravelly loam	25-45	7.2						
			18+	igneous bedrock								
B	20-45	50% gravel, cobble, stones, and boulders	0-11	very gravelly to extremely gravelly sandy loam, sandy clay loam, or loam	45-65	7	10% rock outcrop	10	80	stoniness, depth to rock, slope	dry-slope desert brush	argillic
			11+	igneous bedrock								
C	35-70	45% gravel, cobble, stones, and boulders	0-15	very gravelly sandy loam or loam	35-45	7.2	35% rock outcrop and very shallow soils	15	0	stoniness, rock outcrop, slope	chaparral	mollic
			15+	igneous bedrock			very shallow soils					
D	40-60	40-50% gravel, cobble, stones, and boulders	0-11	very gravelly loam or clay loam	35-55	7.8	40% rock outcrop and very shallow soils	10	0	stoniness, rock outcrop, slope, depth to rock	dry-slope desert brush	argillic
			11+	fractured limestone								
E	40-50+	80% gravel, cobble, stones, and boulders	0-2	very gravelly loamy sand	50	6.6	40% rock outcrop and very shallow soils	6	0	stoniness, rock outcrop, slope, depth to rock	dry-slope desert brush	mollic, argillic
			2-11	very gravelly to extremely gravelly sandy clay loam	40-75	6.8						
			11+	igneous bedrock								

Table 3-50. Typical Soil Characteristics (continued)

Soil Mapping Unit	Slope Range %	Surface Stoniness	Depth (inches)	Texture	Coarse Fragments (% vol.)	Approx. pH	Major Additional Component	Potential Salvage Depth (inches)	Approximate % of Unit Salvageable	Salvage Limitations	Typical Vegetation	Diagnostics of Interest
F	50-60+	60% gravel and cobble	0-15	very gravelly to extremely gravelly loam	30-80	6.8	25% rock outcrop, 15% very shallow soils	0	0	stoniness, rock outcrop, slope	dry-slope desert brush/ chaparral	
			15+	igneous bedrock								
G	20-50+	20% gravel and cobble	0-10	gravelly loam or loam	10-20	7.6	30% rock outcrop and very shallow soils	26	40	rock outcrop, slope	chaparral	argillic
			10-36	silt loam	0-15	7.8						
			36-55+	gravelly sandy loam	30-40	7.6						
H	30-70+	15-20% gravel, cobble, and scattered stones	0-3	gravelly loam or silty clay loam	15-20	7.4	20% rock outcrop and very shallow soils	22	25	rock outcrop, slope, clayey	chaparral	mollic, argillic
			3-40	gravelly sandy clay	20-45	7						
			40+	weathered igneous bedrock								
I	2-4	variable: gravelly to extremely stony	0-60+	very gravelly to extremely gravelly loamy sand or sand, stratified w/cobble, stones, and boulders	45-70	7	60% stony alluvial land	12	35	stoniness	riparian/ chaparral	
J	25-50	80% gravel, cobble, and stones	0-4	gravelly to very gravelly loam	25-50	7.2	10% rock outcrop	34	50	stoniness, slope	dry-slope desert brush	argillic
			4-34	gravelly to very gravelly sandy clay loam	20-65	6.8						
			34+	weathered igneous bedrock								
K	30-50	30% cobble and stones	0-18	sandy loam or sandy clay loam	0-15	7	15% rock outcrop and rubble	52	30	stoniness, slope, sandy >18"	chaparral	argillic
			18-52	gravelly loamy sand	25	7.4						
			52+	igneous bedrock								

Table 3-50. Typical Soil Characteristics (continued)

Soil Mapping Unit	Slope Range %	Surface Stoniness	Depth (inches)	Texture	Coarse Fragments (% vol.)	Approx. pH	Major Additional Component	Potential Salvage Depth (inches)	Approximate % of Unit Salvageable	Salvage Limitations	Typical Vegetation	Diagnostics of Interest
L	25-40+	60% gravel, cobble, and scattered stones	0-8	gravelly loam or clay loam	20-25	7	10% shallow soils	8	90	stoniness	dry-slope desert brush/ chaparral	argillic
			8-42	extremely gravelly sandy loam	70	7.2						
			42+	weathered conglomerate								
M	30-50	50% gravel, cobble, and stones	0-10	gravelly loam, clay loam, or sandy clay loam	15-30	6.9	10% rock outcrop and very shallow soils	12	35	stoniness, slope	dry-slope desert brush	argillic
			10-21+	fragmental								
N	50-70	90% gravel and cobble	0-8	very gravelly to extremely gravelly sandy loam or sandy clay loam	60-75	6.8	40% rock outcrop and moderately deep soils	0	0	stoniness, rock outcrop, slope, depth to rock	dry-slope desert brush/ chaparral	argillic
			8+	igneous bedrock								
O	25-50	30% cobble	0-6	sandy loam to gravelly loam	5-20	6.8	50% basalt "cap"	20	50	rock outcrop, slope	chaparral	argillic
			6-20	gravelly sandy clay	15-20	6.8						
			20-42+	extremely gravelly loam	65	6.8						
P	25-35+	55% gravel, cobble, and scattered stones	0-8	gravelly clay loam	30-35	7.6	10% shallower soils and rock outcrop	34	90	stoniness	chaparral	mollic
			8-19	very gravelly to extremely gravelly loam or sandy clay loam	50-70	7.8						
			19-34	very gravelly loamy sand	65	7.8						
			34+	igneous bedrock								
Q	15-35	20% gravel and cobble	0-42+	gravelly loam or clay loam	15-25	7.4	20% rock outcrop and very shallow soils	18	80	rock outcrop	chaparral	argillic

Table 3-50. Typical Soil Characteristics (continued)

Soil Mapping Unit	Slope Range %	Surface Stoniness	Depth (inches)	Texture	Coarse Fragments (% vol.)	Approx. pH	Major Additional Component	Potential Salvage Depth (inches)	Approximate % of Unit Salvageable	Salvage Limitations	Typical Vegetation	Diagnostics of Interest
R	25-50	60% gravel and cobble	0-12	very gravelly sandy loam	35-50	7.2	20% rock outcrop and moderately deep soils	12	40	stoniness, rock outcrop, slope, depth to rock	juniper grassland/ chaparral	
			12+	igneous bedrock								
S	50-60	75% gravel and cobble	0-5	very gravelly sandy loam	40-50	6.8	10% rock outcrop	6	10	stoniness, slope	juniper grassland/ chaparral	
			5-18	extremely gravelly sandy loam or loam	70-90	7.2						
			18+	igneous bedrock								
T	10-25	30-50% gravel and cobble	0-35	sandy loam or loam	10-20	7.4		70	100	too sandy 35" to 55"	chaparral	
			35-55	very gravelly loamy sand	35	7.2						
			55-70+	sandy clay loam	0-15	7.2						
U	30-50	variable: gravelly to extremely cobbly	0-10	gravelly loam to very gravelly clay loam	20-35	7.2	This soil = 55% of unit	10	40	stoniness, depth to rock, slope	chaparral	argillic
			10+	weathered schist								
			0-12	gravelly loam or clay loam	20-35	7	This soil = 35% of unit				chaparral	mollic, argillic
			12-32	extremely gravelly loam	65	7						
			32+	weathered schist			10% rock outcrop					
V	10-30	30% gravel, cobble, and stones	0-18	gravelly to very gravelly loam	30-40	7	20% rock outcrop, talus, and deep soils	18	80	stoniness, rock outcrop	chaparral	
			18+	igneous bedrock								
W	10-25	granitic rock outcrop					90% rock outcrop	0	0	rock outcrop	rubbleland chaparral	
X	20-40+	60% gravel and cobble	0-16	gravelly sandy loam or loam	20-30	7.2	5% moderately deep soils	16	90	stoniness, slope	dry-slope desert brush	mollic, argillic
			16-42+	extremely gravelly sandy loam	65	7.2						

layers are typical in this unit. Mapping unit V typically consists of shallow, coarse-textured gravelly soils less than 20 inches deep over schist bedrock.

Soils in the southeastern section of the project area have developed in materials weathered from granites. Mapping units H and W dominate this section; unit W is by far the most extensive (Cedar Creek Associates, Inc. 1994a). Mapping unit H primarily consists of moderately-deep and deep, well-developed soils with dark surface layers and clayey subsoils. Unit W consists of rock outcrops of granite. Small inclusions of shallow "grus" weathered from granites are interspersed with rock outcrops.

Within each of these major sections of the project area, other geologic materials and soils developing from them occur to a lesser extent. For example, the soils in major drainages, such as Powers Gulch and Pinto Creek, are deep and coarse-textured with a substantial content of rock fragments (mapping unit I). The parent materials are narrow deposits of alluvium. Textures are primarily extremely gravelly loamy sands and sands with significant volumes of cobbles, stones, and boulders in most locations. Coarse colluvial deposits also occur, particularly along upper drainages.

Climate and vegetation vary over the project area and result in soil variations. The climate is semi-arid, with summer thunderstorms (monsoons) and more gentle winter rains and occasional snow. Two soil temperature regimes (thermic and mesic) and one dominant soil moisture regime (ustic) occur in the project area. The thermic soil temperature regime exists at lower elevations and on warmer south- and west-facing aspects. Generally in this regime, the mean annual soil temperature is 15°C or higher, but less than 22° C. In contrast, the mesic soil temperature regime generally consists of mean annual soil temperatures of 8°C or higher, but less than 15°C (Soil Conservation Service 1975). Within the project area, mesic soil temperatures generally occur at higher elevations and on north- and east-facing aspects or sheltered sites.

The ustic soil moisture regime is dominant within the project area. This regime is generally characterized by limited moisture, but moisture is usually available at times when conditions are suitable for plant growth (Soil Conservation Service 1975). Within the project area, the ustic moisture regime transitions toward both drier and wetter regimes, depending primarily on elevation and aspect.

3.4.1.2 Estimates of Existing Erosion Losses

Estimates of existing erosion, as calculated by the Revised Universal Soil Loss Equation (RUSLE), indicate that where soils occur, moderate to high amounts of soil are lost on the project site in the undisturbed condition primarily because of steep slopes and high-energy rainfall. Soil amounts up to approximately 12 tons/acre/year could be lost on the undisturbed Cactus Southwest mine rock disposal site, with losses of approximately 3 to 7 tons/acre/year for other mine rock disposal sites and the proposed leach pad in their existing undisturbed condition.

3.4.1.3 Existing Disturbance

Existing mineral-related disturbance in the project area consists primarily of roads, shafts, drifts, mine rock areas, and drill holes and drill pads from past exploration and mining. The most prominent features date back 50 years or more. The total acreage of disturbance from pre-project mining features is small, and most of the disturbed areas would be excavated or buried during the construction of the proposed project.

Surface exploration disturbance by Carlota has primarily involved approximately 3.5 miles of road construction or maintenance to allow drilling access and well construction. Drilling sites are located within the roadbed or at the road terminus. Water bars would be constructed on all roads as necessary to minimize erosion. All drill holes would be abandoned in accordance with Arizona Department of Water Resources specifications, or they would be mined out. Test pits would be mined out or recontoured and reseeded.

The Forest Service EIS objectives for reclamation activities are given below:

- Conduct concurrent reclamation of project areas where reasonable and practical.
- Provide for short-term and long-term protection of surface and ground water quality.
- Remove facilities and appurtenances.

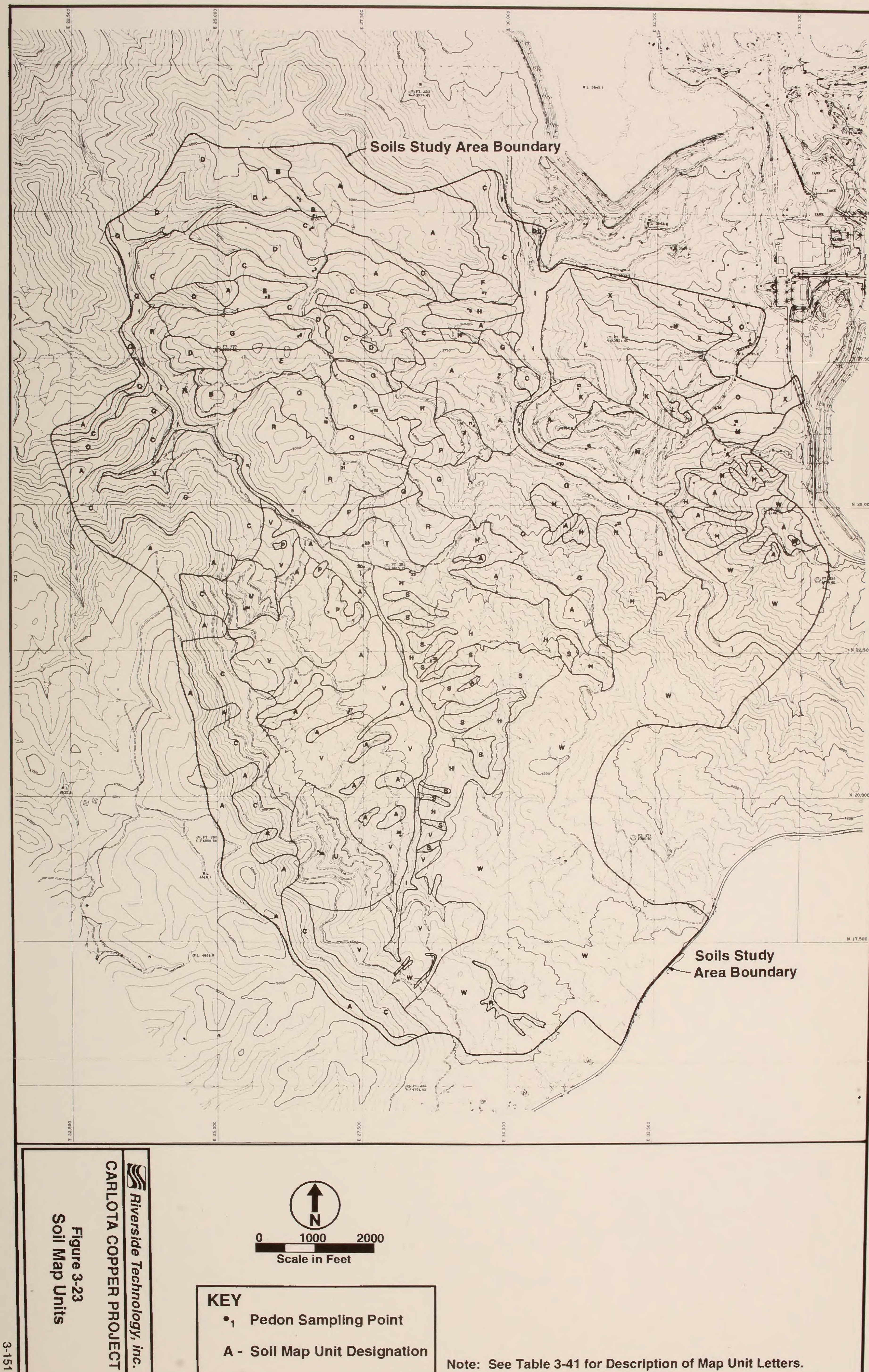

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Figure 3-23
Soil Map Units

- Control short-term and long-term erosion and runoff.
- Control and remove hazardous materials.
- Reshape and revegetate disturbed areas where reasonable and practical.
- Restore productive postmining land uses, including aquatic and wildlife habitat, livestock forage production, and dispersed recreation.
- Mitigate potential public safety hazards.

3.4.2 Environmental Consequences

Issues related to soils and reclamation for the proposed Carlota Copper Project include the potential loss of soil resources or reduction of soil productivity from project operations, and potential damage to surface resources of the National Forest system lands. Evaluation criteria used to describe project impacts on soils and reclamation include the following:

- Area (in acres) requiring restoration of topsoil
- Volume (in cubic yards) of salvageable topsoil materials
- Projected postdisturbance soil erosion (in tons/acre/year) for project component sites based on the RUSLE
- Area (in acres) for which postreclamation objectives cannot be met because of design or placement of project components
- Anticipated annual postreclamation inspection and maintenance costs

3.4.2.1 Proposed Action

Reclamation Planning

Carlota Copper Company has provided a Reclamation and Closure Plan as part of the Plan of Operations. The removal of facilities, site recontouring and drainage restoration, erosion and sedimentation controls, stabilization of process solutions, and topsoil replacement and revegetation efforts are the basic components of the proposed reclamation program. Carlota's proposed plan describes the reclamation and closure efforts for the proposed action; Carlota's proposed reclamation and closure would also apply to the project alternatives.

The overall commitment by Carlota is to recreate productive land uses; control erosion and sedimentation; and restore stable, safe, and productive postmining conditions to the project area to the degree practical and achievable under available technology and BMPs. Given that project designs are in a detailed yet preliminary condition at the time of this EIS, Carlota recognizes the need for continued analysis, planning, and implementation of reclamation practices as the project progresses. Such activities would be an ongoing part of project activities and would involve input from appropriate agency personnel in developing and carrying out a coordinated reclamation program.

General Reclamation Approach

Reclamation of the proposed project is planned and designed to reasonably ensure public safety and to return the land to productive postmining land uses compatible with and supportive of its premining uses. The proposed Reclamation and Closure Plan (Carlota 1994a) consists of the following key measures:

- At the time of closure, the project site will be surveyed for potential public safety hazards. No chemical or electrical hazards will remain after closure. Physical hazards will be minimized using measures such as berming, fencing, or filling, depending on the specific perceived hazard.
- The Carlota/Cactus pit will be partially backfilled to further stabilize the Pinto Creek diversion and to enhance the postmining site configuration.
- The Eder pits will be recontoured so that excess precipitation will exit as stormwater discharge.
- The leach pad slopes will be recontoured to a continuous approximate 2.5:1 (H:V) slope.
- The leach pad surfaces will be reworked to prevent deep surface water percolation into the pad, thereby eliminating the potential for discharge from the pad. This activity will consist

of a combination of compacting, applying suitable rock material and topsoil, and promoting the establishment of adapted plant species. All salvaged topsoil will be placed on the reworked leach pad.

- The top surface of the mine rock disposal areas will be revegetated on a growth medium developed from the waste rock, amended as necessary, and directly reseeded. Sideslopes of the mine rock disposal areas will remain at the angle of repose, except for the North Eder mine rock disposal area. This component will be partially recontoured so that sideslopes approach 2.5:1.
- Facilities will be dismantled and removed from the site or buried.
- Erosion control measures other than re-establishing vegetation will be implemented as needed to prevent sedimentation of surface drainages.
- Diversion channels will be prepared for postclosure functioning.
- Ripping, grading, and seedbed preparation will be performed on surfaces planned for reclamation. A surface material survey will be conducted before reseeding to determine the need for seedbed amendments. Mulching may be used in conjunction with revegetation practices.
- Grasses will be emphasized in reseeding mixes to ensure short-term site stabilization, but shrubs and forbs will also be seeded. To the extent practical, native and adapted seed will be purchased from a southwestern seed source.
- Methods of seeding and establishing vegetation will be reviewed before planting. Where topography and site conditions allow, drill seeding is preferred. Hydroseeding and broadcast seeding may also be employed as site-specific conditions dictate.
- Test plots to further define reclamation practices will be developed in close cooperation with Forest Service specialists.
- Opportunities for innovative reclamation practices may emerge during the life of the project. Areas where special reclamation practices may be warranted include wetland and riparian area replacement, cactus habitat replacement, stock pond construction, and riparian expansion. New approaches to mine reclamation, such as livestock and holistic management, which are currently showing promise in the Globe-Miami area, may have potential. A riparian/wetland mitigation plan has been developed by the Carlota Copper Company and reviewed by the COE and the Forest Service (Aquatic and Wetland Consultants, Inc. 1996a). A wetland and waters of the U.S. Compensatory Mitigation Plan for the Carlota Copper Project has been prepared and approved by the COE. A plan to mitigate potential impacts to the Arizona hedgehog cactus (*Echinocereus triglochidiatus arizonicus*) has been developed and approved by the U.S. Fish and Wildlife Service (Cedar Creek Associates, Inc. 1996a, 1996b).

On lands administered by the Forest Service, interim, concurrent, and final reclamation of the proposed project would be the responsibility of the project proponent and would become a point of compliance in the final approved Plan of Operations. The responsibility to conduct reclamation is further reinforced by requiring the operator to post a reclamation bond that provides financial assurance that the reclamation, as specified in the final approved Plan of Operations, would be completed.

Additional details about proposed project reclamation activities and goals are presented in the reclamation portion of the Plan of Operations developed for the project. This document served as the basis for the following analysis of potential impacts.

A final Plan of Operations, which would include specifics on reclamation and closure, would be submitted and approved prior to project implementation. The final Plan of Operations would reflect the additions or changes to reclamation generated by the analysis. In addition, preparation of the final Plan of Operations would provide a mechanism through which Carlota and the Forest Service could ensure that postmining land uses are compatible and supportive of premining uses.

The following sections address specific considerations related to soils and reclamation that would have a bearing on potential project operations and ongoing reclamation efforts. Where necessary, additional mitigation measures beyond those described in the proposed action have been recommended.

Potential Impacts to Soil Resources

Potential impacts to soils from the proposed action include the physical loss of soil materials and decreases in soil productivity. Physical losses would occur as a result of accelerated erosion and removal by excavation, construction uses, or burial. Soil productivity would be affected by removal, compaction, and fertility losses.

Affected Acreage. The proposed Carlota Copper Project would disturb approximately 1,428 acres (in plan view), of which approximately 1,207 would be directly affected by excavation or other earthwork. Approximately 221 acres of buffer strips and construction traffic/staging areas would be disturbed to a lesser extent. The acreages directly affected by excavation or other earthwork within the proposed component footprints are listed by component in *Table 2-2*.

As proposed by Carlota in its Reclamation and Closure Plan, all salvaged soil materials would be respread on the top and sideslopes of the recontoured heap-leach pad (Carlota 1994a). This represents an area of approximately 270 acres. Reclamation of excavated areas that do not receive topsoil would consist of ripping the seedbed on flatter areas, testing and amending seedbed materials with fertilizers and mulch as necessary, and seeding. These activities would occur on approximately 447 acres of excavated areas on the top surfaces of the mine rock disposal areas, the Carlota/Cactus backfill, roads, the SX/EW plant, and small miscellaneous areas. In total, 717 acres affected by earthwork would be revegetated, 270 of which would be topsoiled.

Soils on the remaining project areas disturbed by earthwork (approximately 500 acres) would be removed from postmining land uses. These areas consist mostly of angle-of-repose slopes, pit walls, or other steep areas. In addition, soils on approximately 221 acres of buffer strips and staging areas would be disturbed by grubbing and compaction. The buffer strips and staging areas would be revegetated at the end of operations.

Topsoil Used in Construction. Soil would be used as both a construction material and a plant-growth medium. Near-surface soil materials of suitable quality for salvage and use as plant-growth medium are referred to as topsoil in the subsequent text. A certain amount of topsoil would be used as construction material to build roads, embankments, and pads. The largest amount of topsoil likely to be used in construction would occur at the proposed leach pad area. Compacted soil bedding overlain by a synthetic liner would be installed at this location to prevent discharges of process solutions to ground water and surface water. Although the topsoil used as a bedding for the leach pad would be unavailable for postmining revegetation and land use restoration efforts, it would perform an important role in long-term environmental protection.

The volume of material needed to provide a 1-foot thick constructed earth bedding under the proposed leach pad and PLS ponds (approximately 270 acres) is on the order of 435,000 cubic yards. The bedding would be primarily developed from the scarification and compaction of in situ materials, including potential topsoil sources. The construction volume includes salvageable topsoil otherwise available for reclamation in the proposed leach pad area. (The actual volumes required and available would vary from these preliminary estimates according to final design and construction).

Other potential borrow sources have been identified during project development. While preparing the EIS, examination of the proposed leach pad design and geotechnical appendix (Knight Piésold and Company 1993b) indicated that 100,000 to 300,000 cubic yards of potential construction materials may occur in the vicinity of the proposed leach pad. The actual volume present may vary, depending on a more detailed investigation during construction. The further delineation and use of borrow sources for construction purposes would improve the availability of topsoil for reclamation. As a result, mitigation measures are recommended in Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures.

Topsoil Salvaged for Reclamation. To initiate a proposed topsoil salvage plan, Cedar Creek Associates, Inc. made salvage depth recommendations for each mapped soil unit (Cedar Creek Associates, Inc. 1994a). These recommendations are shown in *Table 3-51* and *Figure 3-24*. To subsequently estimate soil salvage volumes, Carlota used these depth recommendations and incorporated operational considerations. Because of heavy equipment safety considerations, Carlota proposes to limit topsoil salvage to suitable topsoil materials present on disturbed areas with less than a 30 percent slope. The salvage volumes were estimated by examining the proposed disturbance footprint, buffer and traffic areas, and a slope map. Losses equaling 15 percent of the potential salvageable volume were also used to account for the size of rock fragments, outcrops, inaccessibility, and losses in transport. The proposed total salvage volume is estimated at approximately 460,000 cubic yards.

For the leach pad and other proposed components, Carlota has estimated the volume of topsoil that could be salvaged and stockpiled for reclamation. This is shown by component in *Table 2-11*. The estimated topsoil volume for reclamation from the leach pad area (approximately 192,000 cubic yards) takes into account the use of topsoil during construction.

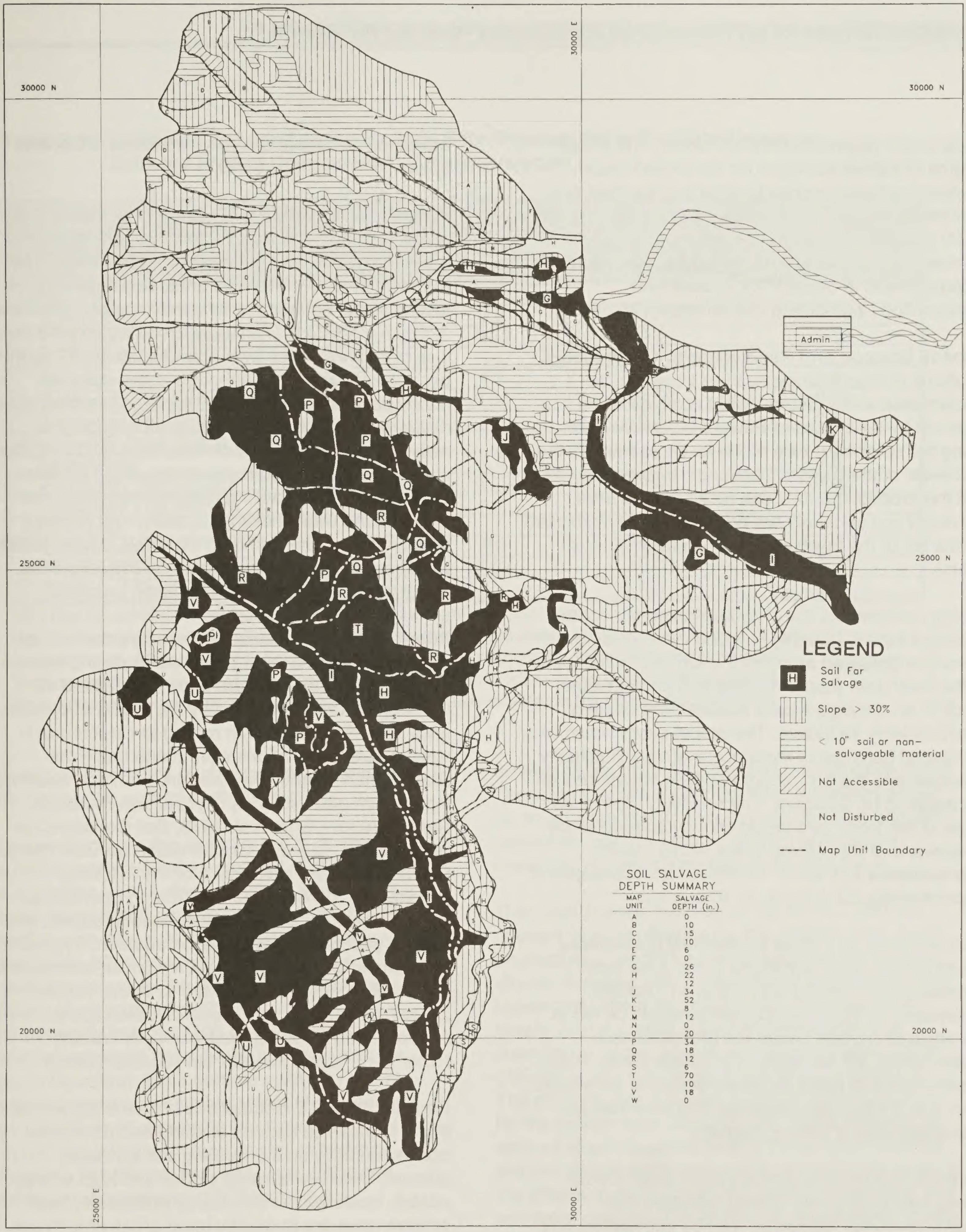
The total volume estimate developed by Carlota includes topsoil salvaged from the entire area of disturbance exhibiting less than 30 percent slopes.

This includes areas for traffic and staging that may not be affected by excavation and other earthwork that would remove soils. If soils were left in place on

Table 3-51. Soil Salvage Depth Summary

Map Unit	Salvage Depth (inches)	Percent of Unit Salvageable	Primary Salvage Limitations
A	6	0	Surface rubble, rock outcrops, slope
B	10	80	Depth to bedrock, slope
G	15	0	Slope, rock outcrop, surficial bedrock and rock cover
O	10	0	Slope, surficial bedrock, rock outcrops
F	6	0	Slope, surficial bedrock, coarse fragment content
F	6	0	Slopes, coarse fragment content
G	20	40	Slope, surficial bedrock, depth to weathered bedrock
H	22	25	Slope, surficial bedrock
I	12	35	Alluvial gravel/cobble/rock/boulder accumulations
J	34	90	Slope, existing disturbance, depth to bedrock
K	52	90	Slope, surficial bedrock
F	6	90	Coarse fragment content, depth to weathered bedrock, slope
M	12	35	Surficial bedrock, slope, coarse fragment content
N	6	0	Slope, coarse fragments, bedrock, existing disturbance
O	20	90	Basalt cap, slope
P	34	90	Surficial bedrock, depth to bedrock
Q	18	40	Slope, soil depth
P	12	40	Slope, surficial bedrock outcrops, depth to bedrock
S	6	10	Slope
I	70	100	None
U	10	40	Slope, surficial bedrock
V	18	80	Depth to bedrock, talus, surficial bedrock outcrops
W	0	0	Rock outcrops, surficial bedrock, lack of soil
X	16	90	Coarse fragment content, slope

Source: Cedar Creek Associates (1994a)



SOIL SALVAGE DEPTH SUMMARY

MAP UNIT	SALVAGE DEPTH (in.)
A	0
B	10
C	15
D	10
E	6
F	0
G	26
H	22
I	12
J	34
K	52
L	8
M	12
N	0
O	20
P	34
Q	18
R	12
S	6
T	70
U	10
V	18
W	0

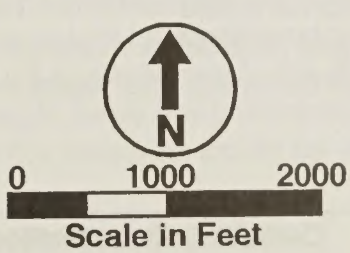


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Figure 3-24
Areas of Suitable Salvageable Soils

these areas (approximately 221 acres), the actual volume of topsoil salvaged for the project under Carlota's salvage approach could be less than the estimated 460,000 cubic yards, perhaps by as much as 20 percent. In order to ensure the appropriate recovery of suitable topsoil resources, mitigation is recommended in Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures.

Topsoil Storage and Replacement. The proposed locations of topsoil stockpiles are shown in the Reclamation and Closure Plan. Locations occur adjacent to the proposed Powers Gulch diversion along the southwest side of the leach pad and to the northwest of the Carlota/Cactus pit, between the pit and the proposed Main mine rock disposal area. Salvaged soil materials are proposed to be stockpiled for the life of the leach pad (i.e., approximately 20 years).

During reclamation, the proposed placement of the salvaged topsoil (roughly 460,000 cubic yards over the entire disturbed area) on the top and sideslopes of the leach pad (approximately 270 acres) would result in an average topsoil replacement depth of approximately 13 inches. The actual depth would vary somewhat because of the amount of topsoil actually salvaged and the equipment handling capabilities on the areas to be topsoiled. The relatively flat top surfaces of the leach pad would occupy approximately 54 acres, and the sloping areas would occupy approximately 216 acres having continuous slopes of approximately 2.5:1 (H:V), or 40 percent.

Approximately 447 acres of relatively flat surfaces would remain after operations at the mine rock disposal areas, SX/EW plant, and pit backfills. Sideslopes on the mine rock areas would be left at the angle of repose. Under the proposed action, topsoil would not be replaced on these areas. Plant-growth media at these locations would be developed from in situ mine rock materials and amended as prescribed after a testing program.

A review of soils data for the project area (Cedar Creek Associates, Inc. 1994a) indicates that additional topsoil resources may be accessible, and that the placement of topsoil on additional flatter component surfaces would enhance the potential for achieving reclamation goals. For this reason, mitigation measures are recommended in Section 3.4.4.

Potential Excavation Losses. Approximately 1,207 acres would be directly affected by excavation or other earthwork, and native soil materials would be removed or buried over this area. Subsequently, topsoil would be restored to approximately 270 acres during reclamation. Ultimately, there would be a net loss of soil resources over approximately 937 acres because of earthwork. Although native soils are poorly developed on the site, some soil profiles show differentiation with depth as a result of biological activity and geologic and climatic factors. During the course of salvage and replacement, such profiles would be disrupted, with effects on infiltration, soil aeration and water-holding capacity, and fertility relationships in the respread materials. These factors would create an adverse impact on soil resources, which would be offset by reclamation practices.

Potential Erosion Losses. The estimated erosion losses on selected mine components during various phases of development are shown in *Table 3-52.* Components were selected by the extent of disturbance and the location with regard to natural drainages. These calculations were made using the RUSLE manual and computer program and additional inputs from other sources (Agricultural Research Service 1990, Clyde et al. 1978, Soil Conservation Service 1975, and Soil Conservation Service 1983). Calculations were performed for the following conditions: native undisturbed, during operations, immediately after proposed reclamation efforts, and several years after proposed reclamation. Typical soil characteristics, slopes, vegetative cover, and erosion control practices were selected for these various cases from on-site resource information (Cedar Creek Associates Inc. 1994a), project maps, and the Reclamation and Closure Plan (Carlota 1994a).

Results of RUSLE calculations (*Table 3-52*) indicate that a substantial amount of sheet and rill erosion occurs naturally on the existing soil surfaces, primarily because of steep slopes and high energy rainfall. However, for the overall watershed, total erosion rates are limited by large areas of rock outcrops and other non-erodible surfaces. The predicted amount of sheet and rill erosion would generally change as a result of mining operations and recla-

Table 3-52. Estimated Erosion Losses by RUSLE for Representative Erodible Slopes on Selected Project Components[1] (in tons/acre/year)

Project Component	Native Undisturbed Conditions	During Operations	0 to 6 Months After Proposed Reclamation	Approximately 5 Years After Proposed Reclamation
Leach Pad				
Sideslopes[2]	7.2	0.3	20 to 30	20 to 30
Proposed Top Surface	n/a	0.03	0.3	0.8
Main Rock Dump				
Sideslopes[3]	2.6	4.9	4.9	4.9
Proposed Top Surface	n/a	0.03	<0.03	<0.03
Topsoiled Top Surface	n/a	n/a	0.3	0.8
Cactus SW Rock Dump				
Sideslopes[4]	11.6	4.9	4.9	4.9
Proposed Top Surface	n/a	0.03	<0.03	<0.03
Topsoiled Top Surface	n/a	n/a	0.3	0.8
Eder Dump				
Sideslopes[5]	5.5	4.9	4.9	4.9
Proposed Top Surface	n/a	0.03	<0.03	<0.03
Topsoiled Top Surface	n/a	n/a	0.3	0.8

[1]See text for constraints on these calculations; values are intended for comparative purposes only.
[2]Approximately 28 percent of the slopes in this area are non-erodible in the undisturbed condition.
[3]Approximately 58 percent of the slopes in this area are non-erodible in the undisturbed condition.
[4]Approximately 48 percent of the slopes in this area are non-erodible in the undisturbed condition.
[5]Approximately 38 percent of the slopes in this area are non-erodible in the undisturbed condition.

mation primarily because of changes in topography and the nature of exposed earth materials.

During operations, mining would result in coarser and less erodible materials being exposed at the surface compared to the undisturbed condition. However, it should be noted that the predicted loss rate after reclamation activities is high for replaced topsoil (approximately 20 to 30 tons/acre/year). After proposed recontouring, the leach pad would have sideslopes of approximately 2.5H:1V, with slope lengths generally between 400 and 800 feet. If unprotected, replaced topsoil may become unstable on this configuration. Such surface instability would inhibit the successful re-establishment of vegetation. Eroded topsoil could move into the stream channel. This would result in an adverse impact to surface water quality. For this reason, additional mitigation measures are recommended in Section 3.4.4.

As proposed in the Reclamation and Closure Plan, topsoil stockpiles would be located northwest of the Carlota/Cactus pit and adjacent to the Powers Gulch diversion. Although these are preliminary locations, stockpiles near the diversion would be subject to erosion hazard from flooding and maintenance traffic. The loss of topsoil resources from stockpiles would be an adverse impact to both surface water and soil resources. For this reason, additional mitigation measures are recommended in Section 3.4.4.

There are specific features of the RUSLE that are relevant to its application for this project. First, it can be used as a predictive tool to compare the relative effects of certain land management practices on soil losses from sheet and rill erosion. The numerical results do not predict actual erosion losses in a quantitative sense, unless an extensive site-specific calibration and testing effort has been undertaken. The program has not been implemented in this way for the project area. Second, the results indicate the amount of soil removed from a slope rather than the amount of sediment delivered to a stream, because of the effects of downslope topography, vegetation, and sediment controls. The RUSLE is site-oriented; it was developed to examine erosion problems and controls at the site of origin, rather than the movement of sediment through the drainage system. Third, gully erosion and the effects of concentrated runoff are not accounted for in the RUSLE. These are often significant problems along roads and drainages and on steep or extensively disturbed sites.

Considering these features of the RUSLE, the predicted erosion losses shown in *Table 3-52* are useful in a comparative sense rather than an absolute sense. Sheet and rill erosion would decrease as a result of mining on the mine rock disposal areas but would substantially increase on the leach pad. Under the severe rainfall conditions common to the project area, topsoil placed on the leach pad sideslopes would be difficult to revegetate under the proposed reclamation program. The sideslopes would continue to erode at near the unvegetated rates, creating an adverse impact. For this reason, mitigation measures are recommended in Section 3.4.4. In addition, gully erosion and critical area conditions (i.e., erosion and sedimentation along roads, drainages, and at the toes of cuts and fills) may further accelerate soil losses. As stated in the Reclamation and Closure Plan, Carlota has committed to employing BMPs in controlling sediment and implementing erosion control measures other than revegetation, as needed. If appropriately implemented and maintained, these activities would mitigate most potential erosion impacts.

Potential Soil Productivity Losses. Long-term soil productivity would be decreased by soil excavation, erosion, compaction from traffic or construction in buffer strips and staging areas, and by losses of microbial populations during a lengthy period of stockpiling. Approximately 221 acres would be affected by traffic and/or light-duty construction activities that would not involve significant removal of soil resources. Compacted and denuded soils remaining in these areas would be subject to accelerated erosion, decreased infiltration and percolation, poorer aeration, and decreased root penetration. The ultimate effect of these factors would be to reduce soil productivity in these areas, with detrimental effects on postmining land uses.

Topsoil would be stockpiled for approximately 20 years. A number of studies have indicated that long-term stockpiling creates conditions detrimental to soil microbial populations (Reeves et al. 1979, Rives et al. 1980). In addition, plant growth media developed from disturbed wastes typically have reduced populations of soil biota needed for the successful establishment of desirable vegetation (Miller 1979, Reeves et al. 1979, and Fresquez and Aldon 1984).

There is a potential for soil productivity impacts associated with these conditions to occur at the project site. For example, the beneficial effects of nitrogen-fixing microorganisms on plant production have been documented (Buckman and Brady 1969). These organisms can be sensitive to acidity and low macronutrient availability, conditions that may occur on the disturbed site. In addition, an association with fungi is necessary for optimum growth and possibly even survival for the majority of plant species, especially in arid and semi-arid areas (Miller 1979). The lack of appropriate fungal populations appears to favor invasion by undesirable plants. If left unaddressed, microbial conditions and the potential presence of highly competitive undesirable species would inhibit the re-establishment of desirable, successional plant communities for a number of years following revegetation efforts (Reeves et al. 1979), which would result in an adverse impact.

On areas to be reseeded, soil productivity impacts could be successfully mitigated by Carlota's commitment to test and amend plant growth media (including replaced topsoil) as prescribed in the Reclamation and Closure Plan. If necessary, the addition of organic matter, fertilizer, and microbial inoculants would largely mitigate the effects of long-term topsoil stockpiling. Soil productivity would be largely restored on approximately 54 acres of the flatter top surface of the leach pad, where topsoil replacement would occur, and on 221 acres of buffer zones. However, if not protected, predicted erosion losses on approximately 216 acres on sideslopes at the leach pad would severely limit soil productivity at that location. Successful reseeding and appropriate seedbed amendment efforts on approximately 447 acres of the mine rock disposal areas, roads, and pit backfill would mitigate productivity losses on those areas. On other areas, soil productivity would be adversely affected where seedbed amendment and reseeding are not undertaken, such as on the sideslopes of mine rock disposal areas and pits. These areas would comprise approximately 490 acres. However, portions of this area may be suitable habitat for relocating the endangered Arizona hedgehog cactus.

Potential Impacts from Acid Mist. Based on project-specific air quality modeling and other analyses described in Section 3.1, Air Resources, no adverse impacts to soil resources are anticipated from acid mist or deposition.

<u>Potential Reclamation Impacts</u>

Erosion and Sedimentation. Sheet and rill erosion on roads and gully erosion alongside roads can be significant features of mining projects during operations. This erosion is primarily caused by the erodibility of road surfaces built from compacted native materials and the concentration of runoff from the road and contributing watershed into roadside ditches and culverts. Off-site impacts potentially resulting from such conditions are related to the erosion and sedimentation of watercourses from concentrated flows and the deposition of eroded material. On-site impacts could occur at areas such as unprotected culvert outfalls, where concentrated flows scour material from around the outfall. Locations especially prone to such impacts include areas where culvert pipes are suspended above channels.

Without Carlota's commitment to control drainage, erosion, and sedimentation, these impacts could occur during operations on the project area, particularly along the proposed well field access road, the main haul roads near the Eder pits and mine rock disposal area, and along the mine shop and the southeastern side of the Main mine rock disposal area. All of these configurations drain to a major channel; the Eder road system drains to the proposed Powers Gulch diversion, and the others drain to Pinto Creek.

Drainage and sediment controls for such road systems are addressed in the proposed action. Adverse impacts to surface drainages would therefore be minimized. Additional erosion and sedimentation considerations are discussed in Section 3.3, Water Resources.

The postclosure inspection and maintenance of the Pinto Creek and Powers Gulch diversions and the sediment control structures around the proposed Main mine rock disposal area should be addressed in the proposed action. Postclosure inspection and maintenance activities would be necessary for a period of time until reclamation has been deemed successful. These activities could prevent the long-term failure of the diversions, which otherwise could create extensive erosion and sedimentation impacts downstream and could affect on-site reclamation efforts, resulting in adverse impacts. Therefore, monitoring and mitigation measures are recommended in Section 3.4.4.

A review of the Main mine rock disposal area design (Call and Nicholas 1992) did not indicate that seismic considerations were factored into the proposed design. Mass stability analyses were based on unsaturated, free-draining conditions within the mine rock disposal area. Reasonable construction, drainage, and monitoring recommendations were provided to encourage these drainage conditions (Call and Nicholas 1992).

Since mine rock materials are likely to be coarse, the amount of sediment yielded to a stream from a failed mine rock face is not expected to be large, although some fine sediments would be transported downstream. The stability of the mine rock disposal area surface would be compromised to a limited degree. If failure was extensive, rejuvenation of erosional conditions on the surface could affect long-term stabilization and revegetation until equilibrium is reached. However, even if such a slope failure occurred, it would probably affect only a limited area. Assuming that streams or diversion channels were not blocked by a mass failure, potential impacts from slope failure of a mine rock area would be considered minor from a reclamation standpoint. Further discussions of mine rock disposal area considerations are presented in Sections 3.2, Geology and Minerals, and 3.3, Water Resources.

Restoration of Productive Postmining Land Uses. Potential impacts to the restoration of productive land uses may result from certain activities and conditions associated with the proposed action. These impacts would mainly result from the proposed postmining topography. The proposed methods, materials, and locations of revegetation efforts would also influence the success of reclamation.

<u>*Extent*</u>. A large amount of the postmining configuration would consist of steep slopes and pits. These areas would comprise approximately 490 acres. This

acreage is characterized primarily by steep backfill slopes and pit walls at the Eder and Cactus/Carlota pits and angle-of-repose slopes at the mine rock disposal areas. This acreage would not likely support adequate vegetation or present adequate topography for the land use goals identified in Chapter 2 unless revegetation efforts and stable, suitable plant growth media could be employed.

The Reclamation and Closure Plan does not describe any revegetation efforts on the areas mentioned above because the steep, rocky slopes would prevent equipment access if common revegetation practices were attempted. In general, low water-holding capacity, low fertility, and rapid drainage would be typical of the materials on the mine rock disposal areas and pit backfills. Given the high-energy rainfall common to the region, microsites where plant-growth media does occur would be exposed to considerable splash erosion. These conditions would severely limit the potential for successful re-invasion by desirable vegetation on these sites.

The Carlota/Cactus pit would be partially backfilled, which would recreate approximately 21 acres of relatively flat surface on top of the backfill that could be revegetated. Generally, the remaining part of the backfill would be at angle-of-repose. An additional 27 acres of the pit area would be composed of accessible benches near the diversion that could be reclaimed. Approximately 33 acres of the Eder pits would consist of backfills that could be reclaimed. Approximately 286 acres remaining within pit footprints would not be reclaimable in the proposed postmining configuration. This area (which is included in the 490 acres of steep slopes and pits) would be too steep for revegetation efforts. It may be suitable for Arizona hedgehog cactus relocation or other specialized postmining uses, but the capability for typical productive uses would be highly restricted.

In addition, patented lands currently exist within the project area, and the possibility exists for additional lands to be patented over the life of the project. The commitment to reclaim all patented lands to the same level as public lands within the project area is not specifically defined in Carlota's Plan of Operations documents since the Plan of Operations is only applicable to the surface use of National Forest System lands. Project components proposed on existing patented lands include the administration building and parking lot; the Pinto Creek diversion channel; the eastern half of the Carlota/Cactus pit; parts of the mine shop area, Main mine rock disposal area, and associated sediment controls; haul road; and main access road. Reclamation activities are proposed for these components; however, reclamation on patented lands falls under the jurisdiction of the State of Arizona Mine Inspector's Office, rather than the Forest Service. Carlota has submitted a reclamation plan to the State of Arizona Mine Inspector's Office and will be bonded for this reclamation.

<u>Revegetation Materials and Practices</u>. A major goal of the reclamation program is to revegetate suitable disturbed areas and restore forage production and wildlife habitat land uses. The types of premining vegetation communities include interior chaparral, rubbleland chaparral, dry-slope desert brush, juniper/grassland, and riparian (Cedar Creek Associates, Inc. 1994a). Shrubs and low-growing trees, such as scrub live oak, pointleaf manzanita, and junipers, dominate the project site.

The proposed revegetation composition on the disturbed areas would involve three mixes of plant species. These would consist of Seed Mixes L (for the leach pad), R (for mine rock disposal areas and other areas), and S (for topsoil stockpiles), as presented in Section 2.1.9, Alternatives Including the Proposed Action - Carlota's Proposed Reclamation and Closure. The mixes would be subject to modification as the project and its associated reclamation needs evolve. The proposed mixes consist primarily of native and introduced grasses, accompanied by lesser amounts of shrub and forb species.

In general, the highest proposed seeding rates are for weeping lovegrass and yellow sweetclover, two commonly used species for revegetation and erosion control. An annual grass, red brome, is also included in the proposed seed mix for the leach pad. The lovegrasses, yellow sweetclover, and red brome are particularly competitive, aggressive species that tend to dominate sites where they are seeded and are not especially compatible with native species in seed mixtures (Wasser 1982, Reichenbacher 1994). High seeding rates for these species relative to more desirable species in the mixes would inhibit the redevelopment of successional plant communities on the site. In addition, galleta, a species proposed for the leach pad, is widely acknowledged to have very low seeding success (Moore 1994). Because these approaches could adversely affect restoration of productive postmining land uses, mitigation is recommended in Section 3.4.4.

It should be noted that Executive Order 11987 (on exotic organisms) limits the use of non-native revegetation species; therefore, native species are recommended. Introduced plant species should be used only for specific purposes and if suitable native species are unavailable.

The use of weeping lovegrass in Seed Mix S may be suitable for providing short-term stability of soil stockpiles, but it is not recommended for long-term rehabilitation uses unless no other species is suitable because it inhibits the re-establishment of native species. Annual oats can spread to adjacent areas and become a weed problem. Similarly, Lehmann's lovegrass and red brome spread aggressively and compete with more desirable species.

Although seeding methods and seasons are not specified in the Reclamation and Closure Plan for the proposed action, Carlota has made a commitment in the Reclamation and Closure Plan to discuss these considerations with the Forest Service and additional agencies. It is assumed that these discussions would result in appropriate seeding methods and planting seasons, and therefore no impacts would result from these factors. However, further specifications of seeding methods and seasons are needed to improve the potential for successful revegetation, to schedule revegetation activities, and to calculate the reclamation bond.

Mulching is suggested as a conceivable application in the Reclamation and Closure Plan. In areas to be reseeded without topsoil replacement, several studies have indicated that incorporating a usable source of organic carbon into the seedbed may significantly improve the establishment of desirable plants (Fresquez and Lindemann 1982, Lindemann et al. 1984, Lindsey et al. 1977). Given the length of time for topsoil stockpiling, organic amendments also would probably be beneficial in restoring microbial populations in topsoil.

Such organic sources would include hay or straw mulches or manure. In addition to erosion control and moisture-related benefits, these materials can provide an energy source for microbial activity and, in turn, improve nutrient uptake by desirable plants. The application of supplemental nitrogen and phosphorus fertilizers are typically beneficial in mulched conditions. Carlota has committed to applying seedbed amendments after they are prescribed from test program results. Details of the test program, and names of participants in its implementation and the interpretation of results, would be defined later with the Forest Service during the project.

Suitable implementation of the testing program, and subsequent application of its results, is a significant part of the project. It is likely that without mulches and tackifiers or erosion control netting or matting on topsoiled slopes, soil erosion impacts would result from intense storm events. In addition, without mulching and other amendments, major adverse postmining land use impacts could occur if revegetation efforts fail on approximately 663 acres where topsoiling is not proposed or may not remain stable. This area includes approximately 447 acres of flatter surfaces on components other than the leach pad and approximately 216 acres of steeper slopes on the leach pad where replaced topsoil would be more likely to erode.

Public Safety and Demolition/Removal of Facilities and Infrastructure. According to the proposed action, Carlota would minimize physical hazards using measures such as berming, fencing, or filling, depending on the specific perceived hazard. Public access to the pits would be blocked by a substantial rock berm. A barbed-wire or chain-link fence would be erected to provide additional protection against entry, if directed by the Forest Service. Weather-proof "dangerous condition" signs, as required by state statute, would be posted at intervals along the rock berm to provide notice to the public. Postclosure maintenance of fences and signs is not addressed in the proposed action.

Currently, the primary safety hazard that would exist as a postmining feature is the proposed Carlota/Cactus pit. The remaining open pit would present some degree of hazard to wildlife and the public. Pit walls are located approximately 0.5 mile west of a well-traveled Forest Service road. Control of access to the pit and the lower reaches of Pinto Creek via the remaining diversion should be specifically addressed in the Reclamation and Closure Plan. In addition, mass stability considerations and a postclosure period of pit wall monitoring should also be addressed because pit access and stability would influence the location of protective berms and safety benches. The nature of pit wall stability considerations is further discussed in Section 3.2, Geology and Minerals. Failure to address these factors would create wildlife and public safety impacts. As a result, additional mitigation is recommended in Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures, and in Section 3.2, Geology and Minerals.

The Reclamation and Closure Plan states that building and infrastructure components would be dismantled and disposed of off the site in accordance with all applicable federal, state, and local laws, regulations, rules, and ordinances (Carlota 1994a). After closure, no chemical or electrical hazards would remain. Foundations would be buried in place. Building sites would be ripped to reduce compaction and then seeded with an approved seed mix (Carlota 1994a).

Forest Service policy stipulates that foundations will be removed. Burial of foundations in place could create adverse impacts from long-term releases of process-related substances remaining in foundation materials or to public safety should the buried materials become exposed over time. Because of this, additional mitigation is recommended in Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures.

Approximately 160 acres of roads would exist under the proposed action. Portions of roads that are proposed to remain for permanent access after operations are shown on the postmining topography map (*Figure 2-13*). These road portions involve the main access road, the road to the leach pad and the SX/EW plant, and road sections in the Eder area. These areas, comprising approximately 19 acres, would remain to allow postclosure inspection and monitoring.

The proposed reclamation of other roads would entail ripping and seeding the road surfaces. In addition, downhill fill or slopecast materials would be broadcast-seeded. Natural drainage patterns would be reestablished as much as possible, and water bars or other sediment controls would be constructed as needed. If roads that are planned for postclosure access are wider than necessary, a portion of the road width would be reclaimed in the manner described above. Tonto National Forest policy, as established in the Resource Access and Travel Management Plan (USDA Forest Service 1990), provides options for closure that are based on resource management objectives and needs. The options include passive closure, barrier construction, or obliteration. Based on the potential for postclosure soil and erosion impacts, public safety concerns, and the presence of actual or potential habitat for an endangered plant species, obliteration best meets management needs. Therefore, additional mitigation is recommended in Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures. It is anticipated that after all roads are successfully reclaimed, potential soil and erosion impacts would be minimal. The proposed reclamation and closure of access roads and haul roads, as defined in Section 2.1.9.2, Roads, Conveyor Routes, and Yards, could lead to potential soil and erosional impacts and subsequent long-term erosion and sediment transport if inspection and maintenance activities are inadequate. Because of the potential need for postclosure maintenance, additional mitigation is recommended. Additional information regarding Forest Service approval of final road configurations is presented in Section 3.13, Transportation.

Control and Removal of Hazardous Materials. According to the Reclamation and Closure Plan, no chemical or electrical hazards would remain on the site after closure, including chemicals in process tanks, piping, or other containers. No impacts would occur from these sources after successful closure and reclamation efforts.

An additional consideration involves closing and reclaiming the leach pad. This component presents a potential long-term toxic materials hazard. In order to limit infiltration and subsequent seepage outflows, the Reclamation and Closure Plan calls for a restrictive layer to be constructed on the leach pad surface. Subsequent reclamation and closure practices on the closed leach pad would involve placing mine rock on top, applying topsoil, and revegetating. Potential damage to the integrity of the restrictive layer may occur during earthmoving operations.

From a reclamation standpoint, the long-term geomorphic and structural stability of the leach pad is an important consideration. An erosion hazard exists from the potential for rills and gullies to form on the sideslopes. Erosional effects on the proposed pad configuration after reclamation could compromise its long-term integrity, creating adverse impacts to downstream resources. Because of this potential, additional monitoring and mitigation measures are recommended in Section 3.4.4.

Postmining Site Stability. Physical site stability considerations include pit wall stability, slope stability at the mine rock disposal areas and leach pad, and accelerated erosion on slopes and at drainage structures. The stability of these facilities would affect the ultimate success of proposed reclamation practices. A reasonable duration of periodic inspection and maintenance would be necessary to ensure the postmining integrity of the site configuration. Adverse impacts would result from failure of diversions, pit wall and pad embankment mass failures, and accelerated surface erosion. While some of these occurrences would be minor, others would create major adverse impacts, depending on their location and magnitude.

Additional discussions of postmining site stability, particularly erosion and sedimentation considerations, are presented in Section 3.3, Water Resources.

Mass movement of a pit wall could remove a section of the protective berm and create a public safety hazard. Additional disturbed area would be added by such an occurrence. Depending on the location, these would probably be minor impacts. However, if the movement occurred along the north or west sides of the Carlota/ Cactus pit, the stability of the Pinto Creek diversion or the leach pad could be compromised, respectively. Failure of either of these components would create an adverse impact. Further discussion of this consideration is presented in Section 3.2, Geology and Minerals, particularly under the topic of slope stability.

At critical areas, accelerated sheet and rill erosion, gullying, and downstream sedimentation may occur after operations without monitoring and maintenance activities. Examples include water bar washouts and erosion along ditches, steep slopes, and at culverts. At locations such as the leach pad and along the main haul roads, adverse impacts would result. Because of this potential, mitigation measures are recommended in Section 3.4.4.

Revegetation Success. Erosion, sedimentation, and land use productivity impacts would continue to occur if revegetation efforts are not successful. The potential for ongoing revegetation costs to both Carlota and the public exist unless reasonable agreed-upon revegetation success standards are in place.

Potentially Hazardous Materials. The operational design and inspection of the leach pad would reasonably ensure its stability. However, the post-mining stability of the leach pad would potentially be affected by slumping and accelerated surface erosion. Potential impacts from slope failures and accelerated erosion would include the spread of potentially toxic materials downslope and into watercourses and the exposure of revegetation seedings to adverse chemical conditions. Carlota has proposed a postclosure monitoring program for water resources (see Section 3.3, Water Resources). An additional discussion of potential hazardous materials considerations is presented in Section 3.14, Hazardous Materials.

Reclamation and Closure Bonding. In accordance with 36 CFR, the Forest Service has the authority to require a reclamation bond for stabilizing, rehabilitating, and reclaiming the area of operations prior to approval of the Plan of Operations. This authority extends only to lands administered by the Forest Service; therefore, elements of the bond required by the Forest Service would only reflect those activities proposed on National Forest System lands. Activities proposed on private lands within the state are subject to bonding requirements under the Arizona Mined Land Reclamation Statutes and Aquifer Protection Program.

Bonding estimates proposed by Carlota and presented in the Reclamation and Closure Plan (Carlota 1994a) reflect general reclamation considerations in response to Forest Service regulations (36 CFR 228.13). Estimates were based on costs that Carlota has calculated for both internal work and subcontracting. They do not cover all the activities detailed in the Plan of Operations that are necessary to adequately close and reclaim the site in accordance with state and federal regulations. In particular, road obliteration and demolition and removal of project facilities, process materials, and equipment are not included in the bond estimates, nor are long-term monitoring and maintenance costs. Closing the leach pad would require expenditures for drain-down and disposal of solutions, recontouring, and placement of a low-permeability zone covered by mine rock. Drain-down of the heap would be necessary as a part of closure activities, and costs for this should be included in bond estimates. Costs for constructing and maintaining protective berms, barricades, and fencing are apparently not included. Furthermore, these estimates do not reflect unit costs as they would be incurred by the Forest Service in the event that the agency had to conduct reclamation activities instead of Carlota. For these reasons, mitigation has been proposed to ensure that the amount of the reclamation bond is adequate (Section 3.4.4, Soils and Reclamation - Monitoring and Mitigation Measures).

3.4.2.2 Alternatives

It has been assumed in the following analysis and discussion that soil salvage, erosion control, and reclamation practices similar to those developed by Carlota in the Reclamation and Closure Plan for the proposed action would be applied to the alternatives.

Mine Rock Disposal Alternatives

Alternative Mine Rock Disposal Sites. The use of mine rock disposal sites at the Cactus Central and Cactus South locations would result in additional disturbance to approximately 44 acres of native soils. Soil removal and reduction in productivity would be potential adverse impacts over this additional acreage.

It is assumed that soil salvage operations would be carried out on the additional mine rock disposal areas. This would create additional resources for reclaiming the leach pad. In the Cactus Central area, which would be on private land, the affected soils would consist of mapping units I, K, L, and O. In the Cactus South area, disturbed soils would consist of mapping units A, H, M, and N. Approximately 29,000 cubic yards of potentially salvageable topsoil exist on these areas, taking into account salvage limitations and transport losses.

Rather than devoting these topsoil resources to reclaiming the leach pad, this volume would be sufficient to replace a depth of approximately 8 inches of topsoil on the flatter top surfaces of these mine rock disposal alternatives. This practice would improve the chances of successful restoration of soil productivity and postmining land uses on these flatter surfaces, which would comprise approximately 27 acres.

Additional Backfill of the Carlota/Cactus Pit. This alternative would create an additional 110 acres of reclaimable area within the proposed pit, representing approximately 56 percent of the entire pit footprint when combined with the 48 acres under the proposed action. Approximately 36 acres of buffer zone would be revegetated as with the proposed action. Additional flat acreage (approximately 43 acres more) would be created on the Main mine rock disposal area as its surface is lowered. These would be beneficial impacts since such surfaces would be more suitable to successful reclamation activities. The erosion potential would also be reduced. Additional pit backfilling would further mitigate potential public safety hazards associated with the pit. The timing of backfill operations would contribute to concurrent reclamation. The potential impacts to soil resources, beyond those of the proposed action, would be negligible. Implementing this alternative would cost approximately $50 to $52 million and would require approximately 190 people for 3 to 4 years.

Additional Backfill of the Eder South Pit. This alternative would create negligible impacts to soil resources beyond those discussed previously under the proposed action. Beneficial effects would result from this alternative in that approximately 42 acres of pit area would be reclaimed (16 acres more than under the proposed action), and the resulting elimination of the Eder mine rock disposal area would increase the available reclaimed area by approximately 33 acres. Thus, an additional 49 acres of land surface would be made more suitable for reclamation activities than would occur under the proposed action.

The estimated cost for this alternative (approximately $2.6 million, requiring 190 personnel for 2.3 months) would be a substantial addition to reclamation costs. However, the commitment of funds, labor, and equipment to this alternative may be achievable.

Eder Side-Hill Leach Pad Alternative

This alternative would disturb approximately 458 acres of soils within the footprints of the pads compared to 270 acres within the pad footprint for the proposed action. However, this alternative would create lesser disturbance associated with the relocated Eder mine rock disposal area. Overall, approximately 134 additional acres of soils would be disturbed by earthwork for this alternative than would be disturbed by earthwork on the proposed pad and Eder mine rock disposal area. This additional disturbance would consist of soil removal and the associated loss of productivity, which would be adverse impacts. Further acreage would be disturbed to a lesser degree in the associated buffer zones around the pads and mine rock disposal area. Approximately 12 fewer acres of alluvial soils, occupied in part by riparian habitat, would be disturbed under this alternative than in the proposed action.

The affected soils would consist of mapping units C, E, U, and V. Additional topsoil resources consisting of approximately 33,600 cubic yards could be salvaged from these units under the pad footprints. In addition, approximately 43,400 cubic yards would be available from the relocated Eder mine rock disposal area. Soils that would be disturbed to a lesser degree than in the proposed action consist of mapping units A, H, I, P, Q, R, and S. A decrease of approximately 56,500 cubic yards of potentially salvageable topsoil would be available from these units under this alternative as opposed to the proposed action. Overall, approximately 20,500 cubic yards of additional topsoil would be salvageable under this alternative as opposed to the proposed leach pad configuration. This would be adequate to restore 5 to 6 inches of topsoil on the additional disturbed area.

The alternative leach pad configuration would modify the postmining topography from that of the proposed action. Approximately 54 acres of flatter area on top of the proposed pad would be lost under this alternative, but approximately 20 acres of flatter surfaces would be created on the relocated Eder mine rock disposal area. Thus, a net 34 acres of flatter surface area would be lost under this alternative. The reclamation configuration would consist of steep slopes throughout the leach pad area. The erosional instability of these slopes, and the questionable long-term geotechnical stability of associated embankments, would inhibit reclamation success. Major adverse impacts could result. Monitoring and mitigation measures would be the same as those recommended for the proposed action.

Water Supply Alternative

Minimal impacts to soils would result from these alternatives, which would be similar to the water supply component of the proposed action. This conclusion assumes that the similar reclamation and erosion control practices outlined for roads in the Reclamation and Closure Plan would be implemented for pipeline and access road disturbances associated with these alternatives.

Alternative Water Supply Well Field Access Roads

Two alternative routes are being considered to access the water supply well field. Alternative A would involve upgrading the existing access road located within the Pinto Creek channel for approximately 1.9 miles. Alternative B would involve constructing 1.2 miles of new road and using 2.6 miles of existing roads. Minimal impacts to soils would result from these alternatives. This conclusion assumes that the reclamation and erosion control practices outlined for roads in the Reclamation and Closure Plan would be implemented. However, any unprotected low-water crossing would create a channel and bank stability impact for which additional mitigation is recommended.

Erosion and sedimentation considerations for the well field access road alternatives are discussed further in Section 3.2, Geology and Minerals.

No Action Alternative

No impacts to soils would result from the no action alternative.

3.4.3 Cumulative Impacts

The proposed Carlota Copper Project would affect approximately 1,428 acres of watershed area within the Pinto Creek watershed (approximately 2.2 square miles). The overall watershed is approximately 178 square miles, and approximately 5 square miles of the watershed have already been affected by existing mining operations. These areas include open pits; several tailings ponds; and associated roads, power lines, and wells. Assuming that successful reclamation and closure activities are carried out as described in the Reclamation and Closure Plan and mitigation sections of the EIS, cumulative impacts to soils from the project would not be significant (Carlota 1994a).

3.4.4 Monitoring and Mitigation Measures

In addition to measures identified in the Reclamation and Closure Plan (Carlota 1994a), and in the *Plans of Operations* (Carlota 1992, 1993a), the following measures are recommended to reduce the potential for impacts to soil resources and to comply with Forest Service regulations.

3.4.4.1 Soils

SR-1: Carlota proposes to salvage approximately 460,000 cubic yards of material from slopes with grades up to 30 percent. By salvaging suitable soils and extending equipment operations onto slopes up to 40 percent, a total of approximately 602,000 cubic yards of topsoil could be replaced. (These figures include 15 percent transport losses and the use of salvageable materials in leach pad construction.) Site-specific criteria for soil salvage are shown in *Table 3-53,* and potentially additional salvage volumes based on these criteria are presented in *Table 3-54.*

Safety and operational constraints would be recognized when salvaging suitable soils on slopes approaching 40 percent. In the sequence of salvaging suitable soils on the footprint of the leach pad and pond areas, preference would be given to achieving the volumes of fine-grained material necessary to reach the design criteria for the liner subgrade. During construction and operation, efforts would be made to maximize soil salvage and minimize excavation and transport losses of soil materials. Materials collected from sediment control structures over the life of the project and salvageable soils from buffer areas subject to disturbance from excavation or fill would be added to the salvage program in order to maximize volumes. Alternative means of increasing topsoil salvage, such as identifying new sources of borrow materials (sources not currently known or available), for leach pad construction would be evaluated as part of the Topsoil Management Plan (see SR-2).

SR-2: Topsoil stockpiles would be located in protected sites approved by the Forest Service. Carlota would include in the final Plan of Operations a Topsoil Management Plan that would detail the stockpile locations, stockpile volumes, footprint acres of the stockpiles, and planned locations and volumes for re-application. The plan would be revised annually to show the subsequent increase or decrease of the volumes in the stockpiles. The plan would include a seed mix used for protecting soil materials. The seed mix would be approved by the Forest Service. The Topsoil Management Plan would also outline the BMPs to minimize salvaged topsoil loss and to maintain soil fertility. These BMPs may include, but are not limited to, a variety of traditional mechanical and non-mechanical methods, including silt fences; crimped mulch; soil amendments, including bacterial/fungal inoculates; hydroseeding; hydromulching with tackifiers; and surface scarification to retain moisture. Testing and application of non-traditional BMPs would also be considered but would be subject to approval by the Forest Service. BMPs that evolve with future technology would also be considered and would be subject to testing and approval. The Topsoil Management Plan would also outline periodic inspections, reporting requirements, and practices to ascertain the stability and success of reseeding/revegetation to stockpiles.

SR-3: Carlota proposes to replace topsoil only on the leach pad. At closure (and for concurrent reclamation during mine operation), the Forest Service, in consultation with Carlota, would review and evaluate reclamation priorities for topsoil placement and the potential for placement of excess topsoil on other areas proposed for revegetation in order to improve the probability of success. Such replacement could be achieved by implementing Mitigation Measures SR-1 and SR-2 and distributing topsoil appropriately between proposed project components. This measure

Table 3-53. Project-Specific Soil Salvage Criteria[1]

Characteristic	Topsoil Suitability Rating			
	Good	Fair	Poor	Limitation
Slope %	<10	10-40	>40	Slope
Rock Outcrop %	<10	10-20	>20	Rock Outcrop
Depth to Bedrock, inches	>20	10-20	<10	Depth to Rock
Coarse Fragment Content, % by Volume	<25	25-50	>50	Stoniness
Soil Texture	Those not rated fair or poor	Loamy Sand, Clay Loam, Silt Loam, Silty Clay Loam	Sand, Sandy Clay, Clay, Silty Clay, Silt	Texture

[1] Based on dozer/truck/shovel equipment availability as indicated in the Plan of Operations (Carlota 1992)

would contribute to increasing the revegetated land use base. Microbial conditions would be improved in the restored topsoil using bacterial and fungal inoculants or other seedbed amendments as available.

<u>SR-4:</u> Prior to initiating construction or reclamation of project components, Carlota would conduct an analysis of BMPs for surface erosion. Subject to Forest Service approval, appropriate BMPs would be selected to prevent excessive erosion. Erosion control practices would be designed to be consistent with existing or postmining topography, to facilitate and improve revegetation efforts, to minimize surface and ground water impacts, to control surface drainage, and to provide overall stability of the site(s). Erosion practices for this mitigation measure are described below:

- During final reclamation of the leach pad, graded slopes would be evaluated for placement of slope breaks and mulches to reduce accelerated erosion to within soil tolerance limits (Soil Conservation Service 1983) or other levels approved by the Forest Service. Slope breaks could consist of permanent features that would minimize downslope runoff energy as a means of controlling erosion. In addition, the slope breaks would be designed on a gentle gradient across the leach pad slopes to maintain free drainage of surface flow and to minimize infiltration into the pad. Flow paths would be stabilized by riprap or vegetation. Leach pad and pond materials would not be moved off of the liner system as a result of recontouring until these materials have been treated and determined to be neutralized.

  Depending on the soil water-balance relationships and the make-up of the seed-bed/rootzone material of the topsoil to be placed on the leach pad at final configuration, other techniques to achieve erosion control and/or water harvesting would also be evaluated. These techniques may include contour furrowing, moonscaping, gouging, land imprinting, basin blading, terracing, or cat tracks along contours.

  Because of intense rainfall in the area, mulches would be evaluated for use on all disturbed areas to be revegetated. Mulches may consist of hydromulches with tackifiers on slopes, straw mulch embedded into the soil mantle with crimping disks, or other techniques approved by the Forest Service.

- Implementation of BMPs for surface drainage control on roads and associated disturbances would be conducted in coordination with the Forest Service and would be subject to Forest Service approval. These BMPs would include (but would not be limited to) such techniques as interim revegetation, construction of waterbars/rolling dips on non-engineered roads, road sloping/crowning, inboard ditching, crown ditching, berm breaks with energy dissipaters, culvert installation with energy dissipaters, straw bale sediment barriers, sediment traps/catch basins, vegetated buffer strips, silt fence/filter

Table 3-54. Recommended Salvageable Topsoil Volumes[1]

	Salvage Volume: YD3																								
Mine Component	Soil A	Soil B	Soil C	Soil D	Soil E	Soil F	Soil G	Soil H	Soil I	Soil J	Soil K	Soil L	Soil M	Soil N	Soil O	Soil P	Soil Q	Soil R	Soil S	Soil T	Soil U	Soil V	Soil W	Soil X	Total YD3 Per Component
Carlota/Cactus Pit							85,896		11,418	26,676	33,348					19,996									177,334
Main Rock Dump							20,684																		20,684
Leach Pad and Pond								22,329	8,765							101,303	49,336	26,896		160,032		93,843			462,504
Mine Access Road																									
Admin. Bldg and Parking																									
Ore Stockpile																12,154									12,154
Mine Shop/Warehouse																									
SX/EW Plant																	2,040	4,360							6,400
Raffinate Pond																									
Cactus SW Rock Dump								29,635																	29,635
Powers Gulch Diversion								25,254														31,812			34,066
Eder North Pit																					6,939	3,341			10,280
Eder High-Grade Pit																									
Eder South Pit																					20,126				20,126
Eder Rock Dump																						92,325			92,325
Eder Roads								8,626														51,466			54,153
Carlota/Cactus Pit; Leach Pad Haul Roads							7,123	3,473								3,959	1,425								15,980
Eder Access Road																									
Road to Cactus SW Dump							3,611																		3,611
TOTAL							117,314	60,376	20,183	26,676	33,348					137,413	52,801	31,256		160,032	27,065	272,788			939,250
Assume that one half of salvageable volume from the Leach Pad goes to construction use																									<231,252>
TOTAL																									707,998
Assume 15 percent losses in handling, storage																									<106,200>
GRAND TOTAL																									601,798

[1] Based on project review and salvage of some units from steeper slopes (up to approximately 40 percent slopes)

fence, brush sediment barriers, soil stabilization filter strips, and other BMPs that evolve with future technology.

Additional erosion and sedimentation measures are presented in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

3.4.4.2 Reclamation

SR-5: Areas receiving final reclamation would be evaluated after the third growing season to determine if the reclamation practices achieve the reclamation performance standards. Should success criteria continue to meet with failure following two additional good faith attempts, including the best reclamation technology available, then alternative measures for determining revegetation success would be evaluated. Such alternative procedures would require the approval of both Carlota and the Forest Service.

SR-6: As much concurrent reclamation would be incorporated into proposed project operations as possible. Related activities would include mulching and reseeding unused traffic and buffer areas and cuts and fills along roads; rip-rapping and maintaining culvert inlets and outfalls; and appropriately using and maintaining water bars, silt fences, check dams, and straw bales throughout the life of the proposed project. Additional concurrent reclamation would be implemented once mining activities are completed for a certain area.

SR-7: All building and facility foundations would be removed and disposed of in accordance with appropriate regulations.

SR-8: In order to estimate the amount of the reclamation bond necessary to comply with all reclamation measures on National Forest System lands, specific measures need to be defined and associated costs determined in detail. The existing bond estimate would be revised by the Forest Service accordingly. Annual reclamation meetings would be held between Carlota and the Forest Service to discuss any changes in reclamation scheduling or methods and to review the bond for adequacy. The bond would be adjusted to conform to the operations as necessary throughout the life of the project. Similar bonding and review would be implemented in accordance with applicable state regulations for project disturbances located outside National Forest System lands.

Proposed bond estimates would include, but not be limited to, removing and disposing of buildings and appurtenances, reclaiming roads as specified in SR-15, leach pad draindown, leach pad contouring and covering, specific seedbed amendments, specific seeding and planting methods, and administrative costs for monitoring and maintenance.

SR-9: A defined closure and reclamation timetable would be prepared by Carlota and implemented by activity in order to organize and encourage a successful sequence of erosion control, recontouring, topsoiling, seeding, and maintenance. The schedule should reflect the approximate progress of reclamation activities, both concurrent and postmining, in relation to project operation and closure activities. In accordance with 36 CFR 228.8(g), all reclamation activities would commence within 1 year of conclusion of operations.

SR-10: The schedule and location of the revegetation testing program proposed by Carlota would be defined during the construction and initial operation phases to keep from delaying reclamation efforts. A detailed plan has been developed and is presented in the Biological Monitoring & Mitigation Plan (Cedar Creek Associates, Inc. 1996a). As indicated in this plan, testing would involve the dominant seedbed/rootzone materials, particularly with regard to pH and texture, that are anticipated on the final project configuration. Testing would be conducted in order to refine performance standards that would be used as monitoring tools and measures of success after revegetation efforts. Reclamation performance standards have been developed as success criteria in the Biological Monitoring & Mitigation Plan (pages 41-48). The release of the reclamation bond would depend on meeting these performance standards. Annual reports of testing efforts would be provided to regulatory agencies.

SR-11: The types and application rates for seedbed amendments (including microbial inoculants) would be incorporated into the revegetation testing program, and their effectiveness would be identified to the extent possible before they would be used. Regional experts specializing in revegetation of disturbed lands should be used as available from the ADOT, nearby mining projects, the Natural Resources Conservation Service, the Agricultural Research Service, and research studies (Brooks 1993). For example, agency personnel in the region indicate that hydromulches and tackifiers, straw mulches, and adapted native seed species (including shrubs) are common reclamation practices in the area (Taylor 1994). These sources of information should be used early in the reclamation planning and permitting process to define revegetation approaches before they are needed, to develop bond estimates, and to eventually arrange for materials and services. Subsequent field tests and sampling during the project can be used to refine the seedbed amendment program and bond estimates, if necessary.

SR-12: Drilling, broadcasting, and hydroseeding are mentioned as potential methods in the Reclamation and Closure Plan; however, the actual methods of reseeding the various project components would be further defined prior to implementation to include the planned extent and location of these candidate methods. These factors would affect bond estimates and the likelihood of successful revegetation efforts. Seed drilling would be undertaken on all relatively flat surfaces to be revegetated and along suitable roads and drainageways.

SR-13: The proposed seed mixes are subject to substitutions and modifications, as appropriate to evolving project needs, new technology, and materials availability over the life of the project. As described in the Reclamation and Closure Plan, all substitutions would be comprised of locally native plants where feasible. In order to accomplish land use goals, revegetation testing and applications would concentrate on the replacement of native grasses, forbs, shrubs, and trees. For shrubs and trees (e.g., juniper), both seeding and planting containerized nursery stock would be considered in the testing program and for application. Seeding and planting taller species in clumps or pods would improve cover diversity for wildlife. Red brome, weeping lovegrass and Lehmann lovegrass, oats, and galleta may be removed from proposed species lists and substituted with desirable species with reasonable chances of establishment. The use of yellow sweetclover may be necessary; however, its use should be minimized in favor of adapted native species that are compatible in mixtures. Additional forb species will be investigated, and all leguminous species should be inoculated with appropriate bacteria.

SR-14: Additional monitoring and maintenance would be required for the reclamation program, portions of which would be determined during the testing program. Such efforts would involve a team of Carlota and agency personnel over a period of several years until reclamation is deemed successful. Another key consideration would be the success of revegetation and erosion control efforts and the repair or replacement of related reclamation features as necessary. Protection of seeded areas from wildlife and livestock may be necessary until vegetation is established and erosion control is accomplished. This would be critical for the heap-leach pad. Administrative costs for overview of reclamation monitoring and maintenance would be included in bonding estimates. Public safety issues would be addressed and resolved throughout the life of the project. Specific postclosure issues, such as safety around open pits and highwalls, would be addressed at the time of closure. Protective perimeter berms and fences would be moved or maintained as necessary to preclude public access, to the extent practicable. In accordance with 36 CFR 228.11, Carlota would maintain fire prevention programs, firefighting capabilities, and fire notification protocols until reclamation and closure were deemed successful by the agencies.

Additional monitoring and maintenance measures related to erosion and sedimentation are recommended in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

SR-15: With the exceptions of the roads in the pits, roads designated for future used by the Forest Service, and roads identified for specific reclamation prescriptions, all roads (located on lands administered by the Forest Service) constructed or impacted by this project for the purpose of exploration activities (existing and proposed), mining activities, and access in support of general mine activities (including access to the well field or alternative water sources) would be closed to normal vehicular traffic. Culverts would be removed; cross drains, dips, or water bars would be constructed; the road surface would be shaped to as near a natural contour as possible (full recontouring); and the road would be stabilized. To facilitate the goal of long-term, maintenance-free reclamation practices, the end product of final reclamation and closure for all roads no longer needed for operations (as defined above) is to shape to as near natural contour as possible, revegetate to meet Reclamation Performance Standards, and be stabilized to minimize erosion and sediment transport. Roads to be left open for future use or existing roads that were impacted by this project (those that would exist after operations) would be stabilized to minimize erosion and sediment transport.

SR-16: The impoundment area created by an embankment on Powers Gulch upstream of the leach pad would be backfilled with suitable waste rock, and a drainageway would be recreated for surface flows to ensure they would not impinge on the pad. The area between the leach pad and the embankment would also be lined and backfilled to improve the postmining stability of the components. Backfilled material would be revegetated. This mitigation measure would enhance the postmining stability of the leach pad and diversion inlet area beyond what is provided by the proposed action.

3.4.4.3 Additional Mitigation for the Alternatives

Mitigation measures for all of the alternatives would reflect the same content and objectives as those described for the Proposed Action. Reclamation bond estimates would be revised in accordance with SR-8 for any selected alternatives.

3.5 Biological Resources

3.5.1 Affected Environment

3.5.1.1 Terrestrial Resources

Terrestrial resources discussed in this section of the EIS include the existing vegetation and wildlife in the Carlota Copper Project area. The discussion of special status species includes species that have been recognized by the U.S. Fish and Wildlife Service, the Tonto National Forest, and the Arizona Game and Fish Department as meriting special management consideration because of their rareness or vulnerability to threats. Field survey procedures and the delineation of the vegetation in the project area are discussed in the Vegetation and Wildlife Technical Memoranda prepared for the Carlota Copper Company to provide additional data on project area resources (Cedar Creek Associates, Inc. 1994b, 1994c).

Eight terrestrial species listed or proposed for listing as federally endangered or threatened by the U.S. Fish and Wildlife Service are addressed in this document; 30 other terrestrial species of concern are also discussed (*Table 3-55*). These species are listed as (1) federal "Candidate" species for listing as threatened or endangered by the U.S. Fish and Wildlife Service, (2) Forest Service "Sensitive" species, (3) state listed or candidate threatened native wildlife, or (4) former C2 candidates listed by the U.S. Fish and Wildlife Service. A summary of each species' known or potential occurrence in the project area is provided in the following sections. Further discussion of species of concern is provided in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

On April 26, 1996, the U.S. Fish and Wildlife Service issued its Biological Opinion (included in Appendix F) regarding the effects of the Carlota Copper Project on listed taxa. The Biological Opinion stated that "...the Carlota Copper Project, as proposed, is not likely to jeopardize the continued existence of the lesser long-nosed bat or Arizona hedgehog cactus. No critical habitat has been designated for these species, therefore, none will be affected" (USDI Fish and Wildlife Service 1996).

<u>Vegetation Communities</u>

Habitat Types. Five separate vegetation associations were identified in the project area:
(1) interior chaparral, (2) rubbleland chaparral, (3) dry-slope desert brush, (4) juniper/grassland, and (5) riparian. Outside of the riparian corridors, all habitat types are collectively referred to as upland habitats. Upland and riparian habitats are briefly described in the following subsections. Further discussion of these habitat types is provided in the Vegetation Technical Memorandum (Cedar Creek Associates, Inc. 1994b). The acreage and percentage of the project area associated with each vegetation type are indicated in *Table 3-56*. The locations of individual vegetation types are shown in *Figure 3-25*.

<u>Interior Chaparral</u>. Interior chaparral in the project area is typical of that described in Brown (1982). The vegetation is composed of relatively dense stands of closed-canopied evergreen shrubs of uniform height. It is the most extensive vegetation type in the project area (1,532 acres, or 49.5 percent of the project area, *Figure 3-25 and Table 3-56*). This vegetation type is located along all slopes, aspects, and topographic positions, except some of the drier south-facing slopes. Dominant species of this community include one-seed juniper (*Juniperus monosperma*), pointleaf manzanita (*Arctostaphylos pungens*), and shrub live oak (*Quercus turbinella*). Birchleaf mountain mahogany (*Cercocarpus betuloides*) and sugar sumac (*Rhus ovata*) are also present but in lesser numbers. Herbaceous ground cover is sparse. Ground cover for all types of plants in chaparral averages 75 percent but reaches values as high as 100 percent in the densest stands (Cedar Creek Associates, Inc. 1994b). At higher elevation sites, some elements of Madrean evergreen woodland are present on mesic, north-facing slopes in the southern portion of the project area. The most common Madrean species are Arizona piñon (*Pinus fallax*), Arizona white oak (*Quercus arizonica*), and Emory oak (*Quercus emoryi*).

<u>Rubbleland Chaparral</u>. Rubbleland chaparral is a variant of interior chaparral resulting from local soil types. This biotic community comprises 494 acres, or

Table 3-55. Special Status Plant and Wildlife Species Potentially Occurring in the Carlota Project Area

Common Name	Scientific Name	Status
PLANTS:		
Arizona agave	*Agave arizonica*	LE, S
Hohokam agave	*Agave murpheyi*	C2, S
Tonto basin agave	*Agave delamateri*	C2, S
Arizona hedgehog cactus	*Echinocereus trichlochidiatus* var. *arizonicus*	LE, SE, S
Mogollon fleabane	*Erigeron anchana*	C2
Apache wild buckwheat	*Eriogonum apachense*	C2
San Carlos wild buckwheat	*Eriogonum capillare*	C2, S
Fish Creek rock daisy	*Perityle saxicola*	C2, S
INSECTS:		
Maricopa tiger beetle	*Cicendela oregona maricopa*	C2
AMPHIBIANS AND REPTILES:		
Arizona toad	*Bufo microscaphus microscaphus*	C2
Chiricahua leopard frog	*Rana chiricahuensis*	C, SC, S
lowland leopard frog	*Rana yavapaiensis*	C2, SC, S
common chuckwalla	*Sauromalus obesus*	C2
desert tortoise	*Gopherus agassizii*	C2, SC, S
northern leopard frog	*Rana pipiens*	SC
Mexican garter snake	*Thamnophis eques*	C2, SC, S
narrow-headed garter snake	*Thamnophis rufipunctatus*	C2, SC, S
BIRDS:		
southwestern willow flycatcher	*Empidonax traillii extimus*	LE, SE
buff-breasted flycatcher	*Empidonax fulvifrons*	C2, SE, S
loggerhead shrike	*Lanius ludovicianus*	C2
yellow-billed cuckoo	*Coccyzus americanus*	ST
northern goshawk	*Accipiter gentilis*	C2, SC, S
common black-hawk	*Buteogallus anthracinus*	SC, S
American peregrine falcon	*Falco peregrinus anatum*	LE, SC, S
ferruginous pygmy owl	*Glaucidium brasilianum cactorum*	PT, SE, S
bald eagle	*Haliaeetus leucocephalus*	LE, SE, S
Mexican spotted owl	*Strix occidentalis lucida*	LT, ST, S
MAMMALS:		
California leaf-nosed bat	*Macrotus californicus*	C2, SC, S
Mexican long-tongued bat	*Choeronycteris mexicana*	C2, ST, S
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	LE, SE, S
southwestern cave myotis	*Myotis velifer brevis*	C2, S
occult little brown bat	*Myotis occultus*	C2, S

Table 3-55. Special Status Plant and Wildlife Species Potentially Occurring in the Carlota Project Area (continued)

Common Name	Scientific Name	Status
MAMMALS CONTINUED:		
red bat	*Lasiurus borealis*	SC, S
southern yellow bat	*Lasiurus ega*	SC, S
spotted bat	*Euderma maculatum*	C2, SC, S
greater western mastiff bat	*Eumops perotis*	C2, S
Yavapai Arizona pocket mouse	*Perognathus amplus amplus*	C2
Chiricahua western harvest mouse	*Reithrodontomys megalotis arizonensis*	C2

Status:

Federal (U.S. Department of the Interior 1992, 1993)

LE = Taxa listed by the U.S. Fish and Wildlife Service as Endangered under the Endangered Species Act (ESA).

LT = Taxa listed by the U.S. Fish and Wildlife Service as Threatened under the ESA.

PE = Taxa proposed for listing as Endangered under the ESA.

PT = Taxa proposed for listing as Threatened under the ESA.

C = Taxa for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.

C2 = Category 2 Candidate. Taxa with the C2 designation were listed as such at the initiation of the Carlota EIS analysis. Since that time, the U.S. Fish and Wildlife Service has issued a more recent listing of candidate species (Federal Register 61: 7596-7613, February 28, 1996). As a result of this update, none of the plant and wildlife species addressed by the EIS are listed as candidate (C2) species. Chiricahua leopard frog is the only species in *Table 3-48* that still has a candidate (C) designation (see above). Species that were listed as C2 candidates but are not listed as sensitive (Mogollon fleabane, Arizona toad, common chuckwalla, loggerhead shrike, and Yavapai Arizona pocket mouse) no longer have any special federal designation.

State (Arizona Game and Fish Department 1988)

SE = State Endangered as listed on the Arizona Game and Fish Department's list of Threatened Native Wildlife (TNW) in Arizona. Species in imminent danger of extinction within Arizona.

ST = State Threatened as listed on the TNW list. Species with identified, serious threats and populations lower than they were historically and/or extremely local and small.

SC = State Candidate as listed on the TNW list. Species with known or suspected threats, but for which substantial population declines from historical levels have not been documented.

Forest Service (USDA Forest Service 1988)

S = Classified as "sensitive" by the Regional Forester when the species occurs on lands managed by the Forest Service.

Table 3-56. Estimated Coverage by Major Vegetation Community Types in the Carlota Project Area

Community Type	Acres	Percent Coverage
Interior Chaparral	1,532	49.5
Rubbleland Chaparral	494	15.9
Dry-Slope Desert Brush	886	28.6
Juniper/Grassland	131	4.2
Riparian	57	1.8
TOTAL	3,100	100.0

15.9 percent, of the project area (*Figure 3-25 and Table 3-56*). It is best represented along the south side of the project area in the Shultze Granite formation within 1 mile of U.S. Highway 60, and it is bordered by interior chaparral. Species composition is similar to interior chaparral, except it includes the significant presence of rock outcrops and boulder fields and an increased level of understory exposure. Most areas of rubbleland chaparral include scattered clumps of shrubs rather than a continuous impenetrable shrub layer, as in the interior chaparral.

Dry-slope Desert Brush. The dry-slope desert brush vegetation type is transitional between semidesert grassland, Sonoran desertscrub (Arizona upland subdivision), and interior chaparral, since it includes components of all three of these biotic communities (Brown 1982). Dry-slope desert brush covers approximately 886 acres, or 28.6 percent of the project area (*Figure 3-25 and Table 3-56*). This type usually overlies poor soils on dry, south-facing slopes, and tends to exhibit more of the characteristics of Sonoran desertscrub than the other two types. Common species in this biotic community include Wright's buckwheat (*Eriogonum wrightii*), broom snakeweed (*Gutierrezia sarothrae*), gray horse brush (*Tetradymia canescens*), red brome (*Bromus rubens*), and shrub-live oak (Cedar Creek Associates, Inc. 1994b). Dry-slope desert brush is best represented along the northern portion of the project area, but examples are also found on drier slopes in the extreme western end of the project area (*Figure 3-25*).

Juniper/Grassland. Juniper/grassland is a type of semidesert grassland biotic community. It occupies approximately 131 acres, or 4.2 percent of the project area (*Figure 3-25 and Table 3-56*). A total of 59 species was observed in this vegetation type, including hairy grama (*Bouteloua hirsuta*), broom snakeweed, one-seed juniper, and red brome (Cedar Creek Associates, Inc. 1994b). The sparse cover of perennial grasses and junipers may indicate past overgrazing and fire suppression. Juniper grassland vegetation is found only on three south-facing hillsides in the central portion of the project area.

Interior Riparian Deciduous Woodland. Riparian vegetation in the Carlota project area is principally composed of a low density, sparse canopy, mixed-broadleaf community of interior riparian deciduous woodland similar to that described by Brown (1982). It is the least extensive vegetation type, occupying only 57 acres, or 1.8 percent of the project area *(Figure 3-25 and Table 3-56),* but it supports greater species diversity than the other biotic communities of the area (approximately 6 percent more species than the next most diverse community). The riparian community is generally found where ground water or seasonal storage of surface flow is sufficiently close to the surface to allow moisture-dependent species to become established and persist. These conditions generally occur along the alluvial bottoms of Pinto Creek, lower Powers Gulch below the confluence with West Powers Gulch, and in lower Haunted Canyon. Above the confluence of the main stem and western tributaries of Powers Gulch, as well as in other transitional areas, streamside vegetation is dominated by interior chaparral species with an occasional overstory of taxa more commonly associated with Madrean evergreen woodland (these areas were termed mesic chaparral to suggest their transitional nature).

Within the principal riparian zone of Pinto Creek and Powers Gulch, dominant overstory species include Arizona sycamore (*Platanus wrightii*), Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus pennsylvanica* ssp *velutina*), tamarisk (*Tamarix chinensis*), and Goodding's willow (*Salix gooddingii*).

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Figure 3-25
Locations of Major Vegetation Communities

Emory oak (*Quercus emoryi*), an occasional Arizona white oak (*Quercus arizonica*), and one-seed juniper (*Juniperus monosperma*) from the adjacent uplands also contribute to the riparian canopy cover. In the area of lower Haunted Canyon, the principal overstory species are Arizona alder (*Alnus oblongifolia*), velvet ash, Arizona sycamore, Arizona black walnut (*Juglans major*), one-seed juniper, and Arizona cypress (*Cupressus arizonica*). Common scrub understory species include young overstory plants, burrobush (*Hymenoclea monogyra*), desert broom (*Baccharis sarothroides*), seepwillow (*Baccharis glutinosa*), and from the adjacent uplands, shrub live oak, broom snakeweed, and wait-a-minute bush (*Mimosa biuncifera*).

Riparian vegetation within and downstream of the project area is characterized by uneven and irregularly distributed patches and belts of riparian species of differing composition, densities, and ages. This is typical of riparian systems in the arid and semiarid Southwest. These differing riparian subtypes were mapped and measured by Cedar Creek Associates, Inc. (1994b) for over 45,000 lineal feet from above the project area on Pinto Creek to the Iron Bridge downstream of the project area. This mapping included the entirety of Powers Gulch and lower Haunted Canyon and resulted in the delineation of seven subtypes.

Of these seven riparian subtypes, the Fremont cottonwood/Goodding's willow association did not occur within the project area and did not occupy sufficient acreage (1.63 acres in the survey area) to permit use of the Tonto Riparian Inventory and Monitoring Methods (TRIMM). The Arizona alder subtype occupied 11.07 acres and only occurred in lower Haunted Canyon and along a small segment of lower Pinto Creek below the project area. Tree density averaged 145 stems/acre, and canopy cover was estimated at 95 percent. The velvet ash subtype occupied only 2.06 acres (all within the project area and principally within Powers Gulch) and was also too small to allow measurement with TRIMM. The Arizona sycamore/Emory oak subtype occupied 11.39 acres in the survey area (5.29 in the project area) and was principally located in Powers Gulch and upper Pinto Creek. Tree density averaged only 90 stems/acre, and canopy cover was estimated at less than 22 percent. The Arizona sycamore/Fremont cottonwood subtype occupied 48.44 acres in the survey area (1.42 in the project area) and was located intermittently throughout the survey area, but primarily below the project site. Tree density averaged only 38 stems/acre, and canopy cover was estimated at less than 16 percent. The Arizona sycamore subtype occupied 51.54 acres in the survey area (13.09 in the project area) and was located intermittently throughout the survey area. Tree density averaged 114 stems/acre, and canopy cover was estimated at less than 29 percent. Finally, the Arizona sycamore/tamarisk subtype occupied 35.34 acres in the survey area (34.88 acres in the project area), and (as indicated by these acreages) was the dominant subtype in the project area along Pinto Creek. Tree density averaged 34 stems/acre (discounting tamarisk, which is a non-native weedy species), and canopy cover was estimated at a little over 5 percent discounting tamarisk, or 12 percent with tamarisk. In addition to these seven subtypes, two non-riparian types (scoured channel and mesic chaparral) were recorded during the TRIMM surveys. These two types account for any differences in acreage values.

Cedar Creek Associates, Inc. collected additional data from the portion of Pinto Creek's riparian zone in the area of the proposed Carlota/Cactus pit in 1996. These data were designed to be used for the COE Section 404 mitigation plan, but also provide additional characterization of the riparian resources subject to potential impacts. It was found that vegetation ground cover along the COE-defined wetland in this area averaged only 5.77 percent, of which nearly half consisted of two introduced weedy species, Bermuda grass and tamarisk. Riparian species woody plant density for stems greater than 2 inches diameter breast height (dbh) was determined to be 46.6/acre, while density for riparian stems less than 2 inches dbh was determined to be 702.5/acre. Of these values, tamarisk accounted for 7.3 and 262.0 stems/acre, respectively.

As indicated by these data, Pinto Creek and Powers Gulch, especially in the potential impact zones, support relatively low quality stands of Arizona sycamore and tamarisk. Total cover and density of native riparian trees is low. These conditions are most likely a result of two water-related factors and one biological factor: (1) intermittent water flow that leads to extended drought conditions, (2) occasional destructive flood flows, and (3) competition from introduced weedy species, such as tamarisk. Human factors include livestock grazing and mining activities. Haunted Canyon, a major tributary that enters Pinto Creek below (north of) the project area, supports approximately 16.1 acres of the highest quality riparian habitat in the immediate Carlota project area (Cedar Creek Associates, Inc. 1994b). This riparian ecosystem, for approximately 0.7 mile, is supplied with perennial water flows generated from ground water discharged locally. Arizona alder dominates much of this reach in association with Arizona sycamore and Arizona cypress. The stream supports large pools that are not found in other stream reaches within the project area. As indicated previously, canopy cover in this area approaches 95 percent.

Special Status Plant Species. This section summarizes the known locations of special status plant species, including the likelihood of occurrence of these species within the Carlota project area. A detailed discussion of each species is included in the Vegetation Technical Memorandum and the Final Biological Assessment and Evaluation prepared for this project (Cedar Creek Associates, Inc. 1994b, 1994d).

Cedar Creek Associates, Inc., conducted surveys for special status plant species in 1992 and 1993. The surveys focused on areas of potential impact by the Carlota Copper Project. The field survey methodology is described in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

Arizona Hedgehog Cactus (Federal Endangered, Forest Service Sensitive). The Arizona hedgehog cactus occurs in the interior chaparral community of Pinal and Gila Counties, Arizona, at elevations between 3,300 and 5,700 feet. According to Crosswhite (1992), the vast majority of plants are found on relatively open, rocky slopes and steep fissured cliffs, although some isolated individuals have been found in the moderately dense climax stands of interior chaparral. Crosswhite's definition of Arizona hedgehog habitat has been significantly expanded based upon habitat data collected from 1,150 specimens and is more completely presented in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d). Crosswhite (1992) also suggested that, in areas where collection is not a problem, the species is extending its range. The Arizona representatives of the genus *Echinocereus* are currently under revision by Dr. Bruce Parfitt of the Missouri Botanical Garden. In a draft copy of his report, *E. triglochidiatus* var. *arizonicus* is elevated to *E. arizonicus*, although it is not yet clear whether this revision will include other populations of the genus *Echinocereus* in the species *arizonicus*. Estimates based on incomplete data in 1984 indicated that approximately 18,000 Arizona hedgehog cactus individuals comprise the species. Since then, the Forest Service has conducted several reconnaissance surveys for Arizona hedgehog cactus and has documented extensions of the population north and west from the type locality near the project area. Estimates of density in most of these areas were not taken (USDA Forest Service 1991). Based on the detailed definition of habitat developed during extensive project investigations, Cedar Creek Associates, Inc. reinvestigated several Forest Service sightings, evaluated habitat conditions regionally and between sightings, collected density data from 21 transects, and extrapolated density information from eight additional sources of information. As a result of these efforts, an estimate of the Arizona hedgehog population was refined to provide a realistic population projection of 257,500 individuals (Cedar Creek Associates, Inc. 1994d). The most conservative population projection obtained from the same information resulted in a population estimate of at least 187,600 individuals (Cedar Creek Associates, Inc. 1994d).

Of over 2,000 Arizona hedgehog cactus observed by Cedar Creek Associates, Inc. during surveys for the taxon in 1992 and 1993, 1,150 specimens were located within the 100 percent survey areas which were defined by the overlap of the project footprint (including a 200 foot buffer) and areas of cactus habitat (including a 500 foot buffer). The remaining 900+ cacti were observed outside of this area, primarily during reconnaissance and density determination surveys across the entire distributional limits of the taxon. In addition to cactus location efforts, suitable habitat for the Arizona hedgehog cactus was defined and mapped. Further discussion of this species is provided in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

Arizona Agave (Federal Endangered, Forest Service Sensitive). Arizona agave (*Agave arizonica*) is believed to be a sterile hybrid of golden-flowered agave (*Agave chrysantha*) and Toumey agave (*A. toumeyana* var. *bella*) (Cedar Creek Associates, Inc. 1994b, 1994d). The species (taxon) is known only from extremely isolated clusters of one to several rosettes that are all derived from the same seed and are connected by underground rhizomes. Preferred habitat is chaparral and juniper-grassland vegetation on volcanic soils between 3,000 and 6,000 feet elevation. Threats to the species include low numbers, patchy distribution, poor reproduction, and plant collecting (Arizona Game and Fish Department 1990).

The project area may contain appropriate habitat for Arizona agave, but no plants were found. The only parent species in the area is golden-flowered agave; Toumey agave was not observed on the site. The U.S. Fish and Wildlife Service concurs that this species is not likely to occur in the project area, as stated in the Vegetation Technical Memorandum (Cedar Creek Associates, Inc. 1994b) and the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

Other Plant Species of Concern. The distribution and habitat requirements of the following plant species of concern were reviewed in relation to the Carlota project area.

- Tonto Basin agave
- Hohokam agave
- Mogollon fleabane
- Apache wild buckwheat
- San Carlos wild buckwheat
- Fish Creek rock daisy

Refer to *Table 3-55* for a listing of their status.

It was determined that these species are not located in the vicinity of the Carlota project area and/or habitat is not present. Descriptions of distribution and habitat for these species are discussed in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

Wildlife

This section discusses terrestrial wildlife species, including insects, amphibians, reptiles, birds, and mammals, that were observed or are known to exist in the vicinity of the Carlota Copper Project. A discussion of important game species and threatened, endangered, and sensitive species is included. Fish, aquatic insects, and other aquatic arthropods are discussed in Section 3.5.1.2, Biological Resources - Aquatic Resources. Further discussion of wildlife is provided in the Wildlife Technical Memorandum and the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994c, 1994b). Scientific names of wildlife species discussed in this section are provided in Appendix A of the Wildlife Technical Memorandum (Cedar Creek Associates, Inc. 1994c).

Amphibian and reptile species identified in the project area include tiger salamander, Woodhouse toad, canyon treefrog, bullfrog, Sonoran mud turtle, greater earless lizard, eastern fence lizard, short-horned lizard, plateau striped whiptail, Sonoran whipsnake, gopher snake, black-necked garter snake, black-tailed rattlesnake, and others.

General bird surveys and nesting raptor surveys were conducted in the project area in 1992 and 1993. Common birds in the upland habitats were primarily dry shrubland-adapted species, such as scrub jay, bushtit, canyon wren, crissal thrasher, rufous-sided towhee, canyon towhee, rufous-crowned sparrow, black-chinned sparrow, and others. Common avian species identified in the riparian habitat along Pinto Creek included mourning dove, ash-throated flycatcher, Bewick's wren, yellow-warbler, yellow-rumped warbler, black-headed grosbeak, hooded oriole, and others. Cedar Creek Associates, Inc. (1994c) describes in detail the avian species identified in each habitat type in the project area.

Six diurnal and four nocturnal raptor species were documented on or near the project study area: turkey vulture, sharp-shinned hawk, Cooper's hawk, common black-hawk, red-tailed hawk, American kestrel, barn owl, western screech-owl, great-horned owl, and elf owl. Red-tailed hawk and Cooper's hawk were found to be nesting in the project area.

Several species of mammals were directly or indirectly identified in the project area during 1992 and 1993 field surveys, including cottontail, cliff chipmunk, rock squirrel, brush mouse, woodrat, and others. No special status small mammal species are likely to inhabit the project area. Mist-netting was used to survey for special status bat species in 1992 and 1993. Bat species captured in mist nets included Yuma myotis, western pipistrelle, big brown bat, hoary bat, pallid bat, Brazilian free-tailed bat, big free-tailed bat, and others.

The project area is in Arizona Game and Fish Department Management Unit 24B. Big game animals potentially occurring in the area include mule deer, white-tailed deer, collared peccary (javelina), black bear, and mountain lion. According to the Arizona Game and Fish Department, there have been recent sightings of mountain (desert) bighorn in the area, but they are probably not resident (Haughey 1993). Field surveys documented the presence of mule deer, black bear, and collared peccary.

Black bears are widely distributed throughout woodland and coniferous forests in the mountainous portions of Arizona (Hoffmeister 1986). Black bears are omnivorous and are known to eat a large variety of foods, including grasses, berries, honey, fruits, nuts, and carrion. Habitats in the project area that are most likely to be used by black bear are riparian, chaparral, and rubbleland chaparral. Because of their generally sparse numbers, secretive nature, and often inaccessible habitat, black bears are difficult to count. The density of black bears in the region is unknown. The Arizona Game and Fish Department indicates that low to moderate bear numbers occur in the Pinto Creek area (Haughey 1992). Sizes of home ranges of black bear vary greatly from as small as 0.5 square mile to more than 60 square miles (Pelton 1987).

Mountain lions occur throughout the rugged, mountainous portions of Arizona and are known to occur on or near the project area (Haughey 1992). The range of this species is closely associated with deer, the primary prey species (Hoffmeister 1986). Mountain lions follow the seasonal movement of deer, and as a result of their wide ranging habits, population densities are usually low. They are typically shy and avoid areas with human activity. Documented home ranges for mountain lions in the western United States range from 12.5 to 185 square miles (Anderson 1983). Although the presence of mountain lions was not documented, it is likely that portions of the project area occur within a territory occupied by mountain lions.

The collared peccary occurs in Arizona primarily in desert mountain ranges south of the Mogollon Plateau (Hoffmeister 1986). The peccary is found most often in desert scrub habitats, especially in thickets along creeks and old streambeds. Preferred foods include prickly pear and other cacti, agave, forbs, grass, seeds, and nuts. Suitable habitat for the collared peccary exists within the project area, although the population density of the collared peccary in the project area is unknown. The Arizona Game and Fish Department indicates that collared peccary densities are low to medium (one to three animals per square mile) in the Pinto Creek area. Peccary densities vary considerably depending on habitat and food availability (Bissonette 1982).

Mule deer and white-tailed deer are known to occur within the project area (Cedar Creek Associates, Inc. 1994c). The ranges of these two species overlap throughout much of the southeastern portion of Arizona (Hoffmeister 1986). The project area is within year-round range for both species. Where these species occur close together, white-tails usually exist at somewhat higher elevations in oak-pine woodlands, while mule deer are more common in chaparral (Hoffmeister 1986).

Chaparral habitat provides important browse for deer during the summer and winter, but in dense stands of chaparral much of the palatable new shrub shoots are beyond the reach of deer. Dense stands of chaparral vegetation are used by deer as fawning habitat and for cover from predators and the elements.

The Arizona Game and Fish Department has conducted game surveys in Unit 24B since the 1940s (Shroufe 1995). The surveys have indicated that the white-tailed deer densities are high (7 to 15 animals per square mile) west of the project area at Government Hill; mule deer densities are low to medium (1 to 7 animals per square mile) in the Pinto Creek area. Population estimates for 1992 indicated

1,896 white-tailed deer, 3,351 mule deer, and 1,300 collared peccary in Unit 24B. All three populations have increased over the past 3 years. Hunter demand in this section of Unit 24B for 1993 and the average for 1991-1993 is over one applicant per permit. Approximately 10 percent of hunters with permits do not hunt.

The mule deer is the only deer species recorded by the April 1992 field surveys and by Carlota personnel (Whitman 1992). White-tailed deer are more shy and secretive than mule deer and are less likely to be recorded by incidental observations.

Other important species that potentially occur in or near the project area include predators and furbearers, such as coyote, gray fox, raccoon, ringtail, white-nosed coati, striped skunk, western spotted skunk, hooded skunk, hog-nosed skunk, and bobcat. Field surveys documented the presence of coyote, raccoon, striped skunk, and spotted skunk. Given the secretive nature and nocturnal habits of many of these species, little information is available on their distribution and population densities within the project area.

Coyotes are expected in all habitats within the project area wherever suitable small mammal or rabbit prey exist. Coyote scat was encountered occasionally along transects in all habitats within the project area. This species is expected to be the most common predator within the project area. Gray fox occur in Arizona in desert shrub, chaparral, and oak and piñon-juniper woodlands (Hoffmeister 1986). Their preferred foods are small mammals, reptiles, insects, and the fruits of a variety of plants. Like the coyote, the gray fox is expected to occur throughout the project area.

In drier habitats within the project area, raccoons are seldom found far from water (Kaufmann 1982). Raccoon tracks were noted in two areas along portions of Powers Gulch with flowing water during the April flood. One raccoon and raccoon tracks were noted along Pinto Creek during the July bat surveys. The ranges of white-nosed coati and ringtail overlap the project area. Like the raccoon, white-nosed coati and ringtail are omnivorous and are usually found near water. In Arizona, white-nosed coati prefer woodlands consisting of oaks, sycamores, and walnuts (Hoffmeister 1986). Riparian areas along Pinto Creek, West Powers Gulch, and lower Powers Gulch represent the only suitable habitat for this species within the project area. Ringtails prefer rocky canyons near water, but typically avoid heavily wooded areas (Hoffmeister 1986). Areas of rocky, dry-slope desert brush near permanent water in Pinto Creek and lower Powers Gulch provide the most suitable habitat for ringtail within the project area. All four skunk species (western spotted, striped, hog-nosed, and hooded) are potential inhabitants of the project area. Hooded skunks are more common in the lower elevation desert habitats, but have been found as high as pine-oak woodland habitat (Howard and Marsh 1982). Striped skunk was the most commonly observed species near the project area. It was encountered on several occasions along Pinto Creek below the project area.

Bobcats, like coyotes, occur in a wide variety of habitats throughout Arizona. Rugged areas supporting caves, rock outcrops, and ledges are often preferred by bobcats (Hoffmeister 1986). Preferred prey includes large rodents, rabbits, and hares. Bobcats are expected to occur wherever prey and habitat are present, especially in the rimrock areas along the western and northern boundaries of the project area.

Haunted Canyon below the Powers Gulch confluence supports a well-developed riparian habitat. A wide floodplain is provided with perennial water flow, deep pools, and riffles. Cedar Creek Associates, Inc. (1994b) mapped an Arizona Alder Riparian Subtype in addition to smaller areas of Sycamore Riparian Subtype. The Alder Subtype included areas of 95 percent canopy cover of deciduous trees. Riparian vegetation and the proximity of perennial water in Haunted Canyon attract a wide variety of wildlife species, especially songbirds. Trees and snags in riparian vegetation provide important foraging and nesting habitat for accipiters, buteos, owls, songbirds, and woodpeckers. Cedar Creek Associates, Inc. (1994b) found the highest relative abundance and diversity of bird species in riparian habitat. Several songbirds, including acorn woodpecker, brown-crested flycatcher, verdin, ruby-crowned kinglet, solitary vireo, yellow warbler, MacGillivray's warbler, summer tanager, northern cardinal, and black-headed grosbeak, were only found in riparian habitats along Pinto Creek and in Haunted Canyon.

Mammals, such as the mule deer, raccoon, striped skunk, white-nosed coati, coyote, black bear, and collared peccary, use the Haunted Canyon riparian area for obtaining food and water. In addition, riparian corridors along stream courses are used as travel routes by many of these species. Because riparian habitat supports a diversity of flying insects, many bat species are likely to be present as nocturnal foragers. Haunted Canyon also would be expected to support populations of characteristic riparian amphibians, such as canyon treefrog and red-spotted toad. Canyon treefrog was the only amphibian observed during vegetation, fisheries, and general wildlife surveys in Haunted Canyon.

Special Status Wildlife Species. This section summarizes the habitat preferences and distribution of special status wildlife species, including the likelihood of these species occurring within the Carlota Copper Project area. A detailed discussion of each species and the survey methodology are included in the Wildlife Technical Memorandum and the Final Biological Assessment and Evaluation prepared for this project (Cedar Creek Associates, Inc. 1994c, 1994d).

American Peregrine Falcon. The American peregrine falcon is a bird-eating raptor that nests on cliffs (Palmer 1988). Peregrine falcon populations have been identified in Arizona on the Colorado Plateau and in the sub-Mogollon mountain ranges of the southeastern portion of the state (Ellis and Glinski 1988, Skaggs et al. 1989). Peregrine falcon populations appear to have increased in Arizona since 1980, and many subpopulations within the state are either recovered or well on their way to recovery from the precipitous declines observed prior to the mid-1970s (Arizona Game and Fish Department 1988, Ellis and Glinski 1988).

No nesting, foraging, transient, or migrating peregrine falcons have been observed in the project area (Arizona Game and Fish Department 1989-1993). Cliffs and pinnacles along the western edge of the project area may be marginally suitable for nesting peregrines and could be appropriate for foraging purposes. The Arizona Game and Fish Department Heritage Data Management System (Cedar Creek Associates, Inc. 1994c) indicates that the two closest known peregrine nest sites are located in the Sierra Ancha Wilderness and in the Salt River Canyon. The nearest suitable cliff nesting habitat occurs along Pinto Creek, approximately 12 miles north of the project area between the confluences of Bell Gulch and Blevens Wash.

Bald Eagle. The bald eagle is a very large diurnal raptor that primarily occurs near water and feeds predominately on fish (Palmer 1988). Arizona is home to a resident population of 25 to 30 pairs of bald eagles that breed along major rivers and reservoirs in central Arizona (Hunt et al. 1992a). Bald eagles nest on cliff ledges and live trees or snags overlooking bodies of open water. Arizona is also on the southern edge of the wintering range of bald eagles that migrate from frozen northern nesting grounds each year (Millsap 1986). An estimated 150 to 200 transitory bald eagles winter in north-central Arizona each year (Grubb et al. 1989, Beatty 1992).

No bald eagles have been observed along Pinto Creek in or near the project area (Hunt et al. 1992b, Cedar Creek Associates, Inc. 1994b). Suitable habitat for bald eagles does not exist in or near the project area. A bald eagle nesting territory is located approximately 15 miles north of the project area at Roosevelt Lake (Hunt et al. 1992b).

Mexican Spotted Owl. This medium-sized owl is widely but patchily distributed in forested mountain and canyon habitats in the southwestern United States to central Mexico (McDonald et al. 1991). In the sub-Mogollon region of Arizona, the species has been found from 3,750 feet to near 9,000 feet elevation (Duncan et al. 1993).

No spotted owls have been identified in the project area, and no suitable spotted owl habitat exists in or immediately adjacent to the project area. The nearest suitable spotted owl habitat is located approximately 7 miles southeast of the project area in the higher elevations of the Pinal Mountains and approximately 7 miles northwest of the project area in the Superstition Mountains (Arizona Game and Fish Department 1992, Duncan et al. 1993).

Southwestern Willow Flycatcher. Southwestern willow flycatcher is a member of the genus *Empidonax* that breeds locally in dense willow and salt cedar associations in Arizona (Phillips et al. 1964). Populations of this subspecies have declined in recent decades as a result of loss and fragmentation of riparian habitat, brood parasitism by brown-headed cowbirds, and predation (Unitt 1987). The species was reported on the decline as early as the mid-1960s in Arizona (Phillips et al. 1964, Pollock 1994). The willow flycatcher has been found primarily along the Colorado, Verde, and San Pedro Rivers, although scattered populations are known to exist in other riparian areas. The highest breeding densities of willow flycatcher in 1994 in Arizona were on Tonto Creek and the Salt River in the Tonto Basin (Pollock 1994).

No southwestern willow flycatchers were found in the project area during a survey in June 1993. Habitat for this species is not well developed along Pinto Creek. The dense willow understory required by this species is absent from most of the stream. A few willows downed by recent flooding are resprouting along the formerly vertical trunks. Such willows may eventually form dense thickets in the absence of other catastrophic flood events.

Lesser Long-Nosed Bat. The lesser long-nosed bat is a migratory, nectar-feeding bat that occurs as a summer resident in southern Arizona (Hoffmeister 1986, Cockrum 1992). In Arizona, it is known to forage mainly on saguaro cacti (*Carnegiea gigantea*) and agave (*Agave* spp.) nectar and pollen and roosts primarily in caves and mine tunnels (Howell 1972, Cockrum 1992). Currently, there is some question as to the present status of this bat species and whether or not the species did, in fact, experience a decline in numbers during the last 25 years (Cockrum and Petryszyn 1991).

No individuals of this species were captured during 1992 and 1993 mist net surveys, and none were found in searches of inactive mine shafts in the area. Potentially suitable summer foraging habitat for the lesser long-nosed bat is present in and near the project area, but there is no evidence that this species occurs in the general area. The Carlota Copper Project area lies well to the east of the known range of the lesser long-nosed bat (Hoffmeister 1986, Cockrum 1992). Howell (Cedar Creek Associates, Inc. 1994b) considers the accuracy of this range delineation questionable and believes the project area contains sufficient quantities of agave to support foraging nectar-feeding bats. The closest documented occurrences of this bat in relation to the project area include Picacho Peak, southeast of Casa Grande, and Phoenix (Hoffmeister 1986, Cockrum 1992). Both sites are located over 50 miles from the project area.

Maricopa Tiger Beetle. The Maricopa tiger beetle is known from a wide variety of habitats in California, Arizona, Nevada, and New Mexico (Cazier 1993). It occurs in habitats associated with sandy or gravelly streambeds or river banks, springs, reservoirs, lakes, swamps, livestock watering tanks, leaky campground faucets, irrigated fields, canals, and irrigation ditches (Cazier 1993). Sandy or silty substrates near these water sources provide suitable habitat for the burrowing larvae of this species The presence of some form of water appears to be the main habitat consideration. Water quality does not appear to be an important factor since this beetle has been collected in areas with fresh, slightly brackish, or saline water and in small streams red with mine waste beside both the Bisbee and Douglas, Arizona, slag and mine dumps (Cazier 1993). As a result, favorable habitat in the occupied four state area is extensive, and much of it is occupied by viable populations of Maricopa tiger beetle, either permanently or by transient groups (Cazier 1993). Populations of the tiger beetle genus (*Cicindela*) are able to maintain themselves with low numbers and are well adapted for survival and adjusting to environmental changes. Local populations may disappear, but chances of overall extinction of the Maricopa tiger beetle are remote (Cazier 1993).

Banks of deposited sand and silt along the Pinto Creek drainage represent suitable habitat for Maricopa tiger beetle larvae, and one adult beetle was collected in Pinto Creek below the project area in 1993.

Arizona Toad. This true toad is found in drainages supporting free-flowing water along the Mogollon Rim in central Arizona and western New Mexico and in scattered locations in southern Utah, Nevada, and California (Stebbins 1985). Threats to the species probably include habitat destruction, pollution, and introduction of waterdogs (tiger salamander larvae), bullfrogs, and crayfish (Lowe 1985, Fernandez 1993).

Arizona toads were identified at several locations along the Pinto Creek drainage downstream of the project area between the Iron Bridge and Henderson

Ranch (Cedar Creek Associates, Inc. 1994b). In the project area, portions of Pinto Creek, Powers Gulch, West Powers Gulch, and Haunted Canyon that flow during the spring and summer represent potential breeding habitat for this species.

Lowland Leopard Frog. The lowland leopard frog is a true frog species that is an obligate riparian species at elevations from approximately 1,900 to near 6,000 feet (Lowe 1985, Stebbins 1985, Sredl and Howland 1992). The Arizona range of this species includes the central part of the state below the Mogollon Rim, where it overlaps with the range of the Chiricahua leopard frog. Threats to the species are similar to those described for the Arizona toad.

Within the Carlota project area, lowland leopard frogs were located at Yo Tambien Spring in 1992 and in lower Powers Gulch and an isolated pool in Pinto Creek in 1993. Numerous leopard frog observations have been recorded at downstream portions of Pinto Creek, including sites near Henderson Ranch and the weir site (Cedar Creek Associates, Inc. 1994d).

Common Black-hawk. This medium-sized hawk is found in riparian and riverine habitat in central and southern Arizona (Palmer 1988). The rapid loss of riparian habitat is suspected to be the most significant threat to this species (Arizona Game and Fish Department 1988).

Two common black-hawk observations were made along Pinto Creek in the project area during July 1992. In 1993, two additional observations were made downstream from the project area along Pinto Creek. The 1992 and 1993 observations indicate that the common black-hawk probably forages in and near the project area along Pinto Creek. Potential nesting habitat occurs along Pinto Creek; however, no nests or evidence of nesting activity were observed.

Yellow-billed Cuckoo. In Arizona, this member of the genus *Coccyzus* is known to breed in riparian woodlands and mesquite bosques (Phillips et al. 1964, Monson and Phillips 1981). Threats to this species include loss and destruction of riparian habitat.

The yellow-billed cuckoo was not found in the project area in 1992; however, three observations on three consecutive days were recorded in June of 1993 along Pinto Creek downstream from the project area. The closest site to the study area was 3 miles downstream near the Iron Bridge. Riparian areas along Pinto Creek downstream to near Roosevelt Lake represent potential habitat for this species.

Loggerhead Shrike. This songbird prefers open, thinly wooded, or scrubby land characterized by frequent clearings and prominent perch sites (Terres 1980). Phillips et al. (1964) report the loggerhead shrike to be a common summer resident in Arizona in open habitats below the Transition Zone. Dry-slope desert shrub and juniper/grassland represent suitable habitat for the loggerhead shrike in the project area.

No loggerhead shrike were noted during the 1992 surveys, but this species was seen in April and May of 1993. Two observations were recorded in open chaparral west of upper Powers Gulch, and several were observed in the dry-slope desert brush south of Grizzly Mountain near the proposed mine rock disposal site.

Southwestern Cave Myotis. This bat is a migratory, insectivorous species ranging from Honduras to southern Nevada (Hoffmeister 1986). It generally inhabits mine shafts, tunnels, caves, and bridges in desert areas of Arizona (Hoffmeister 1986). Currently, there is some question as to the taxonomic validity of this subspecies. Most professional mammalogists familiar with the species agree with Hayward (1970) that Arizona individuals belong to the subspecies *M. v. velifer* (Sidner 1990). Threats to this species have not been identified, but as with many bats, habitat destruction and roost disturbance may locally affect small colonies or subpopulations.

Two individuals of this species, one in 1992 and one in 1993, were captured during mist net surveys in the project area.

Occult Little Brown Bat. In Arizona, the insectivorous occult little brown bat is found along the Mogollon Rim and in other central Arizona mountain ranges (Hoffmeister 1986). Habitats of ponderosa pine and oak woodland near water are preferred by this species, but it has also been found in lower desert areas along permanent watercourses supporting riparian habitat (Hoffmeister 1986). Natural roost sites are not mentioned in the literature, but recent unpublished work by Morrel (1993) demonstrates the importance of snags and other crevices as roost sites for this species.

No individuals of this species were captured during 1992 and 1993 mist net surveys, although riparian habitat along Pinto Creek, West Powers Gulch, lower Powers Gulch, and Haunted Canyon with water could be used by this species. The occult little brown bat is not expected to be common in the project area because of a lack of pine and oak woodland habitats, and the closest confirmed sightings of occult little brown bat to the project area are in the nearby Pinal Mountains at 7,520 feet elevation (Hoffmeister 1986).

Greater Western Mastiff-Bat. This bat species is a year-round resident and is primarily associated with desert scrub habitat near cliffs and rocky canyons with abundant crevices. It inhabits these suitable habitats below the Mogollon Rim from northwestern Arizona to southeastern Arizona (Hoffmeister 1986). They forage for flying insects at considerable distances from roost sites.

Rock outcrops along the western and northern portions of the project area may provide suitable roost sites for this species, but no individuals of this species were captured during 1992 and 1993 mist net surveys. The closest confirmed sighting of a greater western mastiff bat to the project area is Tonto National Monument (Hoffmeister 1986).

Chiricahua Western Harvest Mouse. Harvest mice inhabit a wide variety of habitats and elevations within Arizona. Grassy habitats usually associated with streams, fences, irrigated areas, and bottomlands are preferred (Hoffmeister 1986). Harvest mice feed on the seeds of grasses and other species. Hoffmeister (1986) does not recognize *R. m. arizonensis* as a true subspecies.

Throughout most of the project area, grass cover is minimal, and the Chiricahua western harvest mouse is not expected to be present. Marginal habitat for this species exists along the lower portions of Pinto Creek north of the project area, where some grassy areas were observed.

Other Wildlife Species of Concern. The distribution and habitat requirements of the following wildlife species of concern were also reviewed in relation to the Carlota project area:

- Chiricahua leopard frog
- Desert tortoise
- Common chuckwalla
- Mexican garter snake
- Narrow-headed garter snake
- Northern goshawk
- Cactus ferruginous pygmy-owl
- Buff-breasted flycatcher
- California leaf-nosed bat
- Mexican long-tongued bat
- Red bat
- Southern yellow bat
- Spotted bat
- Yavapai Arizona pocket mouse

Refer to *Table 3-55* for a listing of their status. It was determined that these species are not located in the vicinity of the Carlota project area and/or suitable habitat is not present. The Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994b) provides descriptions of their distribution and habitat.

3.5.1.2 Aquatic Resources

The aquatic resources potentially affected by the implementation of the proposed Carlota Copper Project or the alternatives occur in Pinto Creek, Haunted Canyon, and Powers Gulch. Pinto Creek has both intermittent and perennial reaches. Based on observations during the baseline period (1992-1996), the segments upstream and through the main portion of the project area are intermittent. Downstream of the confluence of Haunted Canyon, at the lower end of the well field area (Site 3, *Figure 3-26*), Pinto Creek exhibited a short reach of perennial flow during baseline monitoring. The creek then appears to have intermittent flows downstream to below the confluences of the West Fork of Pinto Creek and Horrell Creek. From that point, near the Pinto Valley weir, it has perennial flows for the next 8 to 9 miles (Lewis 1977). Below that segment, it again is intermittent for the last 3 to 4 miles before it reaches Roosevelt Lake (Lewis 1977). Haunted Canyon exhibits perennial flows from just above the confluence of Powers Gulch to just above its confluence with Pinto Creek. Haunted Canyon above Powers Gulch is intermittent. Powers Gulch is an intermittent stream until just above its confluence with Haunted Canyon, where it becomes perennial. Aquatic resources are limited within the intermittent

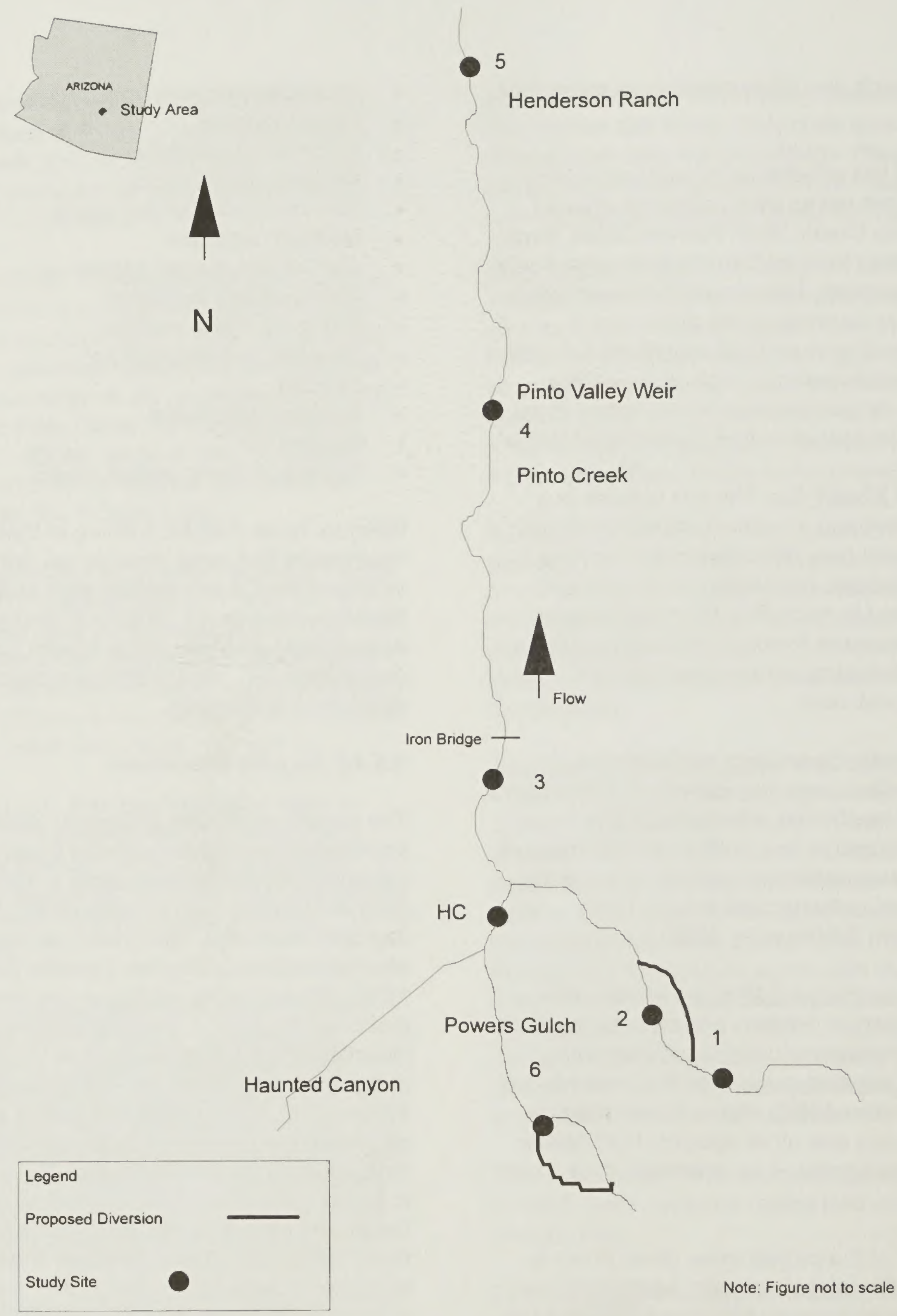

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Figure 3-26
Study Site Locations for Aquatic Biology Sampling

reaches of these streams. Dry stretches occur during summer and fall, resulting in higher water temperatures in available standing water, stagnation, and organic deposition. In addition, there have been impacts to Pinto Creek from past and current mining activity in the drainage. The aquatic biota in Pinto Creek were recently influenced by unusually high rainfall in late 1992 and early 1993, which flooded local streams and carried PLS and tailings material from the Pinto Valley Mine into Pinto Creek. Heavy metals were primarily associated with the PLS.

Few studies have described the existing aquatic resources in Pinto Creek. Lewis (1977) evaluated the effects of the Pinto Valley Mine on the aquatic ecology in Pinto Creek using biotic surveys (fish and macroinvertebrates), laboratory bioassays, water chemistry, and bioaccumulation in sediments and biota. Several macroinvertebrate inventories have been conducted by the Tonto National Forest in Pinto Creek (USDA Forest Service 1992a). The Arizona Game and Fish Department and the Tonto National Forest sampled the fish population in Pinto Creek in July and September 1992 and March 1993 upstream and downstream of the Pinto Valley weir (T2N, R13E, Sec 25) (Miller 1993). Miller & Associates (1995) conducted aquatic sampling at the beginning of low flow season in May and in September 1993 in locations on Pinto Creek and Powers Gulch immediately in or downstream of the proposed Carlota project area. Haunted Canyon was sampled in April 1994 by Miller & Associates. The following data were collected during the aquatic inventory: fish population data, macroinvertebrate data, habitat quantification, and water chemistry characteristics (Miller & Associates 1995). Additional data collected for other disciplines, such as hydrology, water quality, sediment, and riparian conditions, were used to augment existing aquatic resource data.

The most recent description of fish habitat in Pinto Creek and Powers Gulch was conducted by Miller & Associates (1995). Intensive habitat mapping was conducted in Pinto Creek upstream of the planned diversion (Site 1), Pinto Creek within the diversion area (Site 2), Pinto Creek downstream of the diversion (Sites 3, 4, and 5), and Powers Gulch in the diversion area (Site 6) (see *Figure 3-26*). Mapping was conducted using a Forest Service basin-wide protocol. Results of the habitat mapping indicated that riffles were the dominant habitat type in Pinto Creek at reaches above, within, and downstream of the project area (*Table 3-57*). Within the area of the proposed diversion in Pinto Creek, pools, riffles, and glides represented approximately 2, 64, and 34 percent, respectively, of the total area. Riffles were also dominant in Powers Gulch, representing 86 percent of the total area. The most abundant substrates in the reaches where fish were sampled were mainly boulders and rubble.

Unlike Pinto Creek and Powers Gulch, which are dominated by riffle habitat, Haunted Canyon has almost equal areas of pools and riffles (approximately 37 percent and 39 percent, respectively). The percentage of pool habitat area in Haunted Canyon is over four times higher than any section of Pinto Creek or Powers Gulch. These pools provide important refuge habitats for fish during periods of low flow. Pinto Creek supports a warmwater fishery (ADEQ 1992c) dependent on surface flow or temporary pools for survival during dry periods. Seven species of fish have been identified in Pinto Creek in previous surveys by Lewis (1977) and Miller (1993) (*Table 3-58*). Lewis (1977) found six species of fish in the middle and lower portions of Pinto Creek in 1975 and 1976. Three fish species, desert sucker, longfin dace, and green sunfish, were found in areas adjacent to the old Carlota Mine by Miller (1993). Desert sucker and longfin dace are native to Arizona and are on the Forest Service sensitive list (Miller 1993). The mosquitofish is a non-native species. Species diversity has apparently declined since 1976; however, the species lost were not native to the drainage. The Tonto National Forest collected only three species, longfin dace, desert sucker, and green sunfish, in 1992 near the Pinto Valley weir on Pinto Creek (Miller 1993). Longfin dace was the most abundant species. The green sunfish is an introduced species. Special status fish species are listed in *Table 3-59* and discussed in the Special Status Fish Species section.

Recent surveys conducted by Miller & Associates (1995) in Pinto Creek identified four species: longfin dace (*Figure 3-27*), desert sucker (*Figure 3-28*), mosquitofish, and green sunfish. The most abundant species was the longfin dace. Collections in May 1993 were dominated by juvenile and young-of-the-year of all species. Few adult specimens were collected at any site. Adult numbers were higher in the September

Table 3-57. Summary of Habitat Characteristics at Study Sites in Pinto Creek and Powers Gulch May 1993 and Haunted Canyon April 1994

Site	Total Length (ft)	Percent of Total Area			Average Depth (ft)			Average Width (ft)			Average Pool Residual Depth (ft)
		Pool	Riffle	Glide	Pool	Riffle	Glide	Pool	Riffle	Glide	
1	8,263	8.45	67.34	24.21	1.09	0.51	0.72	14.2	9.29	15.73	2.14
2	9,269	2.02	64.13	33.85	1.40	0.49	0.66	11.6	10.08	13.29	2.28
3	1,945	8.42	40.25	51.34	1.10	0.54	0.98	14.0	11.38	17.67	2.17
4	1,818	8.31	42.81	48.88	2.30	0.69	0.96	26.5	10.88	21.20	4.75
5	4,878	0.70	84.19	15.10	1.60	0.94	0.88	18.0	18.27	19.17	2.50
6	4,922	8.60	86.19	5.21	1.68	0.46	0.83	10.8	4.89	8.00	3.32
HC	3,547	36.69	39.58	23.73	1.75	0.49	.94	16.15	9.29	13.86	2.52

HC = Haunted Canyon

Table 3-58. Summary of Fish Species Identified in Pinto Creek and Haunted Canyon

Species Common Name	Scientific Name	Study		
		Lewis (1977)	Miller (1993)	Miller & Associates (1995)
Fathead minnow	*Pimephales promelas*	X		
Golden shiner	*Notemigonus chrysoleucas*	X		
Longfin dace	*Agosia chrysogaster*	X	X	X
Mosquitofish	*Gambusia affinis*	X		X
Desert sucker	*Catostomus clarki*	X	X	X
Green sunfish	*Lepomis cyanellus*		X	X

sampling, but were relatively uncommon (*Table 3-60 and Figures 3-27 and 3-28*). The presence of desert sucker juveniles at Site 3 may indicate that colonization of Pinto Creek is occurring from fish populations in Haunted Canyon. The 1992 and 1993 flood and spill may have influenced fish densities, particularly adult longfin dace and desert sucker, during the May 1993 sampling. Adult desert sucker and longfin dace were relatively common in Haunted Canyon collections taken in April of 1994 (Miller & Associates 1995). Haunted Canyon may serve as the source of fish that recolonize Pinto Creek after extreme flood events or spills. Miller & Associates (1995) reported that no fish were collected or observed in Powers Gulch in May or September 1993. The Arizona Game and Fish Department reported an occurrence of longfin dace in Powers Gulch, downstream of Mule Spring, in November 1992.

Total fish densities and catch-per-unit effort in Pinto Creek are shown in *Figures 3-29 and 3-30*. In general, total fish densities were relatively low in May, when fish/meter $(m)^2$ was less than 0.2 at all sites. Total fish densities in September were considerably higher at sites 2, 3, and 4, with numbers ranging from approximately 2 to 5 fish/m^2. Sites 1 and 5 exhibited densities of 0 and 0.14 fish/m^2, respectively, in September. Catch-per-unit efforts ranged from approximately 0.1 to 10.3 fish/minute in May and 0 to 64.7 fish/minute in September. Haunted Canyon sampling in April 1994 resulted in 1.82 fish/m^2 and a catch rate of 27.9 fish/minute.

Based on surveys conducted by Miller & Associates (1995) in May and September of 1993, macroinvertebrate communities in Pinto Creek and Powers Gulch exhibited low to high densities, depending upon the sampling site and sample date. In Pinto Creek, mean densities ranged from approximately 2,083 to 23,218 individuals/m^2 in May and 1,454 to 10,437 individuals/m^2 in September (*Figure 3-31*). The mean density in Powers Gulch was 3,153 individuals/m^2 in May. Samples were not collected in this stream in

Table 3-59. Special Status Fish Species Potentially Occurring or Historically Occurring in the Carlota Project Area

Common Name	Scientific Name	Status
Gila topminnow	*Poeciliopsis occidentalis*	LE, S
Longfin dace	*Agosia chrysogaster*	C2, S
Desert sucker	*Catostomus clarki*	C2, S
Gila chub	*Gila intermedia*	C

Status:
Federal (USDI Fish and Wildlife Service 1992, 1993)
LE = Taxa listed by the U.S. Fish and Wildlife Service as Endangered under the ESA.
Forest Service (USDA Forest Service 1988)
S = Classified as "sensitive" by the Regional Forester when occurring on lands managed by the U.S. Forest Service.
C2 = Category 2 Candidate. Taxa with the C2 designation were listed as such at the initiation of the Carlota EIS analysis. Since that time, the U.S. Fish and Wildlife Service has issued a more recent listing of candidate species (Federal Register 61: 7596-7613, February 28, 1996). As a result of this update, none of the fish species addressed by the EIS are listed as candidate (C2) species.
C = Candidate species by the U.S. Fish and Wildlife Service. Three preserved specimens of Gila chub recently were found at the University of Michigan, Museum of Zoology. The Gila chub specimens were collected from Haunted Canyon on July 2, 1959 by C.R. Gilbert (Collection No. Z176179). No Gila chub were found during the multiple aquatic surveys conducted in 1977, 1993, and 1994.

September because water was not flowing. The highest macroinvertebrate densities occurred at Sites 3 and 4 in Pinto Creek. Macroinvertebrate biomass varied at the sampling sites during both sampling periods. Mean biomass in Pinto Creek ranged from 0.43 to 3.34 grams (g)/m^2 in May and 1.18 to 3.48 g/m^2 in September.

The most abundant macroinvertebrate taxa were generally similar in Pinto Creek and Powers Gulch. In May, mayflies (*Baetis* sp.), chironomid midges (Orthocladiinae and Tanytarsini), and blackflies (*Simulium*) dominated the macroinvertebrate numbers. Blackflies accounted for the relatively high macroinvertebrate densities at Sites 3 and 4 in May. In September, mayflies continued to dominate the macroinvertebrate numbers. Caddisflies and chironomid midges were the other abundant macroinvertebrate groups in September. Mayflies caddisflies, and blackflies are indicators of generally good water quality conditions. However, many of the species present in the samples are early colonizers, which suggests that good water quality and/or sufficient flow may have only existed for a few months. Macroinvertebrate community structure in Pinto Creek and Powers Gulch during the May 1993 sampling period appears to have been primarily influenced by the flooding or spills that occurred 6 months prior to the sampling. Acute levels of copper exceeded ADWR standards (Hargis & Associates 1993). Species diversity and Diversity and Taxa (DAT) indices were relatively low in both streams in May. The DAT indices resulting from the survey by Miller & Associates (1995) were similar to values that were reported by the Forest Service (USDA Forest Service 1992a). The majority of invertebrates collected in large numbers (*Baetis, Simulium,* and Orthocladiinae) from each station were typically those insects associated with rapid colonization. It is likely that the low diversity values listed in *Table 3-61* are the result of community assemblages that had not attained a balanced state since the flooding. Thus, rapidly colonizing invertebrates were dominant, and they represented an atypically large proportion of the macroinvertebrate community.

Macroinvertebrate species diversities in September were higher at Sites 3, 4, and 5 in Pinto Creek when compared to the May survey. Mean diversities ranged from approximately 2.7 (Sites 2 and 5) to 3.1 (Sites 3 and 4). The DAT indices increased at all four Pinto Creek sites that were sampled in September, with values ranging from approximately 10.4 (Site 3) to 17.6 (Site 5). Since DAT indices at Sites 2, 4, and 5 ranged from 11 to 17, macroinvertebrate communities were indicators of good water quality conditions. A DAT of 10.4 at

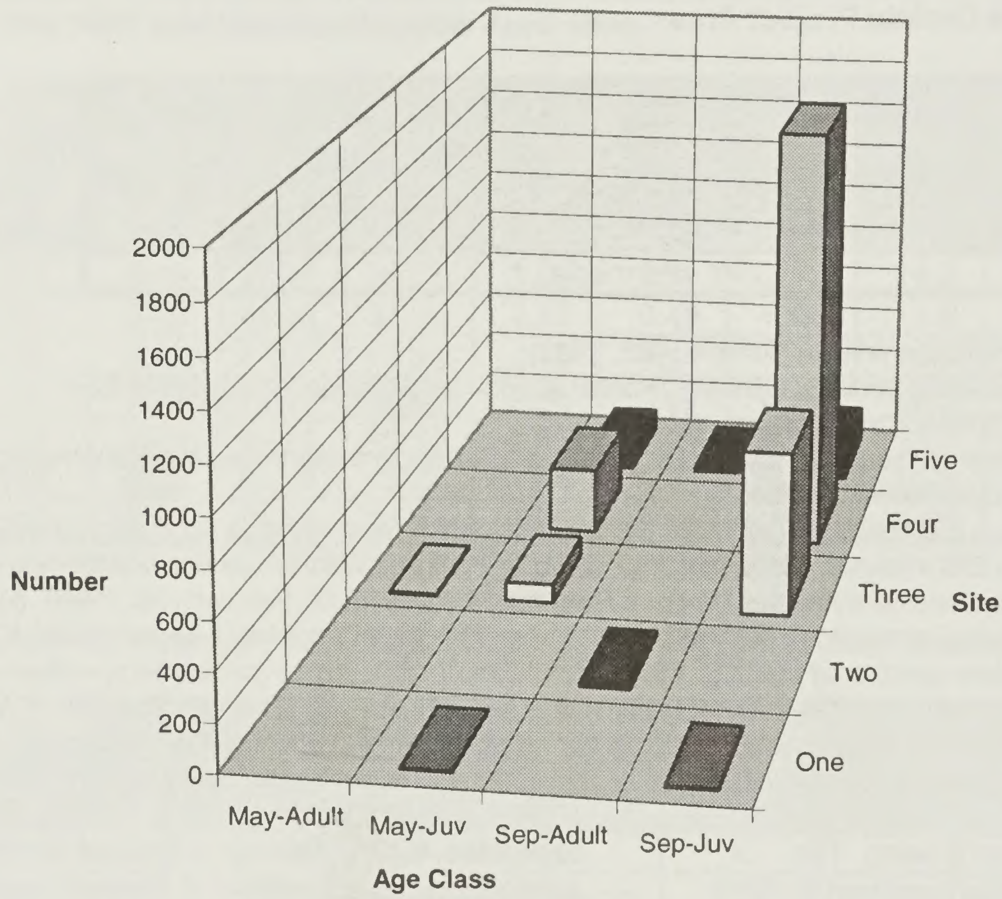

Figure 3-27. Number of Longfin Dace Collected at Pinto Creek Sites in 1993 by Age Class

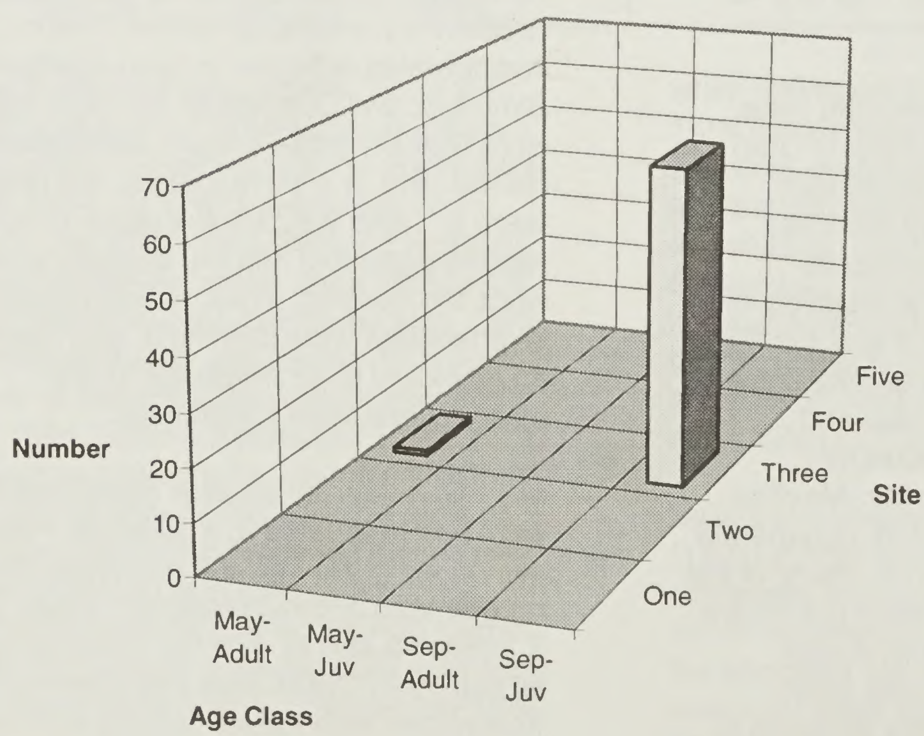

Figure 3-28. Number of Desert Sucker Collected at Pinto Creek Sites in 1993 by Age Class

Table 3-60. Species and Age Class of Fish Collected in Pinto Creek in May and September of 1993 and in Haunted Canyon in April of 1994

Site	Species	Number	Length (mm)		Weight (gm)	
			Median	Range[1]	Median	Range[1]
May 1993						
1	Green sunfish	1	158		80	
	Longfin dace	5	YOY			
2	Green sunfish	4	103	83-138	23	11-46
3	Desert sucker	1	223		142	
	Longfin dace (adult)	9	78	66-84	5.8	3-7.5
	Longfin dace	6	Juv			
	Longfin dace	72	YOY			
4	Longfin dace	279	YOY			
5	Longfin dace	93	YOY			
September 1993						
1	Longfin dace	6	Juv			
	Mosquito fish	1	Juv			
2	Longfin dace (adult)	17	62	48-72	3	2-4
	Green sunfish	1	169		78	
	Green sunfish	19	YOY			
	Mosquito fish	6	Juv			
3	Longfin dace	700	Juv			
	Desert sucker	62	89	72-96	9	5-12
	Green sunfish	2	56.5	48-65	---	---
4	Longfin dace	1826	Juv			
5	Longfin dace	22	75	62-85		
	Longfin dace	153	Juv			
	Mosquito fish	23	Adult			
April 1994						
Haunted Canyon	Longfin dace (adult)	95		47-84		0.6-7.3
	Longfin dace (juvenile)	80				
	Desert Sucker (adult)	33		52-175		0.6-76
	Desert Sucker (juvenile)	89				
	Green sunfish	135		28-175		0.4-126

[1] Size range for all fish captured.
YOY- young of the year
Juv- juvenile

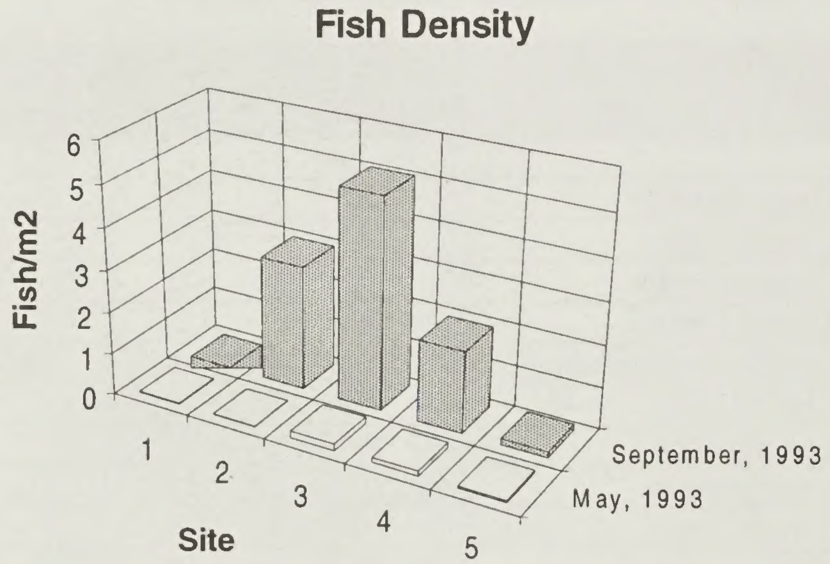

Figure 3-29. Fish Densities in Pinto Creek, May and September, 1993

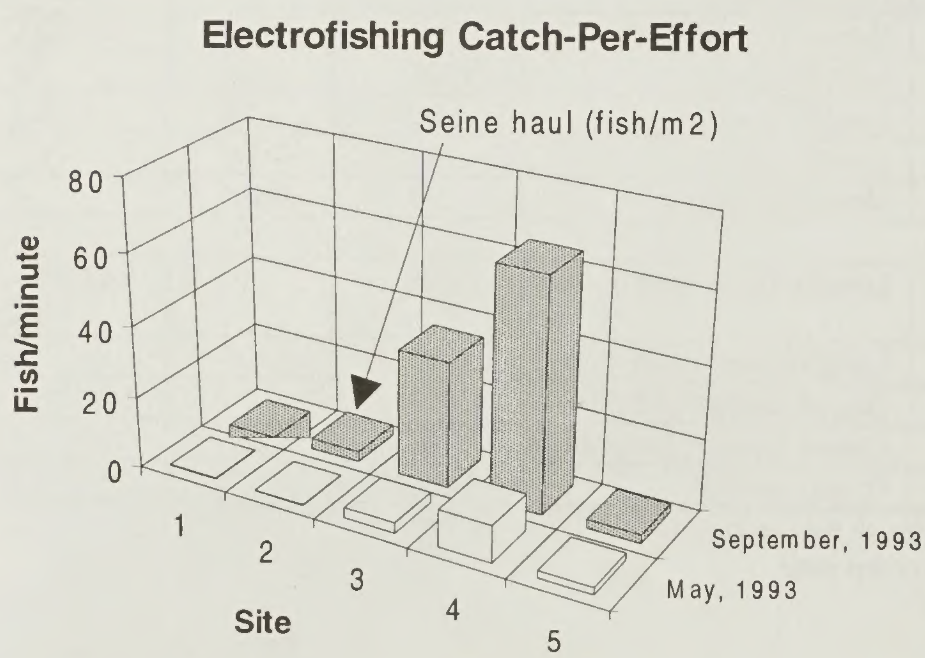

Figure 3-30. Catch-Per-Effort from Electrofishing Surveys Conducted in Pinto Creek, May and September, 1993

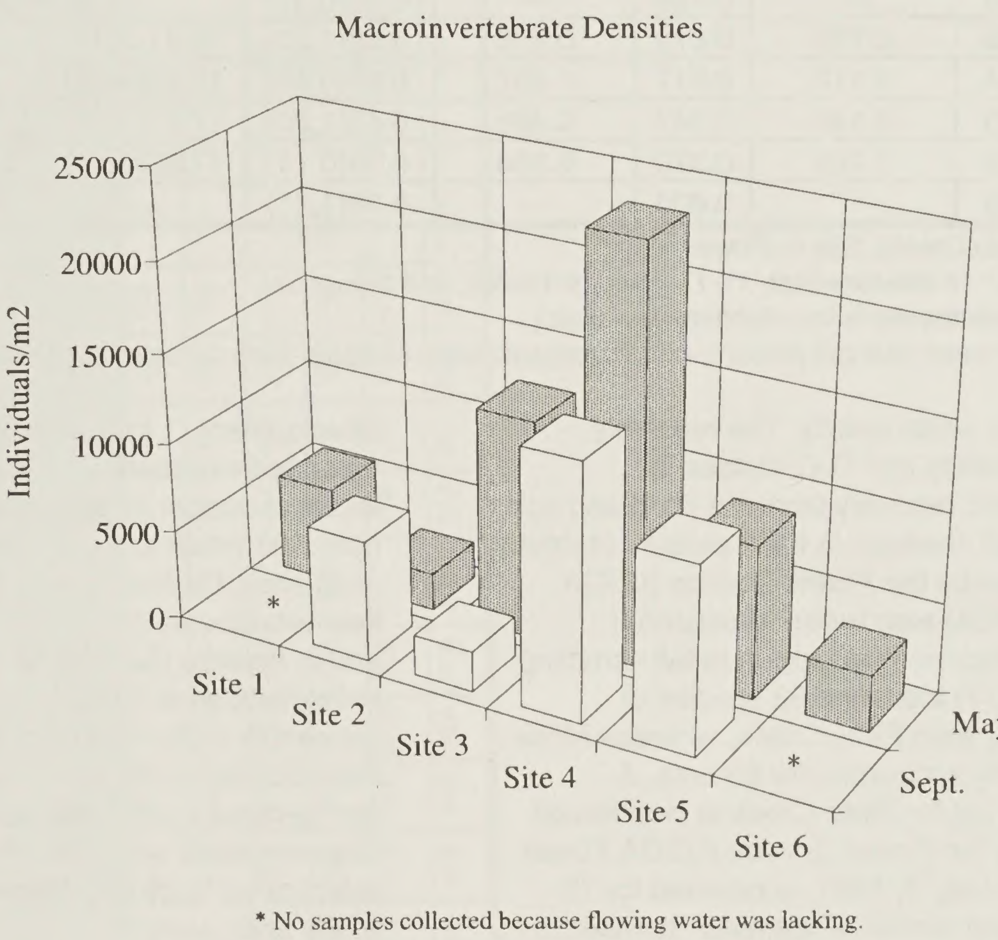

Figure 3-31. Macroinvertebrate Densities in Pinto Creek (Sites 1-5) and Powers Gulch (Site 6), May and September, 1993

Table 3-61. Summary of Shannon-Weaver Diversity, Evenness, DAT Index, and Number of Taxa in Pinto Creek and Powers Gulch

	Diversity		Evenness		DAT[1]		Mean No. of Taxa	
Site[2]	May	September	May	September	May	September	May	September
1	1.865	---[3]	0.466	---	6.29(0.37)	---	12.3	---
2	2.886	2.730	0.679	0.436	9.48(1.26)	14.41(2.44)	14.7	20.7
3	1.854	3.110	0.517	0.837	5.28(0.66)	10.43(2.28)	9.7	14.3
4	1.473	3.140	0.347	0.486	6.43(1.20)	17.17(1.51)	16.0	24.7
5	1.649	2.725	0.370	0.360	6.34(0.11)	17.59(1.24)	13.3	25.0
6	2.453	---[3]	0.600	---	8.34(1.21)	---	12.3	---

[1] Sites 1-5 (Pinto Creek), Site 6 (Powers Gulch).
[2] Scale for DAT: 18-26=excellent, 11-17=good, 6-10=fair, and 0-5=poor.
(Number in parentheses is the standard deviation.)
[3] Since flowing water was not present, no macroinvertebrate samples were collected at these sites.

Site 2 indicated fair water quality. The relatively higher species diversity and DAT indices in September indicated recovery from the flood and spill, as well as seasonal changes in the macroinvertebrate community. Studies by the Forest Service (USDA Forest Service 1992a) also reported seasonal increases in DAT indices from spring to fall sampling periods. Lewis (1977) identified 53 species of macroinvertebrates from Pinto Creek, whereas Miller & Associates (1995) accounted for 60 taxa. A macroinvertebrate list for Pinto Creek at Henderson Ranch reported by the Forest Service (USDA Forest Service 1992a) on May 5, 1991, accounted for 13 taxa, which was very similar to the mean number of taxa (13.3) collected by Miller & Associates at this site. However, the Forest Service collected three insect taxa at this site *(Leuctridae, Capniidae, and Carabidae)* that Miller & Associates (1995) did not detect at any station on Pinto Creek or Powers Gulch. The most logical explanation for this apparent shift of taxa in the community assemblage is that some species may still be in the process of recovering from the flood event and spills.

Fish and macroinvertebrate tissues collected from Pinto Creek were analyzed for bioaccumulation of heavy metals by Lewis (1977) and Miller & Associates (1995) (*Table 3-62*). Sufficient fish biomass for tissue analyses was obtained only from Sites 3, 4, and 5 in Pinto Creek by Miller & Associates (1995). Sufficient macroinvertebrate tissue was collected at all sites. It is important to point out that the majority of the macroinvertebrate biomass was composed of dobson flies *(Megaloptera)*. Dobson flies are relatively long-lived invertebrates in their aquatic stage of development (1 to 3 years), which would allow extended exposure to water quality conditions. Low levels of copper, manganese, and zinc were detected in fish and macroinvertebrate tissues at all sites. Cadmium was detected in macroinvertebrates at Sites 3, 4, and 5 in Pinto Creek and in Powers Gulch (Site 6). Cadmium was found in fish tissues at Sites 4 and 5. Lewis (1977) reported noticeably higher levels of heavy metals in macroinvertebrates compared to the May 1993 samples and generally higher levels in fish viscera samples. Copper values were similar between Lewis' (1977) eviscerated body and Miller & Associates' (1995) whole body samples.

Special Status Fish Species. Three fish species, Gila topminnow *(Poeciliopsis occidentalis)*, desert sucker *(Catostomus clarki)*, and longfin dace (*Agosia chrysogaster*), were evaluated for the proposed Carlota Copper Project based on their historic and current distribution in the general region. The Gila topminnow is a Federal Endangered species and Forest Service Sensitive species; the desert sucker and longfin dace are Forest Service Sensitive Species.

Gila Topminnow. This species is native to the Salt River basin in Arizona. Pinto Creek is within the historic range, although no fish surveys conducted on Pinto Creek reported Gila topminnow in the collections. The Gila topminnow was formerly abundant in streams below 1,500 meters elevation in the Gila River basin. It is now restricted in occurrence and classified as Federal Endangered (listed March 11, 1967). The Gila topminnow habitats include vegetated

Table 3-62. Results of Aquatic Biota Tissue Analyses for Pinto Creek and Powers Gulch

	SITE																					
	Pinto Creek 1		Pinto Creek 2				Pinto Creek 3				Pinto Creek 4					Pinto Creek 5					Powers Gulch 6		Lewis (1977)
	May 1993	Sept. 1993	May 1993	Lewis (1977)	May 1993	Sept. 1993	May 1993	Sept. 1993	May 1993	Sept. 1993	May 1993	Sept. 1993	Lewis (1977)	May 1993	Sept. 1993	May 1993	Sept. 1993	Lewis (1977)	May 1993	Sept. 1993	May 1993	Sept. 1993	Pinto Creek[1]
Parameter	B[2]	F[3,4]	B	B	B,F	F	B	B	F	F	B	B	B	F	F	B	B	B	F	F	B	F	F[1]
Cadmium (mg/kg)	<0.1	NS[5]	<0.1		NS	<0.1	0.2	0.3	<0.1	<0.1	0.1	<0.1		0.2	<0.1	0.2	0.2		0.2	<0.1	0.5	NS	1.2
Copper (mg/kg)	22.0		20.0	328.0		7.0	14.0	7.8	4.0	8.4	11.0	5.8	172	2.8	2.6	11.0	6.6	44	3.2	3.8	6.4		63.0
Mercury (mg/kg)	<0.2		<0.2			<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2	<0.2		<0.2	<0.2	<0.2		<0.05
Manganese (mg/kg)	19.0		30.0	544.0		48.0	34.0	100	5.0	36.0	9.0	19.0	300	1.7	2.4	18.0	46.0	296	3.4	2.4	6.0		11.3
Lead (mg/kg)	<1.0		<1.0			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0	<1.0		<1.0	<1.0	<1.0		3.5
Zinc (mg/kg)	20.0		26.0	122.0		24.0	26.0	32.0	40.0	30.0	22.0	22.0	220.0	19.0	26.0	26.0	22.0	120.0	22.0	22.0	44.0		44.0

[1]Composite Fish Tissue Samples
[2]B = Benthos
[3]F = Fish
[4]Whole Body
[5]NS = No Sample

springs, brooks, and the margins and backwaters of larger water bodies.

Surveys were conducted at six locations in Pinto Creek and Powers Gulch in May and September of 1993. Haunted Canyon was surveyed in April 1994. No individuals of Gila topminnow were found at any of the sites during the collection periods. The absence of the Gila topminnow in the Pinto Creek drainage may be caused by competition with the mosquitofish and habitat modifications. Mosquito fish are known to exclude populations of Gila topminnow when they come in contact through direct predation and competition.

Desert Sucker. This sucker species is native to Pinto Creek and the Gila River basin. The desert sucker was reported in historic fish surveys of Pinto Creek in the 1970s, 1980s, and 1990s. The desert sucker is characteristic of small to moderate size streams with pool and riffle habitats. Young desert sucker inhabit riffles. Larger adult desert sucker inhabit pools during the day and move to riffles at night to feed. The desert sucker was generally common but is now becoming rare in some locations. The species is usually sedentary with little seasonal movement or displacement even during normal high flows. Larval sucker can drift downstream with flow. Juveniles feed mainly on chironomid larvae and adults are primarily herbivorous, feeding on algae scraped from stones as well as plant detritus.

Spawning occurs in riffles in late winter through spring (January through May) in Arizona. Larvae are mature at the end of the second year of life at a length of 85-120 millimeters (mm). The desert sucker showed evidence of reproducing in the Pinto Creek drainage in 1993. Juvenile desert sucker were collected in a perennial reach of Pinto Creek in the downstream project area by Miller & Associates (1995).

Six locations in Pinto Creek and Powers Gulch were surveyed in May and September 1993 for the desert sucker and other fish species. The desert sucker was collected from Site 3 on Pinto Creek approximately 0.25 mile upstream of the Iron Bridge. At this site one adult desert sucker was collected in May 1993 and several juvenile desert suckers were collected in September. Additional sampling in Haunted Canyon in April 1994 resulted in the collection of all age classes of desert sucker. Spawning was observed at one location. Previous surveys in 1992 by the Forest Service and the Arizona Game and Fish Department report collecting desert sucker at locations downstream of the project area near the Henderson Ranch (approximately 10 miles downstream of the proposed project). The Forest Service and Arizona Game and Fish Department did not conduct any sampling in the project area in 1992.

Longfin Dace. The longfin dace is native to Pinto Creek and the Gila River basin according to the historic collections in the 1970s, 1980s and 1990s, and is the most abundant species found in Pinto Creek. The longfin dace is found in small to moderate streams. Young longfin dace are found in slow velocity habitats near stream margins. Adults are found in deep shaded pools as well as in larger substrate, faster velocity habitats.

Longfin dace spawning occurs from December through May over sand. Larvae become mature within the first year of life. Longfin dace exhibit a high tolerance for elevated water temperatures and reduced oxygen, and it is commonly the only native species present at the terminus of desert streams where flows disappear. Adults feed on detritus, zooplankton, aquatic insects, and filamentous algae.

Surveys were conducted in Pinto Creek and Powers Gulch in May and September of 1993 and in Haunted Canyon in April of 1994. Longfin dace were collected or observed at all Pinto Creek sites upstream, within, and downstream from the project area. It was the most abundant species collected in the drainage. Most of the specimens collected in 1993 were young-of-the-year or juveniles. The only adult specimens collected in May of 1993 were at the Iron Bridge location. Several adults were observed at other locations but were not captured. The abundance of juveniles in the September survey also indicates that adults were present in the drainage. The April 1994 survey had an almost even distribution between adult and juvenile longfin dace.

Waters of the U.S. COE regulates the discharge of dredged and/or fill material into waters of the U.S., including adjacent wetlands, under Section 404 of the Clean Water Act (33 U.S.C. 1344). Waters of the U.S. are defined as "all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce including all waters which are subject to the ebb and flow of the tide; all interstate waters including interstate wetlands; all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the U.S.; tributaries of waters identified above; territorial seas; and wetlands adjacent to waters identified above" (33 CFR 328.3).

Waters of the U.S. are determined by the presence of an ordinary high water mark. Of the 157 evaluated stream reaches in the project area, 55 were determined to be waters of the U.S. for a total area of 34.1 acres (*Figure 3-32*). Of the 34.1 acres of jurisdictional waters identified, 3.81 acres were delineated as wetlands using the 1987 COE Wetlands Delineation Manual (*Figure 3-32*). Wetlands are defined as areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas [(33 CFR 328.3(b)]. A wetland delineation in the well field area has not been conducted.

Small intermittent springs occur at scattered locations throughout the project area. Three perennial springs were identified in the project area: (1) Yo Tambien, (2) Mule, and (3) Grizzly Bear. The Forest Service maintains water rights on these three springs. The COE has delineated Yo Tambien and Mule springs as jurisdictional wetlands.

Yo Tambien Spring is located in the southeastern portion of the project area, where seepage from an old collapsed mining adit (Yo Tambien Mine) flows across the old facilities pad and down into Pinto Creek (*Figure 3-32*). At the point where seepage crosses the old pad, a very small wetland (less than 0.05 acre in total area) has formed. This spring is dominated by cattail (*Typha* sp.). Mule Spring is an undeveloped perennial spring near the head of West Powers Gulch drainage (*Figure 3-32*). This spring appears to be perennial and one of the long-term contributors of moisture to lower Powers Gulch. Flow from this spring has contributed to the development of a small wetland area. This wetland is approximately 0.33 acre in area. Grizzly Spring is an undeveloped spring that remains moist year-round, though there is often no surface water.

3.5.2 Environmental Consequences

This section describes the direct and indirect effects of the proposed action and alternatives on biological resources. The biological issues identified during the scoping process are listed below.

- Loss or degradation of on-site and off-site aquatic and terrestrial habitat
- Impacts to wildlife habitat caused by reduction in streamflow, habitat fragmentation, movement restriction, or decreased access to water
- Direct, indirect, and cumulative impacts to special status plant, wildlife, and fish species
- Direct, indirect, and cumulative impacts to other plant and wildlife species
- Chemical contamination of flora and fauna

3.5.2.1 Proposed Action

<u>**Terrestrial Resources**</u>

Criteria that were used to evaluate potential impacts of the proposed project and the alternatives on vegetation and wildlife resources are listed below.

- Vegetation
    - Acres of habitat loss or degradation by general type (e.g., upland, wetland or riparian, waters of the U.S.) and specific type (e.g., cottonwood-willow, chaparral)
    - Relative value of habitat types
    - Number of threatened or endangered plant species affected by the project and number of individuals affected relative to species status elsewhere

- Acres of potential and occupied habitat for threatened or endangered species affected, rated according to habitat quality
- Sensitive species whose viable populations may be affected
- Air quality impacts to native vegetation from chemicals or particulates

- Wildlife
  - Habitat fragmentation or corridor disruption impacts
  - Number of threatened or endangered wildlife species affected by the project and number of individuals affected
  - Acres of potential and occupied habitat for threatened or endangered species
  - Sensitive species whose viable populations may be affected
  - Impact to other wildlife species and estimated populations displaced
  - Potential exposure of wildlife to contaminated water sources
  - Impacts to wildlife species from accidental release of chemicals

Vegetation.

Interior Chaparral. Interior chaparral is a very common habitat on the northern slopes of the nearby Pinal and Superstition mountains. It is used by a variety of wildlife species including deer, collared peccary, black bear, and white-nosed coati, for foraging and cover. Of the 1,532 acres (49.5 percent of the project area) of interior chaparral that occur within the project area, approximately 798.14 acres (including 7.14 acres of mesic chaparral) would be directly affected by the proposed action. A few additional acres of this habitat type adjacent to the immediate impact area may be indirectly affected by erosion. Relative to the amount of this habitat available in the Pinal Mountains, the number of acres directly and indirectly affected by the proposed action would be relatively inconsequential.

Rubbleland Chaparral. Rubbleland chaparral is used to a somewhat lesser degree by the same species as discussed for interior chaparral. Although approximately 494 acres of rubbleland chaparral occur within the project area, this vegetation type would not be directly or indirectly affected by the proposed action.

Dry-Slope Desert Brush. A total of 886 acres (28.6 percent of the project area) of dry-slope desert brush occurs within the project area. Of this area, approximately 488 acres would be directly affected by the project. An additional 2 acres of rock outcrop (associated with the Dry-slope Desert Shrub type) would be directly affected by the project. A small number of additional acres of this habitat type adjacent to the immediate impact area may be indirectly affected by erosion. Relative to the amount of this habitat available in the Pinal and Superstition mountains, the loss of dry-slope desert brush habitat by the proposed action would be very small.

Juniper/Grassland. A total of 131 acres (4.2 percent of the project area) of juniper/grassland habitat occurs within the project area. Of this area, 118 acres would be directly affected by the project. A few additional acres of this habitat type adjacent to the immediate impact area may be indirectly affected by erosion. Since this habitat type also is found at scattered locations throughout the Pinal and Superstition mountains, the loss of a small amount of juniper/grassland would be inconsequential.

Riparian Habitat. A total of 57 acres (1.8 percent of the project area) of interior riparian deciduous woodland, including spring-related habitats, occurs within the project area (see Section 3.5.1.1, Biological Resources - Terrestrial Resources, for a description of these areas). The riparian community is mapped in *Figure 3-25*. Of this area, 21.86 acres would be directly affected by the proposed action. A large portion of this riparian habitat occurs along the two stream reaches that would be cut off from streamflows because of the Pinto Creek and Powers Gulch diversions. In total, the 12.40 acres of directly affected riparian zone habitats is composed of the

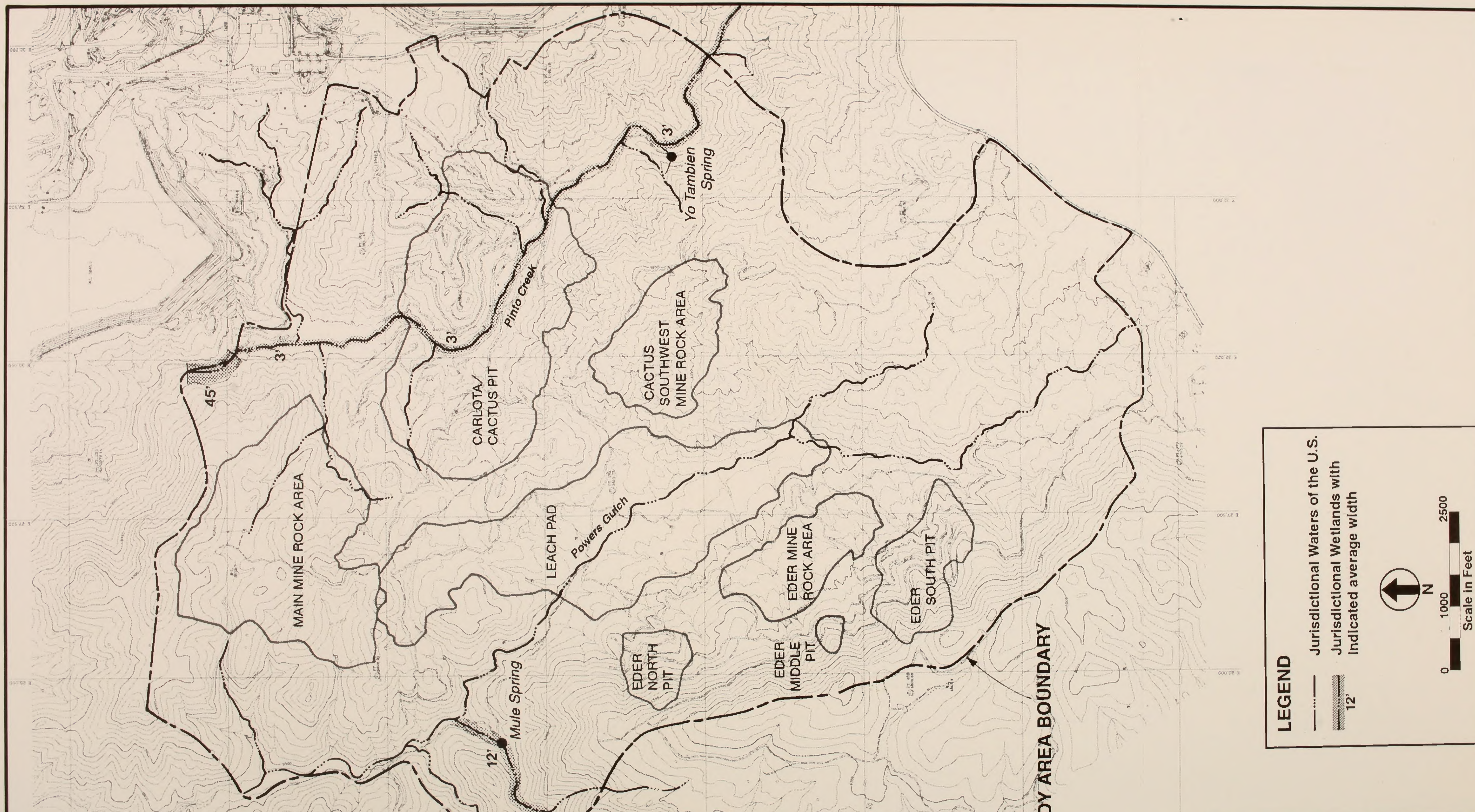

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Figure 3-32

Location of Jurisdictional Wetlands and Waters of the U.S.

following: 3.40 acres of riparian public land in Pinto Creek, 8.10 acres of riparian private land in Pinto Creek, and 0.90 acre of riparian public land in Powers Gulch. Within the riparian zone, additional acreage of wetlands and Waters of the U.S. would be directly affected (see Waters of the U.S. discussion in the Aquatic Resources section). In addition, approximately 16.1 acres of riparian vegetation occur in lower Haunted Canyon in the vicinity of the well field. An additional 15.9 acres of riparian vegetation are located in Pinto Creek across from the well field. These latter two areas are beyond the area of direct impact of the pit and other project features immediately adjacent to the pit but could be indirectly affected by well field operations.

The potential exists for additional impacts to riparian vegetation from spills or short-term changes in water quality during construction or as a result of changes in hydrology associated with excavation and the ground water drawdown associated with pumping the water supply wells. Other potential indirect impacts to this vegetation type include siltation in the immediate vicinity of the diversion intake control structure and downstream of the proposed Pinto Creek diversion, and changes in air and water quality. The loss of riparian habitat would be considered important because of its value to wildlife and its limited existence in the project area.

The anticipated levels of surface and ground water drawdowns from stream diversion, pit dewatering, and well field development are discussed in Section 3.3.2, Water Resources - Environmental Consequences. The actual effects of such activities on riparian ecosystems would mainly result from an incremental increase in the aridity of the riparian habitat. Pools would be smaller and more infrequent, and intermittent stretches would become more predominant. This increasing aridity would place an increased stress on the deciduous trees that dominate the floodplain environment and could cause increased mortality, especially during the normal May-June drought period. More importantly, increasing aridity could limit successful recruitment of young trees.

Special Status Plant Species. Based on information presented in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d), the Arizona hedgehog cactus is the only federally listed threatened, endangered, or proposed plant species that could be affected by development of the Carlota Copper Project.

Arizona Hedgehog Cactus. Approximately 23.94 acres of occupied Arizona hedgehog cactus habitat would be directly affected by the proposed action. In terms of acres disturbed and numbers of individual plants affected, the majority of the impacts would be associated with the mine pits and a few project area roads. The Powers Gulch stream diversion channel and the leach pad would result in relatively few conflicts with the cactus. The mine rock disposal areas, access roads, conveyors, warehouse facility, and mine pits could affect potential, but unoccupied, Arizona hedgehog cactus habitat. Of these latter project components, most of the impacts to unoccupied habitat would be associated with the mine rock disposal areas. The number of individual cacti and acreages for both occupied and potential habitat are quantified for the various project components in the Final Biological Assessment and Evaluation prepared for the project (Cedar Creek Associates, Inc. 1994d). Of the 1,150 cacti within the 100 percent survey area, only 207 were found to be in direct conflict with planned project facilities. An additional 12 cacti were located close enough to mine pits and/or roads and rooted upon unstable material such that vibration from blasting activities could place them at risk.

A few additional cactus plants may be subject to additional direct effects by the proposed action because of their proximity to the proposed pits or their location immediately adjacent to the Powers Gulch diversion outfall. These individuals could be affected by a potential spill of contaminated water from the leach pad or erosion as a result of waterflow as it exits the diversion. These potential impacts are discussed further in Section 3.3, Water Resources. Mitigation measure WR-12 addresses outfall erosion. The U.S. Fish and Wildlife Service accounted for such possible additional effects in its Biological Opinion (see Appendix F).

Despite the loss of 23.94 acres of occupied habitat, 217 individual plants, and 237.6 acres of potential habitat as direct effects of project implementation, mitigation measures discussed under Section 3.5.4 are expected to compensate for these losses. The U.S. Fish and Wildlife Service (1996) has concurred with this conclusion with its issuance of a "non-jeopardy" opinion in its Biological Opinion on the effects of the Carlota Copper Project. Even without mitigation, there would be a natural recovery of losses over time since additional habitat would be created (similar to cactus colonization sites observed along Highway 60) and since a positive recruitment ratio of 1.65 new recruits to each mortality was documented for the cactus in the field by Cedar Creek Associates, Inc. (1994d).

Wildlife. Numerous species of wildlife, including insects and other arthropods, amphibians, reptiles, birds, and mammals, would be directly affected.

Both upland and riparian vegetation types, which provide foraging and breeding habitat for wildlife species, would be affected by the proposed action. Acreages of vegetation types lost are discussed in the previous vegetation section. The loss of habitat would result in indirect effects to wildlife that use the project area for foraging or breeding but are sufficiently mobile to escape direct impact. This would include many species of birds, bats, and other small animals that would be driven out of the area by construction and operation activities.

Big game species that may be indirectly affected by implementation of the proposed action would include mule deer, white-tailed deer, collared peccary, black bear, and mountain lion. Reliable population estimates are not available for the vast majority of wildlife species inhabiting the project area, but Arizona Game and Fish Department big game surveys conducted in Unit 24B (which includes the project area) provide information on the potential impacts of the project on populations of the most common large mammals. These data indicate minimum and maximum density estimates of 7 to 15 white-tail deer per square mile, 1 to 7 mule deer per square mile, and 1 to 3 collared peccary per square mile. The total loss of 1,428 acres of habitat for all of these species could result in the loss of approximately 17 to 37 white-tail deer, 2 to 17 mule deer, and 2 to 7 collared peccary. It is important to note that there would be a loss of future generations of these animals, as well as nongame wildlife, through time until the habitat value of the site is restored.

Habitat fragmentation is a concern where loss of habitat continuity could result in populations of a species becoming isolated from others of the same species, thereby preventing genetic interchange and resulting in the potential loss of viability as large-scale habitats are converted from being suitable to hostile. For the Carlota Copper Project, fragmentation would not be an issue for any species since habitat conversion would not be on a large enough scale to be a threat to any given species (see following discussions on threatened, endangered, and other wildlife species of concern).

Project development would result in a short-term disruption of the Pinto Creek stream channel until development of the Pinto Creek diversion channel has been completed. For birds and mammals, this would not disrupt any movement linkages between populations or important habitat areas. Wildlife species that use the Pinto Creek stream channel as a movement corridor have already adapted to a number of naturally occurring areas along the creek bottom where riparian vegetation is lacking and/or vegetation cover is nearly absent.

The disruption of the Pinto Creek channel could isolate upstream populations of amphibians from downstream populations over the short-term until the diversion channel is completed. However, this situation would not result in any loss of species viability because local populations have already adapted to periods of isolation and habitat loss since Pinto Creek seldom carries continuous surface flow between its upstream and downstream segments. Once the diversion channel has been completed, potential interchange between local amphibian populations in the drainage would be maintained during periods when the creek carries continuous flow.

The potential for wildlife exposure to contaminated water sources would be very low with the Carlota Copper Project. There would be only three possible sites during the life of the operation where wildlife could be exposed to potentially toxic process solutions. These sites would be the plant PLS pond and the raffinate pond within the plant operations area and the top of the heap-leach pad if surface pooling of the leachate solution (raffinate) occurs as it is distributed on the heap-leach pad. All other aspects of ore processing would take place within enclosed structures with no risk of wildlife exposure.

Raffinate consists primarily of a sulfuric acid solution (approximate pH of 1 to 2), which could be harmful to wildlife if exposure pathways are provided. The PLS would contain metals and other potentially toxic constituents in solution, in addition to being acidic (see Appendix C, Table C5-3).

Copper ore in the leach pad would be leached by raffinate distributed over the leach pad by solution emitters (drip lines), impulse sprinklers, and/or wobbler sprinklers. Under most conditions, solution emitters would be the preferred distribution mechanism (see Section 2.1.4.2). This distribution method would be the least likely to cause pooling on the heap-leach surface. Operationally, it is not efficient or cost-effective to allow raffinate to pool on the top of the heap-leach facility. As a result, the distribution of raffinate on the heap-leach surface would be constantly monitored by Carlota personnel to ensure its proper distribution and that surface pooling does not occur (see Section 3.5.4). Therefore, the risk of wildlife being attracted to potentially toxic water sources on top of the heap-leach facility would be very low.

Once metal bearing leachate passes through the heap-leach facility, it would be collected within two PLS ponds. The two PLS ponds would be constructed as internal structures within the heap-leach facility; therefore, there would be no surface exposure of PLS at the ponds. However, reclaimed PLS could be recirculated for distribution back on the heap-leach surface to enhance PLS grade or solution management. The risk for wildlife exposure to PLS on the heap-leach surface would be low for the same reasons that exposure risk to the raffinate would be low.

Most of the PLS would be pumped via pipelines from the heap-leach PLS ponds to the plant PLS pond in the operations area (see *Figure 2-5*) and be held there until it is pumped to the SX plant for mineral extraction. Once the metal extraction processes are completed, barren raffinate would be returned and stored in the raffinate pond in the operations area (see *Figure 2-5*) prior to redistribution on the heap-leach surface. The plant PLS and raffinate ponds would be approximately 1 acre in size and would be constructed with a double liner and leak detection system. The pond and pond embankments would be of sufficient size to contain a 72-hour (1/2 - PMF) storm event (see Section 2.1.3.2). Carlota has not proposed any fencing for these ponds and both would have open surface water that could attract wildlife. However, the ponds would be surrounded by mine facilities and operational activities (see *Figure 2-5*) and would not be an attractive water source for wildlife. In addition, the high acidity of the solutions in both ponds would give off an acrid odor and a bitter taste that would repel wildlife before a potential lethal or debilitating dose would be ingested. The chemical makeup of process solutions in Carlota's ponds would be similar to other copper mine operations in Arizona. In contrast to the wildlife mortalities documented for cyanide solution process ponds used by the gold mining industry, wildlife agency personnel in Arizona have not documented similar problems related to wildlife consumption of water from copper mine process solution ponds (Haughey 1997, King 1997).

The raffinate and plant PLS ponds would be monitored on a regular basis by Carlota personnel to determine if there are any wildlife mortalities at the ponds (see Section 3.5.4).

Another potential surface water quality concern for wildlife is the lake that would form in the Carlota/Cactus pit after mine closure. It is projected that a pit lake would form as a result of ground water inflow, collection of surface runoff from the contributing watershed area, and direct precipitation (see Section 3.3.2.1). The pit lake would be available for use by water birds as well as by other more mobile terrestrial species, such as deer, coyote, and songbirds. Modeled projections of water quality in the pit lake (see Section 3.3.2.1 and Appendix Table C5-1) at equilibrium (125 years after closure) indicate that although the pit lake is not subject to Arizona surface water quality standards (Arizona Administrative Code R18-11-102), the only violations of potentially applicable water quality standards would be the predicted value of 4.36 mg/L of fluoride (exceeds the Arizona Aquifer Protection Program standard of 4.0 mg/L) and the predicted value of 275 mg/L of sulfate (exceeds federal secondary MCL for drinking water). There are no agricultural livestock water quality standards or aquatic life criteria for fluoride or sulfate as these constituents are considered to be relatively non-toxic. Projected levels of fluoride and sulfate at the time of pit lake equilibrium would not be expected to have any deleterious effects on water birds or other terrestrial wildlife that may occasionally use the lake for drinking water. Even though the concentrations of some major ions (sodium, chloride, sulfate) and TDS in the pit lake water are likely to increase over time after equilibrium is reached (see Section 3.3.2.1), an increase in these constituents would be unlikely to produce potentially toxic water conditions for wildlife. If levels of sodium, chloride, and sulfate become too high, an unpleasant taste would likely repel wildlife before a debilitating quantity of water could be ingested.

Special Status Wildlife Species. Based on information presented in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d), the bald eagle is the only federally listed threatened, endangered, or proposed wildlife species that could be affected by development of the Carlota Copper Project.

The Final Biological Assessment and Evaluation prepared for the Carlota Copper Project (Cedar Creek Associates, Inc. 1994d) also evaluated the potential for project-related impacts on a number of other species of concern (see *Table 3-55*). Maricopa tiger beetle, Arizona toad, lowland leopard frog, common black-hawk, yellow-billed cuckoo, and loggerhead shrike were determined to be the only species that could be subject to adverse effects. A summary of conclusions from the Final Biological Assessment and Evaluation is provided for each species in this section.

Bald Eagle. No bald eagles were observed in the project area. This species would not be directly affected by the proposed action.

A bald eagle nesting territory is located approximately 15 miles north of the Carlota Copper Project area at Roosevelt Lake (Hunt et al. 1992b). Indirect effects could potentially include the reduction of prey in perennial waters downstream from the project site by accidental releases of contaminated surface waters from leach ponds or seepage into the Pinto Creek drainage, or the build-up of toxic substances in adult or juvenile eagles as a result of ingestion of contaminated prey.

Although a release from the heap-leach facility is not expected during operation or after closure, any major release could have the potential to degrade the quality of Pinto Creek water entering Roosevelt Lake and have an adverse effect on local nesting pairs of bald eagles or on winter transient eagles feeding in the lake.

As indicated in Sections 3.3.4 and 3.5.4, numerous monitoring and mitigation measures are proposed to avoid potential impacts and to reduce or alleviate adverse effects associated with potential changes in surface water quality and quantity. Reductions in surface and near surface flow in Pinto Creek and Haunted Canyon would be mitigated by augmenting flow from the well field or other sources (Cedar Creek Associates, Inc. 1996a). Water quality degradation would be mitigated by promptly identifying the contaminant source, correcting the release source, and implementing remedial measures as necessary. As long as recommended monitoring and mitigation measures are implemented, indirect impacts on eagles feeding in Roosevelt Lake would not occur. The U.S. Fish and Wildlife Service has concurred with this conclusion with its issuance of a non-jeopardy opinion in its Biological Opinion (Appendix F) on the effects of the Carlota Copper Project.

Maricopa Tiger Beetle. The direct loss of stream channel along Pinto Creek and Powers Gulch in the project area would reduce potential foraging habitat for adult Maricopa tiger beetles. This loss of foraging habitat would be mitigated, to a large extent, by the creation of new diversion channels that would carry water during flow periods. The larval stages of this species use undisturbed silty or sand substrate. The predominant substrate along the portions of Pinto Creek and Powers Gulch proposed for direct removal is composed primarily of cobble, gravels, and/or bedrock and would not provide suitable habitat for the burrowing Maricopa tiger beetle larvae. Potential reductions in surface flow along the intermittent Pinto Creek stream channel 2,000 feet above and below the Carlota/Cactus pit would result in minor reductions in the extent of suitable foraging habitat for Maricopa tiger beetle within the Pinto Creek drainage.

As indicated in Section 3.5.1.1, populations of Maricopa tiger beetle are widespread and highly mobile. Further, populations are able to maintain themselves with low numbers and are well adapted for survival and adjusting to environmental changes. Local populations may disappear, but chances of overall extinction of Maricopa tiger beetle are remote.

The Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d) concluded that project development may adversely affect a few adult Maricopa tiger beetles and reduce the total extent of foraging habitat, but would not likely adversely affect populations of Maricopa tiger beetle within the Pinto Creek drainage.

Arizona Toad and Lowland Leopard Frog. These species were identified at several locations in and near the project area along Pinto Creek (Cedar Creek Associates, Inc. 1994b). In the project area, as well as downstream, flowing portions of Pinto Creek, Powers Gulch, West Powers Gulch, and Haunted Canyon represent potential breeding habitat for these species. Direct effects would result from siltation of aquatic habitat located upstream and downstream of the proposed diversions, and the loss of breeding habitat as a result of pit and diversion construction.

Populations of Arizona toad downstream from the project site may be indirectly affected by changes in surface water quality, as a result of releases or seepage from leach ponds or by changes in hydrology in the drainage system from excavation activities and drawdown from pumping the water supply wells.

Reductions in water quality in Pinto Creek have been attributed to past mining activity in the drainage (see Section 3.3.1.2). Recent flooding and associated leach solution and tailings releases into Pinto Creek from the Pinto Valley Mine provide an example of a large-scale release into the drainage. Although mining-related water quality impacts have occurred in the Pinto Creek drainage, the effects of these impacts on the Pinto Creek populations of Arizona toad and lowland leopard frog are unknown. The documented presence of young and breeding adult Arizona toads and lowland leopard frogs in downstream portions of Pinto Creek in 1993 indicates that these species have been able to survive and persist in the drainage in spite of past flood flows and mine-related perturbations.

As indicated in Section 3.3.4 and 3.5.4, numerous monitoring and mitigation measures are proposed to avoid potential impacts and to reduce or alleviate adverse effects associated with potential changes in surface water quality and quantity. Reductions in surface and near surface flow in Pinto Creek and Haunted Canyon would be mitigated by augmenting flow from the well field or other sources (Cedar Creek Associates, Inc. 1996a). Water quality degradation would be mitigated by promptly identifying the contaminant source, correcting the release source, and implementing remedial measures as necessary. Therefore, the Final Biological Assessment and Evaluation prepared for this project (Cedar Creek Associates, Inc. 1994d) concluded that, as long as recommended monitoring and mitigation measures are implemented, water quality and quantity impacts in Pinto Creek and Haunted Canyon should be minimized. Impacts to Arizona toad and lowland leopard frog would result primarily from minor reductions of suitable breeding habitat along Pinto Creek within the project area, but project development is not likely to adversely affect populations of these species in Haunted Canyon or in the downstream portions of Pinto Creek.

Common Black-hawk. Observations of the common black-hawk in 1992 and 1993 indicated that this species probably forages along Pinto Creek. Potential nesting habitat occurs along Pinto Creek; however, no nests or nesting activity were observed. This species would not be directly affected by the proposed activity.

The elimination of the riparian type by the proposed action may indirectly affect the common black-hawk by reducing the foraging area for individuals and reducing prey. Indirect effects could also occur from a reduction of baseflows in Haunted Canyon or Pinto Creek, or from any increase in the presence of toxic substances in the common black-hawk's prey base (aquatic and semi-aquatic species).

As indicated for Arizona toad and lowland leopard frog, numerous monitoring and mitigation measures are proposed to avoid potential impacts and to reduce or alleviate adverse effects associated with potential changes in surface water quality and quantity. These same measures would also limit the risk of adverse effects to potential common black-hawk nesting and foraging habitat. Impacts to common black-hawk would result primarily from minor reductions of suitable foraging habitat within the project area. Therefore, the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d) concluded that the Carlota Copper Project may impact individuals or habitat of common black-hawk, but would not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species.

Yellow-billed Cuckoo. The yellow-billed cuckoo was not found in the project area. This species would not be directly affected by any proposed activities.

Observations of yellow-billed cuckoo were recorded in riparian habitat along Pinto Creek downstream from the project area. Yellow-billed cuckoo prefer riparian habitats with dense shrub understory. Riparian habitat in downstream portions of Pinto Creek and in Haunted Canyon between Powers Gulch and Pinto Creek could be indirectly affected by water withdrawals associated with well field development and pumping. A reduction in surface and near surface flows would increase the aridity of the existing stream channels and riparian habitat. Reductions in water flow could increase mortality and decrease successful germination and establishment of woody riparian species. However, as long as historic flow regimes are maintained in lower Pinto Creek and Haunted Canyon, project development would not have any direct, indirect, or cumulative effect on suitable riparian habitat or populations of yellow-billed cuckoo in Haunted Canyon or downstream portions of Pinto Creek (Cedar Creek Associates, Inc. 1994d).

Loggerhead Shrike. Concerns for declining numbers of this species are associated primarily with populations in the midwestern and northeastern United States. The loggerhead shrike is fairly common throughout western portions of its range, including Arizona. Dry-slope desert brush and juniper/grassland communities represent suitable habitat for this species within the project area. Several observations of loggerhead shrike were recorded in dry-slope desert brush habitat south of Grizzly Mountain near the proposed Main mine rock disposal area.

Approximately 488 and 118 acres of dry-slope desert brush and juniper/grassland, respectively, would be lost or disturbed by project implementation. Within the Pinto Creek drainage basin, this would result in a relatively minor reduction of suitable habitat. Suitable habitat is not limited in this region; therefore, minor reductions in habitat may affect a few individual birds, but would not adversely affect regional populations (Cedar Creek Associates, Inc. 1994d).

Acid Deposition and Ozone Analysis for Terrestrial Biota. An evaluation was conducted to estimate the potential for the Carlota Copper Project's air emissions to affect terrestrial resources within the Superstition and Sierra Ancha Wilderness areas, the Tonto National Monument, and the Carlota Copper Project area, including impacts to the Arizona hedgehog cactus. This evaluation is presented in Appendix D, Acid Deposition and Ozone Analysis, of this EIS. One of the main conclusions of this analysis was that no adverse effects to populations of the Arizona hedgehog cactus would be associated with air emissions from the Carlota Copper Project.

Aquatic Resources

The evaluation criteria for assessing impacts of the proposed action or the alternatives on aquatic resources are listed below.

- Acres of aquatic habitat loss or degradation
- Effects of changes in water quality parameters on aquatic species (bioaccumulation)
- Impacts to aquatic habitat during critical months of use caused by temporarily increased sedimentation
- Number of threatened, endangered, and sensitive aquatic species potentially affected by the project
- Amount of habitat suitable for the recovery of extirpated species that may be affected by project activities
- Indirect air quality impacts to aquatic biota from chemicals or particulates
- Risk of impacts to aquatic species from accidental releases of chemicals

The primary potential impacts to aquatic resources would include habitat loss from two open-channel diversions, potential flow alterations in the Pinto

Creek drainage from pit dewatering, potential flow reductions in Haunted Canyon and Pinto Creek from water supply well pumping, temporarily increased sedimentation from construction activities, and accidental releases of chemicals to the Pinto Creek watershed.

Construction of two diversion channels, one in Pinto Creek and one in Powers Gulch, would result in the loss of existing stream habitat. In Pinto Creek, the length of the diversion channel would be approximately 5,250 feet, which would result in the loss of approximately 5,400 feet of existing Pinto Creek stream channel. Site 2 of the habitat mapping in Pinto Creek and Site 6 in Powers Gulch were located within the reaches that would be affected. The average width of Pinto Creek is 10 feet within the affected reach, the total habitat lost would be approximately 1.24 acres. The diversion channel in Powers Gulch would be approximately 7,900 feet long, resulting in a loss of existing stream channel of approximately 7,300 feet. The average width in Powers Gulch was approximately 5 feet. This equates to an area of approximately 0.84 acre. Based on habitat characteristics summarized in *Table 3-57*, the habitat loss at Site 2 in Pinto Creek is composed of approximately 2 percent pool, 64 percent riffle, and 34 percent glide habitat types. The average pool residual depth is 2.28 feet. Dominant substrate at the fish sample reach in Site 2 is composed of 50 percent boulder and 50 percent sand in the pools and 60 percent rubble and 20 percent gravel in the riffles. In Powers Gulch, habitat loss is composed of 9 percent pool, 86 percent riffle, and 5 percent glide. The average pool residual depth is 3.32 feet in Powers Gulch.

Fish sampling at Site 2 in Pinto Creek and Site 6 in Powers Gulch (Miller & Associates 1995) identified fish species that would be affected by the removal of natural stream habitat. Fish species collected at Site 2 included the green sunfish, longfin dace, and mosquito fish. The longfin dace is the only special status fish species (Forest Service sensitive) in the project area. Dewatering, habitat modification, and habitat loss would cause a loss of populations for these species. It is not possible to quantify the number of fish that would be affected by project actions. Although fish were not observed in 1993, Powers Gulch is used occasionally as fish ranges fluctuate. This may have been the case in November 1992 when longfin dace were reported in Powers Gulch. Dewatering of the Carlota/Cactus pit could potentially affect the intermittent stream upstream and downstream of the pit (see Section 3.2.3.1 for discussion). If this occurs, a reduction in fish and aquatic habitat would likely occur.

Effects on downstream areas include potential changes in water quality and quantity, both of which could impact the longfin dace and desert sucker. Reproducing populations of the desert sucker are found in Haunted Canyon and Pinto Creek downstream of the main portion of the project area, but within the well field area. Decreases in surface water quality and quantity in this area could cause reductions in the desert sucker and longfin dace populations in Haunted Canyon and Pinto Creek (see Section 3.3.2, Water Resources - Environmental Consequences, for a discussion of the anticipated impacts to the quality and quantity of these streams).

Potential water quality changes also could occur in adjacent receiving streams because of surface water and ground water runoff from the disposal sites. The types of water quality changes include possible increases in metal concentrations and reduced pH. However, the duration of these water quality changes would be limited to the periods of high runoff. Although elevated levels of metals and low pH can cause potential reductions in biotic diversity and density through direct toxicity and bioaccumulation of metals in tissues, the expected short duration of runoff events would likely minimize these types of changes.

The pit lake that would form after mine closure could potentially impact aquatic resources. The lake would be accessible to aquatic macroinvertebrates and would have suitable water quality for survival. The lake likely would not be managed for fish species because of access and safety concerns; however, it is possible that unauthorized stocking of non-native species could occur. Since the final pit water surface elevation would be approximately 135 feet below the Pinto Creek stream elevation and the stream and pit lake would not be interconnected, downstream escapement of non-native species would not be expected to occur.

Sedimentation impacts resulting from construction activities would affect the aquatic resources in localized sections of Pinto Creek, Powers Gulch, and Haunted Canyon on a temporary basis. Sedimentation would occur as a result of surface disturbance to soil in the mine areas and along the road corridors. One intermittent stream section in Pinto Creek would be crossed by the main access road, while the Eder access road would cross one intermittent section in Powers Gulch. There would be impacts to aquatic resources associated with increased sedimentation during construction and operation of the well field access road along the west side of Pinto Creek. The well field access road would cross Haunted Canyon near the TW-1 well site with an unimproved crossing. Small ephemeral stream sections also would be crossed by the main access road and the haul roads. Sedimentation increases would be minimized by implementation of BMPs by Carlota.

The effects of suspended solids and sedimentation on aquatic biota are well documented. Silted substrates reduce areas of attachment and support less diverse biotic communities than clean gravel and rubble substrates (Tarzwell 1973; Westlake 1975). Sedimentation of pools and riffles can result in destruction of permanent and refuge habitats important in maintaining biota during drought conditions (Lewis 1977). Increased suspended solids can also reduce survival either through reduction in spawning success (Peters 1965) or by increasing susceptibility to disease (Herbert and Richards 1963). Lewis (1977) found that high suspended solids had two effects on the heavy metal content in Pinto Creek. First, the suspended solids adsorbed heavy metals in the water column, thereby reducing soluble metals. Second, a buildup of complexed insoluble metallic compounds in the sediments resulted from the settling of the metal-enriched suspended solids.

The effects of these sedimentation changes were to bind potentially toxic heavy metals and to serve as the major source of metals for the food chain. Although heavy metals are known to adsorb to sediments, there are several processes that release contaminants bound in sediments (Reynoldson 1987), increasing the bioavailability of these toxicants. Some aquatic organisms could eventually be re-established in affected areas after sediments were removed by a high flow event that would scour the stream channel. As discussed in Section 3.3.2 (Water Resources - Environmental Consequences), long-term sedimentation effects on the watersheds within the project area would be considered minor with the implementation of BMPs by Carlota.

Pinto Creek and Powers Gulch are intermittent streams in the area proposed for diversion channels. The very nature of intermittent streams makes them an unstable environment for fish and invertebrates. Most specimens of fish and invertebrates collected in the area proposed for the diversions are representative of species that directly reflect the unstable nature of these streams. These species are often referred to by biologists as "r-selected" species. They are defined by several qualities, among which is the ability to quickly colonize and establish populations in unstable environments. The longfin dace is a good example of an "r-selected" species that occurs in Pinto Creek. Longfin dace can be sexually mature within 1 year after hatching and are fractional spawners, which have an extended breeding season that can begin in January and run through November (Lewis 1978a). Grimm (1988) determined that the longfin dace is a common and abundant opportunistic omnivore that can change its diet depending on food availability. Historical data provided from studies on Pinto Creek (Lewis 1977; USDA Forest Service 1992a; Miller & Associates 1994) suggest that the macroinvertebrate communities vary considerably and are influenced by heavy metal toxicity, low dissolved oxygen levels, and the compounding effects of seasonal and annual events (e.g., flooding, droughts, etc.). Because the existing conditions in Powers Gulch and Pinto Creek support aquatic communities that are moderately resilient, it is likely that short-term sedimentation impacts from the Carlota Copper Project would have minimal effects on aquatic biota. Additionally, Fairchild et al. (1987) determined that short-term exposure to sediment had no significant effect on benthic invertebrate community dynamics.

The potential exists for impacts on aquatic biota from accidental discharges of heavy metals into Powers Gulch and Pinto Creek. The level of impact would depend on the magnitude, duration, and timing of the spill. The discharge could be continuous and in relatively low volumes, or it could produce a large spill of polluted water, which would travel downstream from a leach pad or from high runoff following heavy rainfall (Lewis 1977). The recent flooding and associated leach solution and tailings spills into Pinto Creek from the Pinto Valley Mine in the spring of 1993 are an example of the latter scenario (see Section 3.5.1.2). Resulting impacts from a toxic discharge of heavy metals into Pinto Creek or Powers Gulch would include altered chemical and physical quality of the stream and an associated reduction in biotic diversity and density. The adverse effects of heavy metals in the aquatic environment have received considerable attention pertaining to fish (Roch et al. 1982, Dallinger and Kautzky 1985, Giles 1988) and macroinvertebrates (Smock 1983, Clements 1994, Rees 1994). Lewis (1978b) provides information on the toxicity of various heavy metals to the longfin dace. The extent to which heavy metals are affecting an aquatic system can be ascertained through biomonitoring (Winner et al. 1980).

Waters of the U.S. The Pinto Creek diversion around the Carlota/Cactus pit would result in the loss of 7.28 acres of waters of the U.S., which includes 0.34 acre of jurisdictional wetlands. The Powers Gulch diversion around the heap-leach pad would result in the loss of 2.18 acres of waters of the U.S. and no losses of jurisdictional wetlands. A total of 9.46 acres of waters of the U.S., which includes 0.34 acre of wetlands, would be lost due to the proposed action; these areas are mapped on *Figure 3-32*.

The COE will require full mitigation for these wetland and waters of the U.S. losses as one aspect of the Section 404 permitting process. As a result, the Carlota Copper Company, in cooperation with the COE and the Forest Service, has developed the *Wetland and Waters of the U.S. Compensatory Mitigation Plan for the Carlota Copper Project* (Aquatic and Wetland Consultants, Inc. 1996a). The plan must be approved by the COE before any impacts to these resources can occur (see Section 3.5.4.2).

Special Status Aquatic Species. The Gila topminnow was not identified within the overall Pinto Creek drainage; therefore, there would be no impacts to this species.

The potential impacts to the longfin dace and desert sucker are discussed in the preceding section.

Acid Deposition and Ozone Analysis for Aquatic Biota. An evaluation was conducted to estimate the potential for the proposed project's air emissions to affect aquatic resources within the Superstition and Sierra Ancha Wilderness areas, the Tonto National Monument, and the project area. This evaluation is presented in Appendix D, Acid Deposition and Ozone Analysis, of this EIS. Based on this analysis, no impact to aquatic resources is expected from acid deposition.

3.5.2.2 Alternatives

Terrestrial Resources

The following sections describe the terrestrial biology impacts of the project alternatives. Impacts not specifically discussed would be similar to those discussed for the proposed action.

Mine Rock Disposal Alternatives.

Alternative Mine Rock Disposal Sites. Impacts on vegetation and wildlife species associated with the alternative mine rock disposal sites would be greater than the proposed action. An additional 18 acres and 26 acres would be affected for chaparral and dry-slope desert brush habitats, respectively. This could result in the loss of 44 acres of upland habitat for a variety of wildlife species, including deer and collared peccary.

Additional sedimentation would result from hauling the mine rock along roads near the streams. Initial construction of the disposal sites would also contribute sediment to the downstream drainageways. Depending on the time of year and the level of instream flow, sedimentation would either be localized or carried farther downstream. Potential water quality changes would probably be similar to those expected in the proposed action.

Additional Backfill of the Carlota/Cactus Pit. The additional backfill of the Carlota/Cactus pit would provide for the reduction of long-term impacts to vegetation by increasing the reclaimed area of the pit and the Main mine rock area. Under this alternative, approximately 153 additional acres associated with these project components would be reclaimed and revegetated.

During mining operations, potential sedimentation impacts to sensitive amphibian species (Arizona toad and lowland leopard frog) would be similar to the impacts expected as a result of the proposed action. During postclosure, however, sedimentation impacts from this alternative would be less than for the proposed action. Sedimentation would be reduced because the additional backfill would decrease the elevation of the Main mine rock area by 300 feet. Such a reduction in elevation would reduce potential erosion and subsequent input of fine sediments into downstream drainageways.

Backfilling of the Carlota/Cactus pit and the reduction of the Main mine rock area would provide an opportunity for revegetation to offset the loss of upland habitat important to the loggerhead shrike.

Additional Backfill of the Eder South Pit. Excavation of the Eder South pit and Eder mine rock area would impact approximately 140 acres of upland habitat. The additional backfill of the Eder South pit and the reclamation and revegetation of the Eder mine rock area would partially offset impacts to vegetation types through the reclamation of approximately 49 additional acres. Reclamation of the areas where the mine rock is removed would reduce the overall permanent loss of upland habitat.

During mining operations, potential sedimentation impacts to sensitive amphibian species (lowland leopard frog and Arizona toad) would be similar to impacts expected as a result of the proposed action. During postclosure, however, sedimentation impacts from this alternative would be less than for the proposed action. Sedimentation would be reduced because the Eder mine rock area would be removed and reclaimed, thereby nearly eliminating the accelerated erosion potential from that area.

Arizona Hedgehog Cactus. Most of the Arizona hedgehog cactus that would be impacted by the project are currently located in the proposed Eder complex. Excavation of the Eder South pit could potentially result in the loss of 6.9 acres of habitat that supports approximately 177 individuals. The backfill alternative for the Eder South pit could partially offset these impacts. In addition, this alternative could provide an opportunity to offset long-term losses in suitable unoccupied habitat through remediation and enhancement.

Loggerhead Shrike. Backfilling the Eder South pit and reclamation of the Eder mine rock area would provide an opportunity for revegetation to offset the loss of upland habitat important to this species.

Eder Side-Hill Leach Pad Alternative. Direct impacts of this alternative would be the disturbance of approximately 495 acres of upland habitat and associated wildlife species associated with the leach pad and Eder mine rock area. Of primary concern is the potential for accidental releases of leach solution related to the potential instability of this alternative. Terrestrial biological resources potentially impacted by this alternative are discussed below.

Riparian Habitat. The best example of this habitat on the project area occurs at the confluence of Powers Gulch and Haunted Canyon downstream from the proposed embankment and retention pond. Implementation of the side-hill leach pad alternative would increase potential for accidental releases of leach solution into Powers Gulch and downstream.

Arizona Hedgehog Cactus. Implementation of this alternative would require relocating the Eder mine rock area. As stated above, the exact location and extent of this mine rock area is not specifically described. It would be located immediately south of the Eder South pit. A worst case estimation might be the loss of approximately 120 individuals and 20 acres of occupied habitat. The heap-leach pads would also impact a few satellite individuals and additional acreage of occupied habitat.

Arizona Toad and Lowland Leopard Frog. These amphibian species would be vulnerable to habitat degradation from accidental releases of toxic chemicals into the surface or subsurface water. Implementation of the side-hill leach pad alternative would increase potential for accidental releases of leach solution into Powers Gulch and downstream. This alternative could result in moderate adverse indirect effects to these species.

Common Black-hawk. This alternative could potentially affect amphibian food sources and riparian habitat used by the common black-hawk, if there were a failure of the side-hill leach pad facility. A reduction in available foraging habitat and prey species might impact individuals of common black-hawk, but would not likely contribute to a trend toward federal listing or cause a loss of viability to the population or species.

Water Supply Alternative. Implementation of the low-quality water pipeline alternative would result in direct and indirect effects similar to those identified in the proposed action. Additional vegetation may need to be cleared for this alternative within the project area, depending on the actual alignment of the pipeline. Vegetation in much of the area would include chaparral, dry slope desert brush, and juniper grassland. No populations of special status species are likely to occur in these areas, although specific surveys have not been conducted. Potential water quality effects from accidental spills or leaks of low-quality water could have indirect effects on wildlife and vegetation downstream. Lowland leopard frogs and Arizona toads would be especially vulnerable to changes in water quality. Other wildlife species dependent on the streamflow for watering or breeding sites also may be affected.

The advantage to the alternative water source is that less water would need to be extracted from the well field during baseflow conditions in Pinto Creek/ Haunted Canyon. Therefore, impacts to riparian vegetation in this area may be reduced. Impacts would not be eliminated, however, since water would still be pumped from the well field, and the alluvial water table is partially connected to the aquifer below.

Alternative Water Supply Well Field Access Roads. Access to the well field below the confluence of Powers Gulch and Haunted Canyon would be provided by one of two alternative routes. Alternative A would require improving 1.9 miles along an existing, mostly reclaimed road in the bottom of Pinto Creek. Alternative B would require clearing 1.2 miles of upland vegetation and would not enter the riparian vegetation along the portion of Pinto Creek between the Iron Bridge and Powers Gulch.

Improving the old road in the bottom of Pinto Creek would involve clearing some vegetation that has begun to recolonize the area. This road would require frequent maintenance after flood events. Assuming a 20-foot corridor of disturbance, approximately 4 acres of previously disturbed riparian vegetation would be impacted by Alternative A.

Assuming a 20-foot corridor of disturbance, construction of Alternative B would involve clearing approximately 7 acres roughly equally divided between interior chaparral and dry-slope desert brush vegetation. The eastern portion of this road would travel along the existing road identified in the proposed action, which is located on the bench above the riparian area.

Alternative A would result in the improvement of an existing road along the Pinto Creek riparian corridor. Aside from the loss of 4 acres of previously disturbed riparian vegetation, project-related use of this road would result in a minor incremental increase in human disturbance impacts to wildlife species along this portion of the riparian corridor. The road/trail has previously been used, and would continue to be available, for recreational access to the area. Alternative B would impact fewer acres of the more abundant upland habitats.

Long-term effects of disturbance to vegetation from either alternative would be minimized by revegetation efforts to be undertaken by Carlota.

Impacts to special status species from the alternative access roads are discussed below.

Arizona Hedgehog Cactus. Alternatives A and B were not specifically surveyed for Arizona hedgehog. Alternative A is within the floodplain of Pinto Creek, which is not potential habitat for the species. The effect of Alternative B is unknown, although the actual alignment could likely be adjusted to avoid individual cacti if they are present in the area.

Arizona Toad and Lowland Leopard Frog. Preferred stream bank habitat for these species is characterized by small rocks and cobble, while lowland leopard frogs prefer sandy to muddy banks with at least some emergent vegetation. With Alternative A, the only areas where the road could affect potential breeding habitat for the lowland leopard frog and Arizona toad would be at the three stream crossings. Habitat at the crossings consists primarily of non-vegetated stream channel with a substrate of small rocks and cobble. These crossing sites represent marginal habitat for lowland leopard frog but could provide suitable breeding habitat for Arizona toad when surface water is present. However, the stream crossings would be located at points where crossings for the existing road currently exist, and the potential for construction and operation of the Alternative A road to result in adverse impacts to Arizona toad breeding habitat would be relatively minor. Maintenance and operation of the well field would result in a slight increase in existing vehicular traffic on the Alternative A road, which could increase the risk of toad mortalities during their season of peak activity (April through August). However, the risk of toad road-kills would be increased only slightly over the current potential for road-kills associated with existing vehicle use of the road.

Erosion from road construction and operation could result in indirect impacts to amphibian breeding sites through sedimentation of aquatic habitats in Pinto Creek and Haunted Canyon, but this potential indirect impact would be minimized by the implementation of BMPs by Carlota.

The Alternative B road would be constructed outside of the Pinto Creek and Haunted Canyon riparian zones and would not result in any direct impacts to potential lowland leopard frog or Arizona toad breeding habitat. There would be a slight risk of indirect impacts from sedimentation, but Carlota would minimize this risk by implementing BMPs.

Common Black-Hawk. No direct or indirect effects would occur with Alternative B for the common black-hawk. Alternative A would not result in a direct effect to this species but could have relatively minor indirect effects. As indicated previously, Alternative A would impact 4 acres of riparian habitat and could result in direct impacts to Arizona toad through habitat loss (at stream crossings) and road mortalities. Since common black-hawks use riparian habitats for foraging, and amphibians represent a principal prey item, these impacts could reduce the extent of foraging habitat and the available prey base for common black-hawk. However, the overall adverse effect on common black-hawk use of Haunted Canyon and Pinto Creek riparian corridors would be negligible since potential nesting habitat would not be affected, and projected adverse effects on Arizona toad populations would be relatively minor (see preceding Arizona toad discussion).

No Action Alternative. Under the no action alternative, the terrestrial biological conditions of the project area would remain in their current condition, allowing for natural ecological changes. The adverse direct and indirect impacts to terrestrial biological resources associated with the proposed action and alternatives would not occur.

Aquatic Resources

The following sections describe the impacts of the project alternatives on aquatic resources. Impacts not specifically discussed would be similar to those described for the proposed action.

Mine Rock Disposal Alternatives.

Alternative Mine Rock Disposal Sites. Impacts from sedimentation on the longfin dace and desert sucker would be greater for this alternative than for the proposed action. Additional sedimentation would result from hauling the mine rock along roads near the streams. Initial construction of the disposal sites would also contribute sediment to the downstream drainages. The relative changes in sediment levels in the adjacent streams would depend on the time of the year. During periods of high runoff, sediment reaching the streams would be carried farther downstream and could be mixed with high background levels of suspended solids. In contrast, increased sedimentation would be more localized during the low runoff periods, and background suspended solid concentrations would be relatively low.

Water quality impacts could increase as a result of the movement of existing poor quality water through the Cactus South location, thereby increasing the potential to affect aquatic biota.

Additional Backfill of the Carlota/Cactus Pit. During mining operations, sedimentation impacts on the longfin dace and desert sucker would be similar to impacts expected as a result of the proposed action. During postclosure, however, sedimentation impacts from this alternative would be less than for the proposed action; sedimentation would be reduced because the additional backfill would decrease the elevation of the Main mine rock area by 300 feet. Such a reduction in elevation would reduce potential erosion and subsequent input of fine sediments into downstream drainages.

Additional Backfill of the Eder South Pit. During mining operations, sedimentation impacts on the longfin dace and desert sucker would be similar to impacts expected as a result of the proposed action. During postclosure, however, sedimentation impacts from this alternative would be less than for the proposed action. Sedimentation would be reduced because the Eder mine rock area would be removed and reclaimed, thereby nearly eliminating the accelerated erosion potential from that area.

Eder Side-Hill Leach Pad Alternative. This alternative leach pad location would place the pads outside the main channel of Powers Gulch, which would not result in a loss of Powers Gulch aquatic habitat. Of primary concern is the potential for accidental releases of leach solution related to the potential instability of this alternative. Measures would be in place to reduce the potential for a spill of material into Powers Gulch. During construction and operation, sedimentation and erosion would be similar to the proposed action. Sedimentation impacts would occur in localized areas of Powers Gulch and Pinto Creek on a temporary basis. Because of increased acreage and slopes, erosion and sedimentation would increase during postclosure.

As part of this alternative, the PLS ponds would be located within the side-hill leach pads behind a water-retention embankment. Leaks or spills would result in degraded water quality. However, the probability of containment failure for this alternative is greater than for the proposed action. The magnitude and duration of this containment failure would depend upon the volume of material leaked or spilled, the time of year, and the effectiveness of the containment and control effort.

Water Supply Alternative. The impacts of using low-quality water on water quality and biological resources would depend upon the proper storage and containment of the low-quality water within the Carlota Copper Project area. If a spill or leak occurred in the pond and the low-quality water reached adjacent streams, water quality would be degraded. The magnitude and duration of the impact would depend upon the volume spilled or leaked, location of the spill or leak, time of year, and effectiveness of the containment and control effort. A pipeline would be constructed to deliver the water for these alternatives. Temporary sediment increases would occur during pipeline construction at stream crossings. Potential leaks or spills also could occur during the transport of water through the pipeline. Proper monitoring and maintenance of the pipeline operation would minimize the risk of a pipeline spill or leak. Using low-quality water would reduce the requirement for pumping ground water; therefore, the potential for reducing surface water flow and associated impacts to aquatic biota would be reduced.

Alternative Water Supply Well Field Access Roads. Two alternative routes are being considered to access the water supply well field from the north. Alternative A would involve upgrading the existing access road located within the Pinto Creek channel for approximately 1.9 miles. Alternative B would involve constructing approximately 1.2 miles of new road and using 2.6 miles of existing roads, but would not involve entering the riparian vegetation along Pinto Creek.

Both alternatives would result in an initial increase in sediment levels during the construction/upgrading of the roads. However, because of future flood events, the road in the Pinto Creek floodplain (Alternative A) would require much more maintenance than would the upland road in Alternative B. The required maintenance actions under Alternative A would result in higher, long-term sedimentation impacts to the longfin dace and desert sucker than would the maintenance of the upland road in Alternative B.

Improving the old road in the bottom of Pinto Creek (Alternative A) would involve clearing some riparian vegetation that has begun to recolonize the area. It would also preclude future recolonization of the road corridor by riparian vegetation during the life of the project. This would contribute to reduced stream bank stability, thereby reducing the quality of the habitat for the longfin dace and desert sucker. In addition, the stability of the stream banks would be reduced in the vicinity of each road crossing. Alternative B would result in no loss of riparian vegetation and no reduction of bank stability.

In summary, Alternative B would result in only minor, indirect impacts to the longfin dace and desert sucker, while Alternative A would result in moderate, adverse direct and indirect impacts to these species.

No Action Alternative. Under the no action alternative, the aquatic biological conditions of the project area would remain in their current condition allowing for natural ecological changes. The impacts described for the proposed action and alternatives would not occur.

3.5.3 Cumulative Impacts

This section describes the cumulative impacts of the proposed action and interrelated projects on terrestrial and aquatic resources. For most terrestrial resources, except for bald eagle and Arizona hedgehog cactus, the cumulative effects evaluation area consisted of the entire Pinto Creek drainage basin. For bald eagle, nesting and foraging use of Roosevelt Lake was also a consideration. For Arizona hedgehog cactus, the entire known population area was evaluated for cumulative effects. The cumulative effects area for aquatic resources consisted of Pinto Creek within and downstream of the project area until surface flow disappears near Roosevelt Lake, as well as flowing portions of Haunted Canyon downstream of the project area.

Nine categories of regional interrelated actions have been identified and are considered in the cumulative impact analysis. These regional interrelated actions include mining projects, grazing, energy and transmission systems, Pinto Creek Wild/Scenic River designation, private land development, highway development, land exchange, dam modifications, and development of recreational facilities at Roosevelt Lake.

Past and projected mining, grazing, power line construction, and roadway construction in the region have impacted vegetation communities and are projected to continue. The amount of these vegetation communities in the region to be impacted by these interrelated activities is impossible to determine at this time, but the rate of habitat loss is expected to be comparable to what has occurred in the past.

Interrelated mining projects that are located in the Pinto Creek drainage include the Old Carlota Mine, Pinto Valley Mine, and placer mining. Although the Old Carlota Mine has subsurface disturbance, there are no extensive tailings ponds or other types of disturbance that would contribute to degraded water quality in the Pinto Creek drainage. However, as ground water flows through the mined subsurface areas, water quality may be affected. The Pinto Valley Mine is an existing mining operation that has surface and subsurface disturbance in the Pinto Creek drainage. During periods of high runoff, spills or leaks from the Pinto Valley Mine could combine with effects from the proposed Carlota Copper Project. While spills from the Pinto Valley Mine are possible, they are less likely than past spills because of recent redesign efforts by BHP Copper. The existing placer mining that occurs in the Pinto Creek drainage is limited to small-scale operations. These operations could contribute slight increases in sediment levels, but the relatively small size of these activities would suggest minor additional effects on water quality in the drainage.

Past, present, and reasonably foreseeable future actions have the potential to affect riparian and aquatic habitat, depending on the location. The impacts may be adverse, in the case of disturbance, or beneficial when riparian and aquatic habitat restoration occurs.

Riparian loss associated with the dam modifications has been mitigated and has resulted in improvements to riparian habitat. Recent Forest Service range management plans are generally designed to improve riparian and aquatic habitat; however, grazing may continue to degrade the habitat, depending on the habitat location within the allotments. Land exchanges are often structured to ensure the protection of biological resources, so land exchanges likely to occur in the foreseeable future are unlikely to adversely impact biological resources. The Wild/Scenic River program has the potential to benefit riparian and aquatic habitat in the Pinto Creek drainage system. Any activities that would reduce the quantity or affect the quality of water in the Pinto Creek watershed could have deleterious effects on the quality and extent of the natural riparian vegetation and aquatic habitat. Similarly, the BOR created the Tonto Creek Riparian Unit, which converted existing year-long or seasonal grazing to short duration, winter seasonal pastures. This activity is being treated as an experimental mitigation, but the scheme is an accepted management practice when the goal is to improve riparian and aquatic conditions within grazing allotments.

Special status species that could be affected by cumulative impacts from the proposed action and interrelated actions include the Arizona hedgehog cactus, Arizona toad, lowland leopard frog, common black-hawk, yellow-billed cuckoo, loggerhead shrike, longfin dace, and desert sucker. Where appropriate, cumulative impacts for these species have been addressed in the Final Biological Assessment and Evaluation (Cedar Creek Associates, Inc. 1994d).

3.5.4 Monitoring and Mitigation Measures

As part of the proposed project, Carlota would implement BADCT to minimize the potential for seepage or spills from the heap-leach pad (Knight Piésold 1995a). Carlota would also implement a Spill Control and Hazardous Materials Management Plan to detect, contain, and remediate leaks or spills from project facilities (Carlota 1996a). Carlota would also implement measures identified in the Biological Monitoring & Mitigation Plan (Cedar Creek Associates, 1996a). These mitigation and monitoring measures are summarized in the remainder of this section.

Measures to monitor and mitigate potential impacts to ground water and surface water quantity and quality are identified in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures. These water resource measures are also designed to mitigate potential adverse impacts to terrestrial and aquatic resources.

Carlota's proposed reclamation plan (see Section 2.1.9) is designed to restore vegetation and the associated wildlife habitat on disturbed lands. Supplemental mitigation for soils and reclamation is identified in Section 3.4.4 of this EIS.

3.5.4.1 Terrestrial Resources

The monitoring and mitigation measures identified below have been designed to reduce the overall effects of the project on terrestrial biology resources. Monitoring would be required to assess the severity of impacts arising from project activities and to ensure that mitigation efforts are meeting their objectives. In those cases where impacts may extend beyond the life of the project, postclosure mitigation measures are designed to continue as appropriate. Specific details of these mitigation measures are presented in the Biological Monitoring & Mitigation Plan (Cedar Creek Associates, Inc. 1996a). The Biological Monitoring & Mitigation Plan details monitoring measures to be implemented, threshold criteria (the exceedance of which would trigger additional mitigation), appropriate mitigation measures, responsible parties, and success criteria. Establishing success criteria ensures minimal or acceptable levels of impact.

<u>Monitoring</u>

The following monitoring measures, as detailed in the Biological Monitoring & Mitigation Plan, would be necessary to determine the levels of effect and results of mitigation to the Arizona hedgehog cactus.

- Approximately 30 cacti would be identified that would be expected to receive the greatest sulfuric acid mist concentrations from the acid tank house. Following initiation of the operation of the tank house, these cacti, as well as a control set of cacti, would be monitored on a regular basis for injury to the plants. Should injury be noted in comparison to the control set, consultation with the Forest Service and/or the U.S. Fish and Wildlife Service would be reopened. The objective of this monitoring would be to ensure that if the acid mist does indeed prove to be detrimental, appropriate actions can be undertaken to prevent further loss.

- Those areas that are staked or fenced to protect cacti from direct impact from mining activities would be visually monitored on an annual basis to ensure that the integrity of the protected area is maintained. In addition, those individual plants that are considered to be proximal enough to planned activities to potentially be impacted by blasting (200 feet from pits, 100 feet from roads) would be monitored within 1 year of blasting to determine if additional losses through indirect impacts has occurred.

- In accordance with the reclamation test plan, those Arizona hedgehog cacti in conflict with project facilities would be transplanted to test plots and then monitored to determine the best reproducible substrate that can be used in reclamation.

Monitoring also would be necessary to detect residual effects on riparian vegetation in the vicinity of and immediately below the well field. Should adverse changes occur, additional mitigation would need to occur quickly to reverse the impacts. In order to detect such changes, efforts intended to provide information that would identify trends in riparian habitat condition have been initiated prior to full-scale operation of the wells. The following measures among others, have been instituted and would be maintained through the life of the project, as necessary:

- Changes in riparian vegetation and amphibian populations would be monitored. Methods, frequency, and data requirements have been developed and are described in the Biological Monitoring & Mitigation Plan. Monitoring of amphibians would occur in conjunction with aquatic species monitoring.

- Riparian vegetation sampling would be conducted in accordance with the Biological Monitoring & Mitigation Plan.

- Photographic documentation of the riparian corridor would be collected from permanent stations in the well field area.

Additional monitoring would be implemented to ensure that no wildlife mortalities occur as a result of exposure to contaminated water sources on the heap-leach facility or in the plant PLS or raffinate ponds. If any wildlife mortalities are detected on the heap-leach facility or at the plant PLS and raffinate ponds, the incidents would be promptly reported to the Forest Service and the appropriate wildlife agency (Arizona Game and Fish Department or U.S. Fish and Wildlife Service). Mitigation or operational measures would be developed in consultation with these agencies to ensure that there would be no re-occurrence of wildlife losses as a result of exposure to contaminated water sources.

Mitigation

TB-1: Arizona Hedgehog Cactus Mitigation - Subject to the U.S. Fish and Wildlife Service Biological Opinion (included in Appendix F), the following measures have been identified to mitigate impacts to the Arizona hedgehog cactus and are fully described in the Biological Monitoring & Mitigation Plan.

- Facility sites and alignments (e.g., roads, buildings, or power lines) have been reviewed for relocation and have been redesigned, to the extent possible, to avoid Arizona hedgehog cactus plants.

- Clearing limits near occupied habitat would be staked or fenced to protect plants from equipment or project activities.

- In accordance with reclamation procedures described in Section 3.4, Soils and Reclamation, revegetation test plots would be established to determine the best methodology for reestablishing vegetative cover during reclamation of the major features of the project. Where avoidance of Arizona hedgehog cactus is not possible, cactus plants would be transplanted into test plots designed to determine optimum re-establishment habitat for the species, the objective being to use the plants and/or their progeny to reestablish the species into the reclaimed mine area. A plan covering the development and implementation of these test sites has been developed prior to the record of decision for the project and is presented in the Biological Monitoring & Mitigation Plan. The Forest Service would work with the U.S. Fish and Wildlife Service to determine if there is a need by researchers, botanical gardens, etc. for any remaining Arizona hedgehog cacti that cannot be avoided by the project and will not be needed for testing.

- Carlota has agreed to assist the Forest Service in the permanent withdrawal from mineral entry of selected parcels that support populations of Arizona hedgehog cactus. One 186-acre parcel would be within the project area. This process, in conjunction with the conservation plan (last bulleted item below), would effectively protect nearly 400 acres of occupied habitat, including the taxon's type locality.

- A grazing permit that includes Arizona hedgehog cactus populations would be acquired, and non-use would be initiated in the occupied habitat to protect that particular parcel from one of the minor threats to the species during operations and reclamation.

- A conservation plan for the Arizona hedgehog cactus has been developed in coordination with the Tonto National Forest to identify several safe areas for protecting the cactus over the long term.

<u>TB-2:</u> In order to mitigate impacts associated with a potential release from the heap-leach pad to Roosevelt Lake on nesting pairs of bald eagles or winter transient eagles feeding in Roosevelt Lake, Carlota would implement the monitoring and mitigation measures described in Section 3.3.4 to reduce or alleviate adverse effects associated with changes in surface water quality and quantity. The contaminant source would be promptly identified, the source of the release would be corrected, and remedial measures would be implemented as necessary.

<u>TB-3</u>: Riparian Mitigation - As identified in Section 3.5.2, Environmental Consequences, 12.40 acres of riparian habitat would be directly impacted. This equates to a net loss of 3.40 acres of riparian public land in the Pinto Creek drainage under the jurisdiction of the Tonto National Forest, 8.10 acres of riparian private land in the Pinto Creek drainage for which the COE has assumed jurisdiction, and 0.90 acre of riparian public land in the Powers Gulch drainage under the jurisdiction of the Tonto National Forest. Mitigation measures that would offset these effects are summarized below and are fully described in the Biological Monitoring & Mitigation Plan.

- A grazing permit would be acquired and grazing non-use would be implemented during the project life. Upon waiver back to the Forest Service at the end of the project, continued protection of riparian habitats would revert to the Forest Service and would be accomplished through NEPA review. Furthermore, the Powers Gulch pasture of the Bellevue Allotment would be retired for the life of the mine, at a minimum.

- An off-site riparian area (Arnett Creek) would be protected from livestock grazing using protective fencing.

- Subject to COE approval and in compliance with the requirements of the CWA Section 404 permit, a mitigation plan has been developed to improve/enhance riparian and aquatic habitats in amounts and/or quality equal to or greater than the area affected by the proposed project. This mitigation would be implemented to establish and enhance appropriate riparian and aquatic habitats in the designed diversion structures and is fully described in the CWA 404 permit (see AB-3).

<u>TB-4</u>: Haunted Canyon Riparian Mitigation - A complete baseline description and photo documentation of the Haunted Canyon riparian area would be developed prior to the initiation of well field pumping as discussed in the Biological Monitoring & Mitigation Plan. Monitoring and mitigation of alluvial water levels in the vicinity of the well field are identified in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures. Although it is anticipated that streamflow augmentation would also support the riparian vegetation that exists in the well field area, there is the potential that the relationship is more complex. In this regard, additional monitoring specific to the riparian vegetation would be initiated (see the Biological Monitoring & Mitigation Plan). Should monitoring indicate that riparian habitats in this area are being negatively affected by the pumping, measures, such as increased water augmentation from the well field, as well as others proposed in the Biological Mitigation & Monitoring Plan to alleviate these impacts would be initiated. If established measures are ineffective, additional mitigation would be developed in consultation with the Forest Service.

<u>TB-5</u>: Bat Roost Mitigation - If bat roosts are identified in disturbance areas during construction, Carlota would work with the Forest Service to identify abandoned mine adits or shafts on its property that could be preserved as alternative roost sites for bat

species. Grating devices or other means would be used to allow bats to enter and exit the adits.

TB-6: Lesser long-nosed Bat Mitigation - Prior to construction, native agaves would be transplanted from areas of greatest density to similar densities in appropriate habitat within the project area.

TB-7: In order to mitigate impacts to upland vegetation and the associated wildlife habitat, Carlota would implement a combination of (1) fencing of mining areas and other key areas, (2) acquisition of grazing permits and implementation of non-use during the project life, (3) closure of certain project area roads, and (4) maintenance of existing off-site water developments.

3.5.4.2 Aquatic Resources

Monitoring

Aquatic biology monitoring would be conducted to detect possible impacts from water withdrawals and upstream mining activity on aquatic resources, particularly longfin dace and desert sucker populations. Sampling would monitor possible population changes, habitat changes, and the effectiveness of mitigation measures. The specific monitoring protocol and schedule should be determined in consultation with the Forest Service, the Arizona Game and Fish Department, and other resource agency biologists.

Sites. According to the Biological Monitoring & Mitigation Plan, fish and macroinvertebrate communities and aquatic habitat would be monitored at four sites in Pinto Creek and two sites in Haunted Canyon. The proposed Pinto Creek sites would be located above the diversion (near water quality site PC-3), within the proposed pit area (near water quality site PC-4), immediately below the diversion and above Miller Springs (PC-MS), and upstream of the Iron Bridge (downstream of Haunted Canyon near water quality site PC-7). After mining begins, a site would be added to the new diversion channel at PC-4A to replace the pit area station lost to mining. The Haunted Canyon sites would be located near water quality sites HC-4 and HC-2. An optional site would be included near water quality site PC-10 only if it is determined that an impact has occurred and data from this site might be beneficial in assessing the spatial extent of effects.

Fish Community and Macroinvertebrate Monitoring. Quantitative sampling would be conducted twice a year for macroinvertebrates and once a year for fish prior to the onset of construction and for 3 years after construction. Thereafter, sampling frequency would be determined by professional personnel implementing the monitoring protocol (refer to page 66 in the Biological Monitoring & Mitigation Plan for a description of the process to be used in determining additional postconstruction monitoring). This practice would effectively (1) provide further baseline data regarding benthic community structure and ecology before the onset of construction, (2) monitor the effects of sedimentation on the stream ecosystem during the construction process, and (3) monitor impacts from mining, including sedimentation and heavy metal toxicity during the years that mining operations are conducted. The detailed procedures for both fish and macroinvertebrate sampling and the indices used to describe aquatic conditions are described in the *Biological Monitoring & Mitigation Plan for the Carlota Copper Project on the Tonto National Forest* (Cedar Creek 1996a). Fish sampling would consist of both visual and active capture methods. Macroinvertebrate sampling would be quantitative with replication at each site.

The spring effort would focus on visual surveys to document spawning activities. The fall sampling would include electrofishing and seining to sample fish communities and quantitative samples and analysis of the macroinvertebrate community. Sampling dates would coincide with major spawning periods in spring and in the late fall after the summer monsoon season.

Habitat Monitoring. Habitat at each site would be measured and analyzed once during each fish and macroinvertebrate survey in the fall.

Mitigation

The following mitigation measures have been identified to reduce the effects on aquatic biology resources in Powers Gulch, Haunted Canyon, and Pinto Creek. The measures are designed to reduce the effects of the proposed Carlota Copper Project on aquatic habitat, aquatic species, and wetlands and waters of the U.S.

AB-1: Construction activities with the potential to generate sediment in Pinto Creek or Powers Gulch would be coordinated with the Forest Service to ensure that measures designed to reduce sedimentation are incorporated and promptly implemented. Activities that could produce higher sediment levels would be scheduled to avoid periods of fish spawning.

AB-2: Wetlands Mitigation - Subject to Forest Service and COE approval, a mitigation program to replace wetlands impacted by the project is proposed to comply with the conditions of Carlota's CWA Section 404 permit. The Forest Service and the COE are reviewing potential mitigation projects to offset the loss of 0.34 acre of designated wetlands within the project area. The impacts would be mitigated by constructing a new 1-acre wetland area along Pinto Creek, extending upstream from the Pinto Creek cutoff wall at a ratio of 3 to 1 (mitigation acres to impact acres). Native wetland vegetation would be planted, maintained, and monitored.

AB-3: Waters of the U.S. Mitigation - As stated in Section 3.5.2, Environmental Consequences, 9.12 acres of designated waters of the U.S. are anticipated to be lost because of the project. Subject to Forest Service and COE approval, and in compliance with the requirements of Carlota's CWA Section 404 permit, mitigation for impacts to waters of the U.S. would include creating a replacement channel in Pinto Creek; the Pinto Creek diversion channel would have biological habitat characteristics similar to the impacted channel. The ratio of mitigation acreage (11.40 acres) to impacted acreage (9.12 acres) would be approximately 1.25:1. The mitigation for wetlands and waters of the U.S. is fully described in *Wetland and Waters of the U.S. Compensatory Mitigation Plan for the Carlota Copper Project (*Aquatic and Wetland Consultants, Inc. 1996a).

3.6 Cultural Resources

3.6.1 Affected Environment

3.6.1.1 Description of Historic Context Development Area

The Forest Service has identified a Carlota Historic Context Development Area (HCDA) encompassing the proposed Carlota Copper Project (SWCA 1993b, 1993c). The study area facilitates assembly of regional cultural resource information and, ultimately, permits development of specific historic contexts within which individual prehistoric and historic sites may be evaluated. The HCDA, with the proposed project in the approximate center, encompasses 290 square miles and is bounded roughly on the north by the Salt River and on the south by the Gila River. To the east, it extends approximately to the community of Globe, and to the west to the town of Superior. The HCDA is within the Forest Service's Globe-Superstition analysis area and encompasses parts of three Forest Geographic Study Areas. These are the Superstition Mountain, Pinal Mountain, and Pinal Creek study areas. The HCDA is quite rugged and lies physiographically within the Central Mountain Transition zone. Vegetation of the interior chaparral community is typical (SWCA 1993b, 1993c).

3.6.1.2 Previous Archaeological Research in the Area

The record of prior research within and near the Carlota HCDA has been detailed in Wood et al. (1989) and SWCA (1993b) and is summarized here. For organizational purposes, these studies are split into two broad groups: early investigations and recent investigations.

The earliest significant archaeological study of record is that of Harold S. Gladwin et al. working through the Gila Pueblo Archaeological Foundation. Gladwin conducted excavations at Gila Pueblo, located near Globe (Gladwin and Gladwin 1934, 1935; Haury 1988). In the late 1920s, Erich Schmidt excavated the pueblo of Togetzoge and Rogers Cliff Ruin, located in the upper Pinto Creek drainage and Superstition Mountains, respectively (Hohmann and Kelley 1988).

In 1932, Florence Hawley conducted partial excavations at the Bead Mountain pueblos, a complex of three pueblos with smaller sites nearby (Hawley 1932). Irene Vickery, operating in the context of 1930s Depression-era public works programs, conducted a major excavation of the pueblo of Besh-bagowa situated in Globe. In the following decade, she also excavated the site of Inspiration I along Miami Wash (Vickery 1939, 1945).

Recent work in the study area has occurred from the early 1970s to the present, with an emphasis on the context of cultural resource management (that is, research prompted by proposed development and mandated by historic preservation statutes). All of the studies named below, except the last one (for the Carlota Copper Project), were conducted by the Arizona State Museum.

In the early 1970s, Ric Windmiller undertook surveys and small-scale excavations in the Globe-Miami-Pinto Creek vicinity (Windmiller 1972, 1974). During this same time, a small pueblo called Central Heights was excavated at a separate project site located near Globe (McGuire 1975). Doyel's (1978) work along State Highway 88, known as the Miami Wash Project, was also undertaken in the early 1970s, and it consisted of eight sites that were excavated a few miles north of the proposed Carlota Copper Project area. As a result of this work, the Miami phase—temporally between Salado and Hohokam—was defined.

The Orme Reservoir Project was undertaken in the 1970s in the vicinity of the confluence of the Salt and Verde Rivers in the northwestern portion of the Globe-Superstition Mountains area; it consisted of a large-scale inventory (without excavation) along both streams (Canouts 1975).

The Cholla Transmission Line Project, conducted along an Arizona Public Service line through the study area, occurred in the late 1970s. Sites were found concentrated in the Devore Wash area, which is located a few miles north of the Carlota Copper Project area; again, no excavations were undertaken (Reid 1982a, 1982b).

Finally, an intensive inventory of over 2,600 acres was conducted for the Carlota Copper Project by SWCA, Inc. in 1991 and 1992 (SWCA 1993a), and an intensive ethnohistoric documentation program was completed by SWCA, Inc. in 1997 (Newton et al.

1997). As a result of this inventory, 89 cultural sites are known to exist in the project area proper, including 83 prehistoric and historic archaeological sites and 6 locations identified by Tribes as traditional cultural properties (TCPs) not specifically associated with other prehistoric or historic sites (see following discussion). The archaeological sites were test-excavated in the fall and winter of 1993-1994 (Goodman et al. 1994; Mitchell et al. 1994). Data recovery excavations were undertaken in 1996-97, and data currently are being analyzed and reported.

3.6.1.3 Cultural-Historical Overview

Four periods of prehistoric occupation have been identified in the Carlota HCDA (SWCA 1993b, Wood et al. 1989): Preceramic (Archaic) period, Ceramic period/preclassic, Ceramic period/classic, and Protohistoric/Historic period.

The Preceramic, or Archaic, period dates circa 7500/8000 B.C. to A.D. 500 and may be subdivided into Early, Middle, and Late phases. No pre-existing Paleo-Indian period has been firmly established in the immediate study area. The Preceramic period is characterized by a mobile to semisedentary hunter-gatherer lifestyle.

The Ceramic period/preclassic dates circa A.D. 500 to 1200 and may be subdivided into successive Early Preclassic, Santa Cruz, and Sacaton phases; the Miami phase, at the end of the period, is transitional with the subsequent Ceramic period/classic. The Ceramic period/preclassic is synonymous with early Hohokam occupation and is characterized by agriculture-based sedentary villages and pottery-making.

The Ceramic period/classic dates from A.D. 1200 to 1500, growing out of the transitional Miami phase into subsequent Roosevelt and Gila phases. This period may be correlated with the Salado culture, which exhibits distinctive architectural, ceramic, economic, and settlement traits. As in the previous period, settlement in the Ceramic period/classic is essentially sedentary and agriculture-based.

The final period, the Protohistoric/Historic, dates A.D. 1500 to the mid-1860s in the study area. It is associated with Western Apache and Yavapai Indian groups, which, although poorly understood, are believed to have been semisedentary hunter-gatherers and part-time horticulturists.

Prehistoric archaeological sites known to exist in the immediate vicinity of the Carlota Copper Project area include cobble masonry structures, pit houses, ceramic and lithic scatters, rock art, and pueblos of varying sizes (SWCA 1993a). Functionally, the known aboriginal sites of the HCDA may be broken down as follows: temporary encampments, residential sites, resource procurement/processing sites, agricultural sites, quarries/mines, and rock art (SWCA 1993b).

Two principal historic themes of the Carlota HCDA are mining and agriculture/ranching. Initial prospecting and mining, oriented strictly toward gold and silver deposits, probably began in the 1850s, although significant early discoveries were not made in this region. Gold and silver (particularly silver) were mined through the turn of the 20th century. Early Anglo-American encroachment in the area resulted in conflict with the Apache Indians, and by the 1870s, the U.S. government had established a military presence. The occurrence and importance of copper deposits in the area became known in the 1870s, and by the early part of the 20th century, copper had eclipsed silver in importance. Although copper production dipped substantially after World War I, it has nevertheless continued to be an economic mainstay of the region. Settlers with livestock entered the region as early as the 1860s, and during the following decade, numerous cattle ranches were established. Ranching continues in the area to the present day (SWCA 1993c, Wood et al. 1989, SWCA 1993a).

Historic sites in the HCDA tend to be associated mainly with mining and agriculture, but numerous other historic themes are also represented. Mining-related sites consist of structural remains, structure platforms, shafts and adits, camps, and exploration sites. Sites relating to ranching and agriculture consist of ranches, homesteads, stock-related features, production areas, and trash dumps. Other historic site types known to occur in the HCDA include non-agricultural residential locations, graves and cemeteries, transportation-related features (e.g., railroad sidings), rock art/graffiti, construction camps (including camps associated with Depression-era public works projects), and military posts and facilities (SWCA 1993a, 1993c).

3.6.1.4 Consultation with Tribal Governments

Nine Tribal Governments have been consulted concerning archaeology, TCP, and the disposition of human remains. Tribes consulted include the White Mountain Apache, San Carlos Apache, Fort McDowell Yavapai, Salt River Pima-Maricopa, Tonto Apache, Yavapai-Prescott, Yavapai-Apache, Hopi, and Zuni. Field tours of the proposed project area have been provided to representatives of the Tonto Apache, White Mountain Apache, San Carlos Apache, and the Salt River Pima-Maricopa Indian communities. In addition, information on the project has been presented to the Hopi and Zuni cultural preservation groups. All tribes have been furnished with copies of survey testing plans and reports, data recovery plans, and ethnohistoric investigation reports for review and comment.

Ethnohistoric investigations have been undertaken to determine if there are any TCPs within the project area. These investigations began with a literature review, which was followed by informant interviews and field visits with Tribal representatives. Traditional Tribal interests in the archaeological sites were documented and several additional areas were identified by Tribes as TCPs to be considered under the procedures of section 106 of the NHPA, as amended. These additional sites included several possible prehistoric shrines, a historic clan origin place, and an area historically used for collecting plants, camping, and ceremonial dancing.

These investigations are documented in Newton et al. (1997). Because of the sensitive nature of some of the information obtained from Tribal informants, portions of this documentation are considered confidential.

In evaluating the identified TCPs for their eligibility for the National Register of Historic Places (NRHP), as required by 36 *CFR* 800, not all of the sites were determined eligible as recommended by the Tribes. While recognizing that all of the identified TCPs have cultural significance to those Tribes identifying them, this determination reflects the fact that some of the identified TCPs lack specific locations, boundaries, or physical manifestations while others are represented by physical features whose identity and association could not be verified. For those TCPs that cannot be avoided by project impacts, the Forest Service will consult further with the concerned Tribes regarding ways to alleviate their concerns prior to project implementation.

3.6.1.5 Information Sources

Information about the general prehistoric and historic cultural setting of the Carlota Copper Project vicinity was gleaned from several literature sources. Most notable among these are the *Tonto National Forest Cultural Resources Assessment and Management Plan* (Wood et al. 1989) and two recent documents produced for the Carlota Copper Company by SWCA, Inc.: *Historic Context Development and Testing Plan for the Carlota Project* (SWCA 1993b) and *Historic Context Development and Testing Plan for Historic Sites in the Carlota Project Area, Gila and Pinal Counties, Arizona* (SWCA 1993c). Site-specific information from within the project boundaries was drawn from the report of an intensive 2,626-acre cultural resource inventory conducted on behalf of Carlota Copper Company by SWCA (1993a) and from respective reports of SWCA's historic and prehistoric site testing programs for Carlota Copper Company (Goodman et al. 1994; Mitchell et al. 1994).

3.6.1.6 Cultural Data Summary

Four hundred and twenty-seven cultural localities were identified and reported in the Carlota Copper Project survey by SWCA (1993a: Appendices A, B, C; Newton et al. 1997). These properties consist of 87 prehistoric and historic sites, 120 prehistoric and historic isolated occurrences (IOs), and 220 properties classified as "other historic-to-recent or recent remains." These figures include previously recorded sites within the study area boundaries. The total number of sites included in the EIS analysis has subsequently been reduced to 83; 7 sites lie outside of project boundaries as currently defined, and 3 additional sites have been recorded within the project boundaries since SWCA's major inventory (1993a). Of the 83 sites, 45 are prehistoric, 32 are historic-to-recent, and 6 are multicomponent prehistoric/historic. Of the 120 IOs, 71 are prehistoric, 47 are historic-to-recent, and 2 are multicomponent prehistoric/historic.

Fifty-five of the archaeological sites also are considered to be TCPs by Tribal informants, either as perceived manifestations of Tribal migration histories and origin myths or by virtue of containing features interpreted by Tribal religious practitioners as prehistoric shrines or other locations associated with religious or ceremonial activities. Six TCPs were identified by Tribes as separable locations from any specific archaeological site. Several of these were noted as isolated occurrences in the original archaeological inventory, but others were not recognized before the field visits and interviews with Tribal informants. This was largely because three of these six have no physical manifestations other than a remembered setting in the landscape (Newton et al. 1997).

For purposes of project impact assessment, IOs and "other" remains will not be considered since they are categorically regarded as non-eligible properties. The discussion from this point forward is thus limited to the 83 archaeological sites and 6 additional locations identified as TCPs.

Of the prehistoric sites (including multicomponent sites with a prehistoric component), 15 exhibit architecture (compound pueblos, one- to two-room structures, rock features), 42 exhibit artifact scatters (ceramics, chipped stone, or ground stone), and 2 include rock art. Of the historic sites (including multicomponent sites with a historic component), 14 exhibit architecture or structural remains, 14 have mine shafts or adits, 5 have test pits (prospect holes), at least 8 have other mining-related features, 9 have refuse concentrations or scatters, and 1 has rock art/graffiti (SWCA 1993a).

Of the six TCPs identified by Tribes that are not associated with previously recorded archaeological sites, three are identified as isolated prehistoric shrines, one as a historic clan origin area, and two as areas used historically for collecting plants, camping, and ceremonial dancing (Newton et al. 1997).

3.6.2 Environmental Consequences

The evaluation criterion for cultural resources is the number of prehistoric and historic sites and TCPs directly or indirectly affected by the proposed Carlota Copper Project. The NRHP, in its modern form, was created by the NHPA of 1966 (as amended).

Eligibility criteria are enumerated in 36 CFR 60 (implementing federal regulations) and consist of the following:

> The quality of <u>significance</u> in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> (a) That are associated with events that have made a significant contribution to the broad patterns of our history;
>
> (b) that are associated with the lives of persons significant in our past;
>
> (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) that have yielded, or may be likely to yield, information important in prehistory or history.

The NHPA makes it clear that a site need not be of national historic significance to be considered eligible; sites of local, state, and regional importance may also be listed and are thus significant in the legal sense. The phrasing of the NHPA is critical with respect to the actual management of cultural resources; a site need not be included on the NRHP to be afforded protection under the law, but simply must meet the requirements of eligibility.

Significance, however, is not the only factor in determining eligibility of historic properties. Integrity is an equally important factor that reflects the fact that properties to be listed on the NRHP must, first of all, be tangible properties with recognizable physical characteristics and finite geographic locations and boundaries. These considerations are especially critical in regard to certain types of properties.

Contexts for prehistoric and historic sites known to exist in the Carlota Copper Project area were developed by SWCA, Inc. in consultation with the Forest Service and the State Historic Preservation Officer (SWCA 1993b, 1993c). A context of this type is defined as "an organizational framework devised by the federal government to assist in the evaluation and treatment of historic properties" (SWCA 1993b). Essentially, sites that meet one or more of the NRHP criteria for eligibility and that specifically have the potential to contribute information relevant to one or more of the themes identified within the contexts will be assessed as significant. Prehistoric themes include (1) Preclassic sociopolitical-ideological systems, (2) Classic period sociopolitical-ideological systems, (3) Prehistoric subsistence, (4) Classic period exchange-trade-commerce, and (5) Classic period demography. Sites with the potential to produce information about prehistoric chronology may also be regarded as significant (SWCA 1993b). Historic themes include (1) demography, (2) technology and architecture, (3) exchange, trade, and commerce, and (4) subsistence (SWCA 1993c). Of the 89 cultural sites, 59 were determined eligible for the NRHP under NRHP Criterion (d). This includes the 55 archaeological sites identified by the Tribes to be TCPs.

For purposes of analysis, two types of impacts are identified: direct and indirect. A direct impact to cultural resources is one that results from an immediate consequence of project actions. It would include impacts resulting from open-pit mining; construction of roads, buildings, and parking areas; construction of leach pads and rock dumps; installation of water pipelines and power lines; and other project activities. An indirect impact is one that exists outside of specific project disturbance areas and is frequently manifested as an impact resulting from increased human access to an area or accelerated erosion.

Either type of impact may result in irreversibly compromising a site's integrity and losing its historic or scientific values. Sites in the proposed Carlota Copper Project area are regarded as threatened with direct impact if they lie within the boundaries of planned project facilities, such as mining pits, parking lots, roads, etc. Sites threatened with indirect impact are those lying outside of, but within 500 feet of, project facilities.

Based upon the results of the information generated during the preparation of the HCDA analysis, a review of the results of the archaeological and ethnohistoric surveys, and the geographic setting of the project area, it became apparent that the Carlota Copper Project area encompassed a distinct prehistoric and historic settlement area centered around the Pinto Creek/ Powers Gulch area. Further review of the proposed alternatives revealed that all alternatives (with the exception of the no action alternative) would result in significant impacts to the sites that comprise this settlement area. Therefore, while analysis of the alternatives is framed in terms of direct and indirect impacts to specific properties, mitigation options and actions will focus on treatment of the impacts to the overall settlement system.

3.6.2.1 Proposed Action

Eighty-nine prehistoric and historic sites (including several with both prehistoric and historic components) and TCP sites have been recorded in the project area. Of this total, 56 sites lie within direct impact areas, and another 12 sites are in indirect impact areas. The remaining 21 sites are not threatened by any type of project-related activity. Many of the 56 sites in direct impact areas also lie within 500 feet of other project facilities, and thus are threatened with indirect as well as direct impacts. Impacts to specific cultural resources relative to the proposed action are detailed in *Table 3-63*. Of the 56 sites located within direct impact areas, 35 are assessed as meeting eligibility criteria of the NRHP; the remaining 21 sites are not NRHP-eligible. Of the 12 sites within indirect impact areas, 8 are NRHP-eligible, and 4 are not eligible.

3.6.2.2 Alternatives

Mine Rock Disposal Alternatives

Of the 89 sites recorded in the project area, 6 would be affected, either directly or indirectly, by various mine rock disposal alternatives (*Table 3-64*). Potential impacts to known sites are as follows:

Table 3-63. Cultural Resource Impacts - Proposed Action

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Type of Impact[2]	Facilities Association[2]
02-425	V:9:244	E	D, I	Haul Road (D) Leach Pad (D) Main Mine Rock Area (D) Main Water Pipeline (D) Power Line(D) Service Road (D) Stockpile/Secondary Crushing Area (I)
02-432	V:9:236	E	D, I	Eder North Pit (I) Haul Road (I) Leach Pad (I) Powers Gulch Diversion (D)
02-433	V:9:237	E	D	Leach Pad
02-434	None	E	I	Leach Pad PLS Ponds Underdrain Collection Pond
02-436	V:9:233	E	D, I	Access Road (I) Leach Pad (D) PLS Pipeline (I) Power Line(I) Stockpile/Secondary Crushing Area (I)
02-437	U:12:66	E	None	N/A
02-438	V:9:222	E	D, I	Leach Pad (D) Access Road (I)
02-848	V:9:247	E	D, I	Carlota/Cactus Pit (D) Access Road (I)
02-1091	V:9:212	NE	None	N/A
02-1092	V:9:213	E	None	N/A
02-1093	V:9:217	E	None	N/A
02-1094	V:9:215	E	None	N/A
02-1096	V:9:217	E	None	N/A
02-1097	V:9:218	NE	None	N/A
02-1098	V:9:219	NE	None	N/A
02-1099	V:9:220	NE	None	N/A
02-1100	V:9:221	E	D	Leach Pad
02-1101	V:9:223	NE	D	Leach Pad
02-1102	V:9:224	E	D, I	Access Road (I) East Diversion Channel (I) Inlet Control Structure (I) Leach Pad (D) Powers Gulch Diversion (I) Spillway (I)
02-1103	V:9:225	E	D	Leach Pad
02-1104	V:9:226	NE	D, I	Access Road (I) Leach Pad (D)
02-1105	V:9:227	E	D, I	Access Road (I) Carlota/Cactus Pit (I) Leach Pad (I) North Diversion Channel (I) Power Line (I) SX-EW Plant Area (D) Water Pipeline (I)

Table 3-63. Cultural Resource Impacts - Proposed Action (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Type of Impact[2]	Facilities Association[2]
02-1106	V:9:228	NE	D, I	Leach Pad (D) Access Road (I) Main Water Pipeline (I) Power Line (I)
02-1107	V:9:229	E	D, I	Carlota/Cactus Pit (D) Pinto Creek Diversion (I)
02-1108	V:9:230	E	D, I	Leach Pad (D) PLS Ponds (I)
02-1109	V:9:231	NE	D, I	Leach Pad (D) PLS Ponds (I)
02-1110	V:9:232	E	D, I	Leach Pad (D) PLS Pipeline (I) PLS Ponds (D)
02-1111	V:9:245	NE	D, I	Main Mine Rock Area (D) Sediment Control Structure (I)
02-1112	V:9:234	E	D, I	Leach Pad (I) PLS Pipeline (I) PLS Ponds (D) Powers Gulch Diversion (I) Underdrain Collection Pond (I)
02-1113	V:9:235	E	D, I	Leach Pad (D) Powers Gulch Diversion (I) PLS Pipeline (I) PLS Ponds (I)
02-1114	V:9:238	E	D	Leach Pad
02-1115	V:9:239	E	D, I	Leach Pad (D) Powers Gulch Diversion (I)
02-1116	V:9:240	E	D	Leach Pad
02-1117	V:9:241	E	D	Leach Pad
02-1118	V:9:242	NE	D, I	Main Mine Rock Area (D) Main Water Pipeline (I) Power Line (I) Service Road (I)
02-1119	V:9:243	NE	I	Main Mine Rock Area Sediment Control Structure
02-1120	U:12:58	E	None	N/A
02-1121	V:9:246	NE	D, I	Main Mine Rock Area (D) Main Water Pipeline (I) Power Line (I) Sediment Control Structure (I)
02-1122	U:12:59	E	D, I	Head Tank (D) Main Water Pipeline (I) Power Line (I) Service Road (I)
02-1124	V:9:248	E	D, I	Access Road (I) Carlota/Cactus Pit (D) Main Water Pipeline (I) Power Line (I)
02-1125	V:9:249	E	D, I	Access Road (I) Carlota/Cactus Pit (D)
02-1126	V:9:250	E	D	Carlota/Cactus Pit
02-1127	V:9:251	E	D	Carlota/Cactus Pit
02-1128	V:9:252	E	D, I	Carlota/Cactus Pit (D) Pinto Creek Diversion (I)

Table 3-63. Cultural Resource Impacts - Proposed Action (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Type of Impact[2]	Facilities Association[2]
02-1129	V:9:253	E	D	Carlota/Cactus Pit
02-1130	V:9:254	E	D, I	Access Road (D) Power Line (I)
02-1131	V:9:255	E	D	Carlota/Cactus Pit
02-1132	U:12:60	NE	None	N/A
02-1133	U:12:61	NE	None	N/A
02-1134	U:12:62	E	None	N/A
02-1135	V:9:256	E	D	Carlota/Cactus Pit
02-1136	V:9:257	E	D	Carlota/Cactus Pit
02-1137	V:9:258	E	None	N/A
02-1138	V:9:259	NE	D	Cactus SW Mine Rock Area
02-1139	V:9:260	E	D, I	Access Road (I) Leach Pad (D)
02-1140	U:12:63	E	None	N/A
02-1141	U:12:64	E	I	Powers Gulch Diversion
02-1142	U:12:65	E	None	N/A
02-1144	V:9:261	NE	I	Leach Pad PLS Pipeline
02-1145	V:9:262	E	I	Leach Pad PLS Pipeline
02-1146	U:12:67	E	I	Leach Pad PLS Pipeline PLS Ponds
02-1147	U:12:68	E	I	Main Mine Rock Area Sediment Control Structure
02-1148	V:9:263	NE	D, I	Haul Road (I) Leach Pad (I) Main Water Pipeline (I) Power Line (I) Service Road (I) Stockpile/Secondary Crushing Area (D)
02-1149	V:9:264	NE	D, I	Access Road (I) Carlota/Cactus Pit (I) Haul Road (I) Leach Pad (I) Main Water Pipeline (I) Power Line (I) Stockpile/Secondary Crushing Area (D)
02-1150	V:9:265	E	I	Access Road Haul Road Main Mine Rock Area Overland Conveyor Power Line Water Pipeline Branch to Truck Shop
02-1151	V:9:266	NE	D, I	Haul Road (I) Main Mine Rock Area (D) Water Pipeline Branch to Truck Shop (I)

Table 3-63. Cultural Resource Impacts - Proposed Action (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Type of Impact[2]	Facilities Association[2]
02-1154	V:9:269	NE	D, I	Access Road (I) Power Line (D)
02-1155	V:9:270	NE	I	Administration building Power Line
02-1160	V:9:271	E	D	Carlota/Cactus Pit
02-1157	V:9:272	E	D	Carlota/Cactus Pit
02-1168	V:9:273	E	D	Carlota/Cactus Pit
02-1155	V:9:270	E	I	Carlota/Cactus Pit Pinto Creek Diversion
02-1160	V:9:276	E	None	N/A
02-1160	V:9:276	E	None	N/A
02-1162	V:9:277	E	I	Crusher Eder South Pit Haul Road
02-1163	V:9:278	E	D, I	Haul Road (D) Leach Pad (I) Powers Gulch Diversion (I)
02-1164	U:12:69	E	None	N/A
02-1166	V:9:280	NE	D, I	Leach Pad (D) PLS Pipeline (I) PLS Ponds (I)
02-1169	V:9:281	NE	D	Leach Pad PLS Pipeline
02-1170	V:9:282	NE	D, I	Access Road (I) Leach Pad (D)
02-1194	None	E	I	Powers Gulch Diversion
02-1195	None	E	None	N/A
02-1196	None	E	None	N/A
02-1217	None	NE	D	Leach Pad
02-1218	None	NE	D	Leach Pad
02-1219	None	NE	D	Carlota/Cactus Pit
02-1220	None	NE	D	Leach Pad Eder South Pit Eder Mine Rock Area Powers Gulch Diversion PLS Pipeline Eder Area Access Road Stormwater Drainage Control Ditch Eder North Pit Eder Middle Pit Sediment Control Structures
02-1221	None	NE	D	Carlota/Cactus Pit Pinto Creek Diversion Sediment Control Structures Mine Access Road Primary Crusher Overland Conveyor
02-1222	None	NE	D	Main Mine Rock Area

[1]NRHP Status: E = Eligible for National Register of Historic Places
NE = Not eligible for National Register of Historic Places

[2]Impact Type: D = Direct
I = Indirect

Table 3-64. Cultural Resource Impacts - Project Alternatives

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Mine Rock Disposal Areas[2,3]	Eder Side-Hill Leach Pad[2,4]	Powers Gulch Inlet Control Structure	Water Supply Well Access Roads	Well Field Area	No Action
02-425	V:9:244	E	None	EH (D)	None	None	None	None
02-432	V:9:236	E	None	WH (D)	None	None	None	None
02-433	V:9:237	E	None	EH (D) WH (I)	None	None	None	None
02-434	None	E	None	EH (I)	None	None	None	None
02-436	V:9:233	E	None	EH (D)	None	None	None	None
02-437	U:12:66	E	None	None	None	None	None	None
02-438	V:9:222	E	None	WH (I)	None	None	None	None
02-848	V:9:247	E	None	None	None	None	None	None
02-1091	V:9:212	NE	None	None	None	None	None	None
02-1092	V:9:213	E	None	None	None	None	None	None
02-1093	V:9:214	E	None	None	None	None	None	None
02-1094	V:9:215	E	None	None	None	None	None	None
02-1096	V:9:217	E	None	None	None	None	None	None
02-1097	V:9:218	NE	None	None	None	None	None	None
02-1098	V:9:219	NE	None	None	None	None	None	None
02-1099	V:9:220	NE	None	None	None	None	None	None
02-1100	V:9:221	E	None	WH (D)	None	None	None	None
02-1101	V:9:223	NE	None	WH (I)	None	None	None	None
02-1102	V:9:224	E	None	WH (D)	I	I	None	None
02-1103	V:9:225	E	None	EH (D)	None	None	None	None
02-1104	V:9:226	NE	None	None	None	None	None	None
02-1105	V:9:227	E	None	EH (I)	None	None	None	None
02-1106	V:9:228	NE	None	EH (I)	None	None	None	None
02-1107	V:9:229	E	None	None	None	None	None	None
02-1108	V:9:230	E	None	EH (D)	None	None	None	None

Table 3-64. Cultural Resource Impacts - Project Alternatives (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Mine Rock Disposal Areas[2,3]	Eder Side-Hill Leach Pad[2,4]	Powers Gulch Inlet Control Structure	Water Supply Well Access Roads	Well Field Area	No Action
02-1109	V:9:231	NE	None	EH (D)	None	None	None	None
02-1110	V:9:232	E	None	EH (D)	None	None	None	None
02-1111	V:9:245	NE	None	None	None	None	None	None
02-1112	V:9:234	E	None	EH (I)	None	None	None	None
02-1113	V:9:235	E	None	EH (I) WH (I)	None	None	None	None
02-1114	V:9:238	E	None	EH (D) WH (D)	None	None	None	None
02-1115	V:9:239	E	None	WH (D)	None	None	None	None
02-1116	V:9:240	E	None	EH (I) WH (I)	None	None	None	None
02-1117	V:9:241	E	None	EH (D)	None	None	None	None
02-1118	V:9:242	NE	None	None	None	None	None	None
02-1119	V:9:243	NE	None	None	None	None	None	None
02-1120	U:12:58	E	None	None	None	None	None	None
02-1121	V:9:246	NE	None	None	None	None	None	None
02-1122	U:12:59	E	None	None	None	None	None	None
02-1124	V:9:248	E	None	None	None	None	None	None
02-1125	V:9:249	E	None	None	None	None	None	None
02-1126	V:9:250	E	None	None	None	None	None	None
02-1127	V:9:251	E	None	None	None	None	None	None
02-1128	V:9:252	E	None	None	None	None	None	None
02-1129	V:9:253	E	None	None	None	None	None	None
02-1130	V:9:254	E	CC (D)	None	None	None	None	None
02-1131	V:9:255	E	None	None	None	None	None	None
02-1132	U:12:60	NE	None	None	None	None	None	None
02-1133	U:12:61	NE	None	None	None	None	None	None
02-1134	U:12:62	E	None	None	None	None	None	None

Table 3-64. Cultural Resource Impacts - Project Alternatives (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Mine Rock Disposal Areas[2,3]	Eder Side-Hill Leach Pad[2,4]	Powers Gulch Inlet Control Structure	Water Supply Well Access Roads	Well Field Area	No Action
02-1135	V:9:256	E	None	None	None	None	None	None
02-1136	V:9:257	E	None	None	None	None	None	None
02-1137	V:9:258	E	None	None	None	None	None	None
02-1138	V:9:259	NE	None	None	None	None	None	None
02-1139	V:9:260	E	None	WH (I)	None	None	None	None
02-1140	U:12:63	E	None	None	None	None	None	None
02-1141	U:12:64	E	None	None	None	None	None	None
02-1142	U:12:65	E	None	None	None	None	None	None
02-1144	V:9:261	NE	None	EH (I)	None	None	None	None
02-1145	V:9:262	E	None	EH (I)	None	None	None	None
02-1146	U:12:67	E	None	EH (D)	None	None	None	None
02-1147	U:12:68	E	None	None	None	None	None	None
02-1148	V:9:263	NE	None	EH (I)	None	None	None	None
02-1149	V:9:264	NE	None	EH (I)	None	None	None	None
02-1150	V:9:265	E	None	None	None	None	None	None
02-1151	V:9:266	NE	None	None	None	None	None	None
02-1154	V:9:269	NE	CC (I)	None	None	None	None	None
02-1155	V:9:270	NE	CS (I)	None	None	None	None	None
02-1156	V:9:271	E	None	None	None	None	None	None
02-1157	V:9:272	E	None	None	None	None	None	None
02-1158	V:9:273	E	None	None	None	None	None	None
02-1159	V:9:274	E	None	None	None	None	None	None
02-1160	V:9:275	E	E (I)	None	None	None	None	None
02-1161	V:9:276	E	E (D)	None	None	None	None	None
02-1162	V:9:277	E	None	WH (I)	I	None	None	None

Table 3-64. Cultural Resource Impacts - Project Alternatives (continued)

Forest No. AR-03-12-	ASM Site No. AZ-	NRHP Status[1]	Mine Rock Disposal Areas[2,3]	Eder Side-Hill Leach Pad[2,4]	Powers Gulch Inlet Control Structure	Water Supply Well Access Roads	Well Field Area	No Action
02-1163	V:9:278	E	None	WH (D)	None	None	None	None
02-1164	U:12:69	E	None	None	None	None	None	None
02-1166	V:9:280	NE	None	EH (D)	None	None	None	None
02-1169	V:9:281	NE	None	EH (I)	None	None	None	None
02-1170	V:9:282	NE	None	WH (I)	None	None	None	None
02-1194	None	E	None	None	None	None	None	None
02-1195	None	E	None	None	None	None	None	None
02-1196	None	E	None	None	None	None	None	None
02-1217	None	NE	None	EH(D)	WH(D)	None	None	None
02-1218	None	NE	None	EH(D)	WH(D)	None	None	None
02-1219	None	NE	None	None	None	None	None	None
02-1220	None	NE	None	EH(D)	WH(D)	None	None	None
02-1221	None	NE	CS(D)	None	None	None	None	None
02-1222	None	NE	None	None	None	None	None	None

[1] NRHP Status:
- E = Eligible
- NE = Not Eligible

[2] Impact Type:
- D = Direct
- I = Indirect

[3] Mine Rock Disposal Areas:
- CC = Cactus Central
- CS = Cactus South
- E = Eder

[4] Eder Side-Hill Leach Pad:
- EH = East Heap
- WH = West Heap

- Alternative mine rock disposal sites (Cactus Central, Cactus South): 4 sites (2 direct impact, 2 indirect impact), an increase of 4 sites when compared to the proposed action
- Additional backfill of the Carlota/Cactus pit (Carlota/Cactus pit, Main mine rock area); 0 sites, which would be the same as the proposed action
- Additional backfill of the Eder South pit: 1 site (indirect impact), which would be the same as the proposed action

Eder Side-Hill Leach Pad Alternative

A total of 35 sites (19 direct impact, 16 indirect impact) would be affected by this alternative (*Table 3-64*), which would be the same as the proposed action.

Water Supply Alternative

No sites would be impacted by the water supply alternative. This represents no change when compared to the proposed action.

Alternative Water Supply Well Field Access Roads

One site would be indirectly impacted by this alternative. This would represent an increase of 1 site compared to the proposed action.

No Action Alternative

No project-related impacts to known cultural resources would occur under this alternative (*Table 3-64*). It is possible, however, that sites in the project area could be affected in the future because existing roads into the mine provide access to the general public.

3.6.3 Cumulative Impacts

The cumulative impact analysis area for cultural resources encompasses 290 square miles and is bounded roughly on the north by the Salt River and on the south by the Gila River. To the east, it extends approximately to the community of Globe, and to the west to the town of Superior. This corresponds to the HCDA that was developed for the archaeological contextual study. Within this area, 17 major interrelated actions were identified that have, or have had, the potential to affect cultural resources. These actions include 10 mines, 2 reservoir projects, 2 highway projects, 1 power line project, and 2 areas of continuing residential or commercial development. Grazing also may affect sites; however, these effects are of a much lower magnitude than those possible from the 17 actions mentioned above. In addition, the trend in the study area has been toward reduced grazing intensity.

All of the identified interrelated projects entail ground disturbance with the potential to impact cultural resources. In addition, one of the dam modification projects could impact sites through inundation since that modification could result in raising reservoir floodpool levels.

The impact to cultural resources from past mining activities cannot be directly quantified. It is possible, however, to produce some indirect estimates of these impacts using the results of recent archaeological surveys within the analysis area. The Carlota Copper Project, the Cyprus-Miami project, and the BHP Copper project surveys covered a combined 5,831 acres. These surveys identified 136 historic and prehistoric sites for an average site density of approximately 1 site for every 43 acres. While it is recognized that there is a great deal of variation in patterning of cultural resources within the analysis area, this composite site density appears to be typical of the overall density. Within the analysis area, 16,525 acres were estimated to have been disturbed by past mining activities (*Figure 1-3*). Using the composite site density as a guide, it is estimated that approximately 384 sites may have been impacted by past mining activity. This would be approximately 8.9 percent of the projected 4,316 sites in the analysis area.

Within the analysis area, new mining (Carlota Copper Project) and expansions of existing mining facilities (Cyprus-Miami and BHP Copper) have the potential to disturb as much as 4,633 acres. As mentioned above, surveys of the project areas identified 136 historic and prehistoric sites that could be potentially affected. Of the 136 sites identified, 110 are within the direct and indirect impact areas of these projects. Effects to these 110 sites would add another 2.5 percent to the number of sites impacted by mining activity in the analysis area.

Past, present, and reasonably foreseeable future mining activities in the analysis area may affect, or have already affected, 11.4 percent of the estimated 4,316 cultural resource properties.

Other major actions with impacts to the cultural resources of the analysis area are the reservoir projects at Roosevelt and Coolidge dams. Upgrading Coolidge Dam will result in minor disturbance to the construction area.

At Roosevelt Dam, the original construction of the dam inundated an unknown number of sites. The recent actions at Roosevelt Dam have affected 73 historic and prehistoric sites in the dam modification direct and indirect impact areas. The original reservoir inundated approximately 3,900 acres that are included in the analysis area. Using the estimated site density calculated above, 87 sites might have been impacted as a result of this action. Compounded, reservoir projects contribute another 3.9 percent to the number of sites impacted in the analysis area.

Highway improvement projects also will impact a number of sites within the analysis area. Construction activities along the Wheatfield section of State Route 88 will impact 16 sites. These 16 sites can be included in the cumulative impact analysis. These sites represent 0.4 percent of the estimated number of sites in the analysis area. While other improvements are planned for State Route 88, it is not possible to calculate impacts to cultural resources at this time. Along U.S. Highway 60-70, several upgrades and alterations have been proposed. Plans for these various activities are not at a sufficient stage to estimate the impacts to cultural resource.

The archaeological survey for the reliability maintenance improvements to the 115-kv transmission line between Superior and Ray also identified cultural resource sites within the project area. Project design, however, was such that there were no impacts to any of these properties.

Estimates of the impacts resulting from past and continued growth of the Globe-Miami and Top-of-the-World areas are, as with mining, only indirectly quantifiable. The Globe-Miami area covers approximately 25,600 acres and Top-of-the-World approximately 960 acres. Using the site density estimate calculated earlier, approximately 618 sites have been or are potentially being impacted by development in these communities. This would be 14.3 percent of the estimated sites in the analysis area.

Overall, it is possible to roughly estimate that cumulative impacts to cultural resources involve approximately 1,288 sites, or 30 percent of the properties in the analysis area. Over the last 25 years, these impacts have been lessened by the fact that mitigation has been required for actions with federal or state involvement. Data recovery procedures, approved by federal agencies and the State Historic Preservation Office, are intended to recover the information potential of impacted sites prior to project impacts. Over the years, these procedures continue to improve so that better information is recovered. As a result, while site loss to actions continues, better mitigation procedures are reducing the amount of information loss. This, coupled with the federal and state goal of avoiding impacts to sites where possible, has slowed the impacts to the resource base.

These mitigation procedures are not required for projects without federal or state involvement. In instances that do not involve federal or state involvement, unless the project proponent acts responsibly, site and information loss will continue.

3.6.4 Monitoring and Mitigation Measures

3.6.4.1 Mitigation Options

Mitigation is defined as any of several forms of management action that has the effect of reducing or eliminating adverse impacts to heritage resource properties. The choice of management options for mitigating impacts to properties is dictated by three factors: assessment of the property's significance, the physical nature of the property, and the nature of the proposed impact. As a general guideline, the best mitigative options are those that ensure the continued existence of a property (e.g., avoidance, protection). Such options are desirable not only from a conservation standpoint but, in most instances, from a cost perspective as well. However, the effects of unavoidable impacts must be handled through data retrieval. The data retrieval process must account for the physical composition of the property and the types of information used to characterize it, as well as the nature and severity of the proposed impact.

The remaining options are designed to manage significant properties that are threatened. These options include avoidance/protection, recording/documentation (including such actions as mapping or archival research), collection, partial or complete excavation, and treatment or maintenance. In practice, impact mitigation often involves a combination of two or three of these actions, e.g., surface collection in combination with partial excavation. Avoidance and protection differ only in that the latter requires some form of action, such as fencing.

3.6.4.2 Recommended Mitigation Actions

CR-1: As the first stage in mitigating the impacts to the remains of the prehistoric and historic settlement areas, all 83 prehistoric and historic sites in the Carlota Copper Project area were test excavated by SWCA, Inc. during the fall and winter of 1993-1994 (Goodman et al. 1994; Mitchell et al. 1994).

The proposed action would result in direct impacts to 56 sites, of which 35 are NRHP-eligible, and indirect impacts to 12 sites, of which 8 are NRHP-eligible. Mitigation consisting of data retrieval was conducted at the 35 directly impacted sites that are NRHP-eligible. Mitigation was carried out in the context of comprehensive prehistoric or historic research designs. The locations of the 8 NRHP-eligible sites in indirect impact areas would be monitored regularly by an archaeologist, and the locations fenced if evidence of encroachment is found. If continued monitoring suggests that fencing is not adequately protecting the sites, mitigative actions consisting of data retrieval would be undertaken.

No mitigation would be conducted at the 15 non-eligible sites in direct impact areas or the 4 non-eligible sites in indirect impact areas.

Considerations for mitigating NRHP-eligible sites associated with various project alternatives would be identical to those employed for sites associated with the proposed action.

The TCPs identified in the project area either were found to be eligible for their information potential or were found not to be eligible under the conditions imposed by the NRHP. Mitigation measures designed for the prehistoric archaeological sites are applicable for retrieving any significant information from these eligible sites said to have traditional cultural significance. No mitigation would be required under the NHPA for the six non-eligible TCPs. However, consultation may continue with the concerned Tribes to identify possible ways to alleviate their concerns.

No management actions are necessary for other cultural localities (IOs and "other" cultural properties) that lie in or near the project area.

3.7 Socioeconomics

Section 3.7 complies with Forest Service Manual (FSM) Section 1970 concerning economic and social impact analyses. FSM Section 1973 states that a social impact analysis should be initiated if the potential social effects of Forest Service policies or actions affect the quality of peoples' lives and social well-being.

3.7.1 Affected Environment

This section describes the existing population, economy, housing conditions, financial resources, and facilities and services in the project area in order to determine whether employment and population impacts from the proposed project or alternatives would beneficially or adversely affect public or private conditions in the area.

The study area for social resources focuses on portions of Gila and Pinal Counties. The communities most likely to be affected by the project include the towns of Miami and Globe and the communities of Claypool, Central Heights, and Midland City in Gila County, and the town of Superior and community known as Top-of-the-World in Pinal County. The geographical area extends from the mine site east to the San Carlos Indian Reservation, north to Roosevelt Lake, west to Superior, and south to Winkleman.

3.7.1.1 Population and Demography

In 1993, the population of Gila County was estimated at 42,075. Of this total, an estimated 6,399 people live in Globe and 2,041 in Miami. An estimated 5,100 people live in the unincorporated areas of Central Heights, Claypool, and Midland City, assuming the same percentage as in 1990 (Arizona Department of Economic Security 1993a). Annual average increases in population in Globe and Miami from 1987 to 1993 were 0.2 and minus 1.9 percent, respectively.

Population growth within the county has fluctuated from 1987 to 1993 because of the instability of the copper mining economic sector. Although population in the Globe-Miami area declined from 1987 to 1993 (*Table 3-65*), signs of improvement in the mining and mining-related manufacturing sectors should boost the population figures somewhat in the future (Arizona Department of Economic Security 1993a).

Population growth that has occurred in Gila County is generally in the northern part of the county, where increasing tourism has stimulated the trade and service sectors of the economy. The San Carlos Indian Reservation, situated east of the Globe-Miami area, has also experienced some growth. The most recent population estimate on the reservation was between 7,000 and 10,000; the town of San Carlos had a 1990 population estimate of 2,918 (Noline 1993).

Compared to Gila County, the population in Pinal County has grown much more rapidly from 1987 to 1993. Most of the growth has occurred in the Apache Junction area, adjacent to the Phoenix metropolitan area. The 1993 population in Pinal County was estimated at 124,700.

The population in Superior, the town in Pinal County closest to the Carlota Copper Project, has declined

Table 3-65. Study Area Population - 1987 to 1993

County/ Town	Year							Total Percent Change	Average Annual Percent Change
	1987	1988	1989	1990	1991	1992	1993		
Gila	39,600	39,900	40,100	40,300	41,050	41,700	42,075	6.3	1.1
Globe	6,315	6,260	6,149	6,071	6,215	6,255	6,399	1.3	0.2
Miami	2,289	2,219	2,159	2,018	2,025	2,030	2,041	(10.8)	(1.9)
Pinal	107,600	110,300	112,600	116,800	119,650	122,600	124,700	15.9	2.5
Superior	3,812	3,779	3,586	3,470	3,470	3,480	3,501	(8.2)	(1.4)

Sources: Arizona Department of Economic Security (1993a)
U.S. Department of Commerce, Bureau of Census (1991)

during the same period. The 1993 estimated population in Superior was 3,501, a decrease of 25 percent from 1980. This population decline was caused by declining production from the Superior Mine, which ceased operations in 1996.

The demographic makeup of the area is primarily composed of Caucasians (68 percent), Hispanics (18 percent), and Native Americans (12 percent).

3.7.1.2 Employment and Economy

The economy in Gila County has historically depended largely on the copper mining industry. With the decline in copper prices in the 1980s, the County's economy experienced a significant slow-down in the Globe-Miami area. In 1993, the economy was still dependent on mining; however, the trade and services sectors and the government sector also play important roles in Gila County's economy. Many of the former mine workers have remained in the area by taking jobs in different sectors.

The economy in Pinal County is more diverse than that of Gila County. Pinal County is one of Arizona's five major agricultural counties. Cotton, grain, and alfalfa are the principal crops. State and local government is the largest employer in Pinal County; major government facilities include the maximum security state prison, Central Arizona College, the county, local school districts, and local community governments.

Mining continues to be an important economic sector in Pinal County, along with manufacturing, trades, and services. Much of the growth in the economic sectors is related to the rapid growth occurring in the Phoenix metropolitan area (Maricopa County), which is adjacent to Pinal County.

In September 1992, the civilian labor force in Gila County was 14,141, while the number of employed persons averaged 12,784 (Arizona Department of Economic Security 1992). The unemployment rate in Gila County reached a high of 25.4 percent in 1983, when the bottom fell out of the copper industry. After 1983, the unemployment rate steadily declined to an annual average low of 8.8 percent in 1991, although in 1992, the average unemployment rate increased to 9.6 percent. Unemployment has decreased partially because of a decrease in the labor force resulting from people slowly moving out of the area. Since 1990, there has been an increase in the labor force in the county.

Table 3-66 shows labor force, employment, unemployment, and percent unemployed in the Globe-Miami area for 1992. In the Globe-Miami labor market in 1992, the unemployment rate averaged 9.3 percent; this was slightly higher than for Gila County as a whole. In 1993, the unemployment rate dropped, along with the size of the labor force. Through June 1993, the average unemployment rate was 7.5 percent.

Generally, economic activity in the area has remained relatively subdued; businesses are maintaining a conservative attitude towards the state of the economy and expansion activities. In 1991, there was limited expansion in the retail trades and some activity in the copper industry. The price of copper has been volatile and has affected the overall condition of the economy in the Globe-Miami area. In 1992, the civilian labor force in Pinal County averaged 39,781, while the number of employed persons averaged 36,347. The unemployment estimate in 1992 was 3,434, with an average rate of 8.6 percent. The labor force and unemployment in Pinal County have also fluctuated throughout the past decade. The

Table 3-66. Labor Force and Unemployment - 1992

Category	Globe	Miami	Midland City/Central Heights	Claypool	Subtotal	Superior	Study Area Total
Labor Force	2,363	650	1,092	629	4,734	960	5,694
Employed	2,179	575	970	569	4,293	846	5,139
Unemployed	184	75	122	60	441	114	555
Percent Unemployment	7.8	11.5	11.2	9.5	9.3	11.9	9.7

Source: Arizona Department of Economic Security (1992)

1992 labor force represents one of the highest labor force figures in the recent past; however, the unemployment in 1992 is also considered relatively high compared to recent years.

The town of Superior had a 1992 labor force of 960, with 846 employed, 114 unemployed, and an unemployment rate of 11.9 percent (*Table 3-66*). From January through June 1993, the labor force increased to 983, the number of persons employed increased to 888, and the number of persons unemployed decreased to 95, with an unemployment rate of 9.7 percent. When combining the Superior labor market with Globe-Miami (1992), statistics include a labor force of 5,694, a total of 555 unemployed, and an average unemployment rate of 9.7 percent.

In addition to the labor forces in the towns of Globe, Miami, and Superior, the San Carlos Indian Reservation, located just east of Globe, has a significant labor pool. In 1992, the total labor force in San Carlos was estimated at 799 (537 employed and 262 unemployed) with an average unemployment rate of 32.8 percent (Arizona Department of Economic Security 1992). According to the Tribal Employment Rights Office (TERO), the actual unemployment on the reservation is closer to 60 percent (Noline 1993). The estimated number of unemployed on the reservation is between 1,000 and 1,500 in the summer and 2,500 and 3,000 in the winter. Many of the Native Americans take seasonal jobs, such as forest fire fighting. Other surrounding towns within potential commuting distance of the proposed project also have some labor availability. These include the towns of Kearny, Hayden, and Winkelman.

The residents of Gila County, particularly those of the Globe-Miami area, are heavily dependent upon a limited number of activities for jobs. *Table 3-67* shows the types of employment in Gila and Pinal counties for 1992 and 1993. More than 90 percent of those classified as manufacturing employees in Gila County are actually employed in the copper smelting, refining, and fabrication activities directly associated with the county's copper mining industry. Because of the relatively high wage levels in the copper industry of Gila County compared to other industries, personal income estimates better reflect the importance of certain industries to the county's economy rather than employment figures.

3.7.1.3 Personal Income

Total personal income in Gila County has increased significantly since the early 1980s. Most of the wages and salaries result from a small number of sources, one of the largest of which is the copper industry, including copper fabrication, refining, and smelting, as well as copper mining. The largest contributor is the government sector, including federal, state, and local government agencies (*Table 3-68*). Retirement, welfare (net transfer payments), dividends, interest, and rents form the largest source of basic personal income; mining and mining-related manufacturing are major sources of personal income, as well as federal and state government jobs.

Personal income has been estimated from the 1990 census. For Globe, Miami, Claypool, Central Heights-Midland, and surrounding areas, the following incomes were estimated for 1989:

Average Household Income - $29,213
Median Household Income - $22,951
Average Family Income - $33,856
Median Family Income - $26,572
Per Capita Income - $11,108

3.7.1.4 Housing

According to the 1990 census, 5,623 housing units are located in the Globe-Miami area; 88 percent are estimated to be occupied (4,968), and 12 percent are vacant (655). Of the occupied units, 67 percent (3,756) are owner-occupied, and 22 percent (1,212) are rental units.

More recently, the Globe Area Economic Development Corporation contracted a housing study to assess the housing market and housing stock in the Globe-Miami area. To evaluate the accuracy of the high vacancy rate reported in the 1990 census, a housing market study was completed by the Drachman Institute for Land and Regional Development Studies (1992) for the Globe-Miami area. The conclusions of the study determined that a large percentage of the vacant housing is substandard and marginally habitable. A more realistic vacancy rate for habitable single-family and multi-family housing was estimated at 2 percent, which suggests a very limited housing market in the area.

Table 3-67. Total Non-Agricultural Employment[1]

County	Industry	Employees 1992	Employees Annual Average 1993[2]
Gila County	Mining	1,300	1,300
	Manufacturing	1,300	1,300
	Construction	725	750
	Transportation, Communication, and Public Utilities	425	450
	Trade	2,600	2,550
	Finance, Insurance, and Real Estate	300	300
	Services	2,250	2,900
	Government	2,875	2,900
TOTAL		11,850	11,875
Pinal County	Mining	3,850	3,800
	Manufacturing	3,975	3,925
	Construction	875	550
	Transportation, Utilities, and Communication	1,100	1,100
	Trade	5,875	6,150
	Fire	550	550
	Services	5,125	5,300
	Government	10,100	10,800
TOTAL		31,425	32,600

[1]By place of residence
[2]Annual average based on January through May 1993 data
Source: Arizona Department of Economic Security (1993b)

Table 3-68. Earnings by Industry (in thousands of dollars)

County	Industry	1987	1988	1989	1990	1991	1991 Percent of Total Earnings
Gila County	Agricultural Services, Forestry, and Fisheries	504	502	440	450	527	<1
	Mining	44,545	D	50,477	D	D	17.0[1]
	Manufacturing	42,805	49,777	52,299	55,807	63,281	20.0
	Construction	17,864	17,571	14,786	19,754	D	6.6[1]
	Transportation, Utilities, and Communication	12,765	12,667	13,968	13,861	14,959	4.7
	Trade	32,672	34,171	35,144	38,623	40,541	12.8
	Fire	6,105	6,294	6,324	6,599	4,556	1.4
	Services	35,324	D	43,380	D	51,416	16.3
	Government	50,292	55,849	59,190	61,211	66,936	21.2
TOTAL		242,876	273,772	276,008	299,526	315,770	100
Pinal County	Agricultural Services, Forestry, and Fisheries	11394	13,267	13,422	14,335	14,599	1.7
	Mining	108,339	166,840	130,639	151,482	184,197	21.4
	Manufacturing	96,460	103,286	108,715	104,669	85,913	10.1
	Construction	49,221	40,275	33,140	30,418	32,850	3.8
	Transportation, Utilities, and Communication	34,616	33,889	36,496	41,405	36,474	4.2
	Trade	81,215	90,827	99,622	100,302	106,574	12.4
	Fire	17,735	18,869	19,267	20,739	15,185	1.8
	Services	81,578	87,205	100,454	104,413	119,391	13.9
	Government	193,151	219,538	233,080	251,304	264,236	30.7
TOTAL		673,709	773,996	774,835	819,067	859,419	100.0

D = Information not available because of disclosure limitations

[1]Estimated, based on 1989 percentages

Source: Bureau of Economic Analysis, Regional Economic Information System (1993)

Conversations with several local realtors verified the information contained in the housing market study. According to these realtors, the vacancy rate is estimated at between 2 and 5 percent. Housing for sale is typically either in the upper end of the market or is older, less desirable property. Many people are currently living in recreational vehicles (RVs) because they are unable to find suitable housing to rent or buy. At the time of this interview (February 1993), approximately 90 homes were listed for sale by four realty companies. These homes ranged in price from $8,500 to $179,000; only six of the homes were built after 1980. If available, a standard two-bedroom apartment or mobile home rents for $400, and a three-bedroom single-family home rents for $600 to $1,000. Rental rates at Top-of-the-World are comparable to the Globe-Miami area.

Records at the Gila County Assessor's Office indicated that over 94 percent of all housing in the Globe-Miami area was built before 1980 (Hom 1993). From 1987 through 1991, only 66 single-family and 50 multi-family unit building permits were issued. More recently, the town of Globe has three subdivision proposals, with a total of 103 lots. To date, none of the plans have obtained final approval (Moseley and Stanton 1993).

Table 3-69 shows an inventory of apartment and mobile home rental units in the Globe-Miami area for 1991, which is considered to depict present conditions. Land for housing development is scarce in the Globe-Miami area, primarily because the topography of the area does not lend itself to development. The most developable land is located to the east and south of Globe. There are fewer than 100 subdivided lots with utilities available for development. Land prices tend to be high; therefore, few developers are interested in building in the area. The demand for housing is greater than the availability of lots or existing marketable housing units (Long 1993).

The town of Superior had a total of 1,730 housing units counted in the 1990 census; 73 percent were occupied (1,260) and 27 percent were vacant (470). Of the occupied units, an estimated 914 were owner-occupied and 346 were rentals. According to the 1990 census, the median rent was $156, while the value of a single-family home averaged approximately $33,109. These figures from the census appear to be somewhat misleading. According to a local real estate company in Superior, there are virtually no rentals available in Superior, except for smaller sized units. There were 10 housing units listed for sale; these ranged from $10,000 to $39,000. The upper-end homes are livable; however, no new homes have been constructed for approximately 30 years (Cagalj 1993). In addition, most of the private land in the area is owned by BHP Copper Company and is unavailable for development, although there are a few smaller parcels that could be developed for single-family units. There is one mobile home park in Superior, which currently has 7 occupied permanent spaces and 13 RV spaces. Trailer park and RV spaces are also available at Top-of-the-World. The RV spaces are available on a nightly, weekly, or monthly basis. Currently, there are 7 temporary spaces available (Ruiz 1993).

Table 3-69. Inventory of Apartment and Mobile Home Units in Globe-Miami Area

Type	Market Rate Apartment Complexes	Government-Assisted Apartment Complexes	Mobile Home/RV Parks
Complexes/Mobile Home Parks	7	2	11
Units/Spaces/RV	117	78	758/23
Vacant	1	0	42

Monthly Apartment Rental Rates:	1 bedroom	$200 - $315
	2 bedroom	$245 - $350
	3 bedroom	n/a
Mobile Home Monthly Costs:	Utilities	$75 - $200
	Water Only $50 - $125	
RV Daily Space Rental:	$13 per day	

Source: Drachman Institute for Land and Regional Development Studies (1992)

3.7.1.5 Public Facilities and Services

Within the study area, public facilities and services are the responsibility of a number of public and private entities. The types of services and facilities include public safety, public utilities, health services, recreation and cultural services, education, and government and public finance. *Table 3-70* summarizes services and facilities for public safety, public utilities, and health and social services. Narrative summaries are provided for education, recreation and cultural services, and government and public finance.

Water and sewer service to the unincorporated areas, including Top-of-the-World, are provided by individual wells and septic systems. There are 99 known wells at Top-of-the-World. The wells have relatively low yields, ranging from less than 1 gpm to 40 gpm and averaging 10 gpm. Wells in the area experience seasonal fluctuations, and declining water levels and decreased yields have occurred in recent years (scoping letters). These wells are discussed in Section 3.3, Water Resources.

Recreational and Cultural Services

Recreational facilities and programs are provided to the Globe-Miami area primarily by the town of Globe and private groups or businesses. The town of Globe has 3 major ball fields, 6 T-ball fields, 12 parks, a municipal pool, a senior citizens' center, an archaeological park and museum, and a library. Magma Copper recently donated land, equipment, and manpower to build a park, including a soccer field, a football field, and two baseball fields, as well as a picnic area, on the north side of Globe. This park is currently under construction. A botanical garden is being built near the Besh-ba-Gowah Archaeological Park. There is no public golf course in the Globe-Miami area, although there is a private course in Miami.

Recreation programs are operated by the town of Globe; however, Gila County participated in the operation of the youth program in 1993 by providing personnel. The town of Globe provides recreation programs for most of southern Gila County. The public works director feels that the recreation programs and facilities are adequate for the existing population and that they would be able to support additional growth in the area.

The town of Superior has three parks, including one with a children's playground. The Superior Recreation Department operates during the summer months by providing recreation programs, such as youth and adult basketball, softball, and swimming (Serrano 1994).

Education

The Globe Unified School District has two elementary schools, a junior high, and a senior high. The grades that are provided in these four schools are shown in *Table 3-71*. All schools have substantial excess capacity (*Table 3-71*). The school enrollment has been the same or has increased slightly during the past several years.

The Globe Unified School District employs 116 teachers, administrators, and classified personnel. There are currently no plans for expansion; additional teachers would be required for growth increments of 25 students. The current staff should be adequate into the future, assuming current growth remains constant. The financial status of the Globe District is a concern because of its limited bonding capacity (Nutting 1993). The district is seeking legal action to deal with this issue.

The Miami Unified School District has four elementary schools, one junior high, and a senior high. School enrollment has stabilized over the past few years. As shown in *Table 3-71* all of the schools have some excess capacity. There are 197 certified teachers, administrators, and classified employees. The Miami District has a strong fiscal condition because it maintained a budget override for long-range planning, district reorganization, and facilities consolidation (Blazevich 1993).

The Superior Public Schools have one elementary school, one junior high school, and one senior high school. Enrollment has been steady or slightly declining for the past several years. As shown in *Table 3-71*, all of the schools have substantial excess capacity. The size of the current staff is 48. The current fiscal condition is considered poor because of the limited bonding capacity of the district (Lennan 1993). Although the high school needs to be replaced, there are no funds or funding mechanisms available for construction. The tax rate in Superior is one of the highest in the

Table 3-70. Summary of Public Facilities and Services for the Globe-Miami and Superior Areas

Type of Service/Jurisdiction	Description of Services	Adequate to Meet Existing Population Needs?
PUBLIC SAFETY		
LAW ENFORCEMENT		
Globe	• 18 officers, 5 dispatchers, 51 records clerks, and 1 animal control officer	Yes
Miami	• 6 officers and 4 dispatchers	Yes
Gila County	• Short-term jail facility with 144 beds and average occupancy of 100 to 110 persons per day	Yes
Gila County Sheriff's Department	• 115 employees including patrol officers, detectives, dispatchers, and other support staff	No
Superior	• 8 officers and 1 animal control officer	Yes
FIRE PROTECTION		
Globe	• 9 paid and 18 volunteer personnel • Fire station with one 1,500-gpm pumper, one 1,500-gpm aerial ladder truck, one 750-gpm pumper, and one 0.75-ton utility truck	Yes
Miami	• 15 volunteer personnel	Yes
Canyon Fire Department	• 16 volunteer personnel • Equipment consisting of one 3,000-gpm tanker, one 650-gpm pumper, one 450-gpm brush truck, one 250-gpm pumper, one 1,250-gpm pumper, and one 450-gpm pumper	Yes
Tri-City Fire Department	• 30 volunteer personnel • Equipment consisting of one 1,500-gpm pumper, two 750-gpm and one 1,500-gpm tankers, and one rescue vehicle	Yes
Central Heights Fire Department	• 44 volunteer personnel • Equipment consisting of three pumping units, one rescue truck, four 4-wheel drive vehicles, and three ambulances	Yes
Canyon Ambulance Service	• 14 personnel	Yes
Superior Fire Protection District	• 19 volunteer personnel • Equipment consisting of one 1,000-gpm pumper, one 750-gpm pumper, and one 500-gpm pumper	Yes
PUBLIC UTILITIES		
WATER AND SEWER		
Globe	• 5 active wells and 1 inactive well • Pump 1.7 to 2.5 million gallons/day (mgd) in summer and 0.6 to 1.0 mgd in winter • No water treatment needed except for chlorine • Sewage treatment capacity of 1.2 mgd; currently treat 0.6 mgd	Yes
Miami	• Water provided by Arizona Water Company • Sewage treatment by Town of Miami	No
Superior	• Water provided by Arizona Water Company • 4 wells and surface water from Queen Creek; water pumped 23 miles • Sewage treatment capacity of 0.75 mgd with current use of 0.25 mgd	Yes

Table 3-70. Summary of Public Facilities and Services for the Globe-Miami and Superior Areas (continued)

Type of Service/Jurisdiction	Description of Services	Adequate to Meet Existing Population Needs?
SOLID WASTE		
Globe-Miami	• Russell Gulch landfill provides services	Yes
Superior	• Pinal County Landfill Department operates transfer of solid waste to landfill in Florence	Yes
ELECTRICAL POWER AND GAS		
Globe-Miami	• Power provided to residents and most businesses by Arizona Public Service Company of Phoenix • Salt River Project and Electric Power Cooperative provide power to the major mining companies • Southwest Gas Corporation of Las Vegas supplies natural gas	Yes
Superior	• Southwest Gas Corporation of Las Vegas supplies natural gas • Arizona Public Service Company supplies electrical power	Yes
TELEPHONE		
Globe-Miami	• U.S. West Communications of Denver, Colorado, provides service	Yes
Superior	• U.S. West Communications of Denver, Colorado, provides service	Yes
HEALTH AND SOCIAL SERVICES		
Globe-Miami	• 16 private physicians, 5 chiropractors, and 11 dentists • Hospital care provided by the Cobre Valley Community Hospital (49 beds with 22 percent occupancy) • Hospital has 16 active medical staff, 12 rotating emergency staff, and 23 visiting specialists • Social services provided by Gila County	Yes
Superior	• 1 dentist and 1 physician • Health care provided by Superior Medical Center; Cobre Valley Community Hospital provides hospital care	Yes

Sources: Barron and Corso (1993), Bribiescas (1994), Dalmolin (1993), Hoopes (1993), Luevano (1993), Malcovich (1993), Serrano (1994), and Stratton (1993)

Table 3-71. Student Enrollment and School Capacities

City	School	Grade	1991	1992	1993	Capacity	Excess Capacity
Globe	Copper Rim	K-4	744	757	800	650	150
	East Globe	5-6	350	325	400	650	250
	Globe Jr. High	7-8	325	350	400	630	230
	Globe Sr. High	9-12	643	625	750	1200	150
Miami	Central Heights	K-4	---	---	264	300	36
	Inspiration	K-4	---	---	264	275	11
	Las Lomas	K-4	---	---	270	300	30
	Bullion Plaza	5-6	---	---	276	300	24
	Lee Kornegay Jr. High	7-8	---	---	348	500	150
	Miami High	7-12	---	---	521	700-1000	179-479
Superior	Kennedy	K-6	382	378	384	650	156
	Roosevelt Jr. High	7-8	110	105	115	200	85
	Superior High	9-12	183	179	173	350	177

Source: Public School Superintendents, (Blazevich 1993, Lennan 1993, Nutting 1993)

state because of the low valuation on property in Superior.

Government and Public Finance

The principal governing bodies in Gila County include the county commissioners, the school district, the town of Globe, and the town of Miami. The three Gila County commissioners supervise county operations, which include administrative, landfill, law enforcement, road maintenance, and social services. The school district is governed by an elected school board. Globe and Miami each have a mayor/council/manager form of government.

The principal governing bodies in Pinal County include the county commissioners, the school district, and the town of Superior. Pinal County also has three county commissioners, and the town of Superior has a mayor/council/manager form of government.

The governmental revenue sources and expenditures in Gila and Pinal Counties are useful in helping to determine the financial impacts of industrial development on the counties and local communities. The fiscal and economic health of an area can often be evaluated based on the growth in assessed valuation. *Table 3-72* shows assessed valuation and the most recent tax rate for the counties and communities within the study area.

Both Gila and Pinal Counties receive their revenues from property taxes, disbursements of severance, sales, and other taxes from the State of Arizona under a formula established by the legislature. The revenues are based on local property taxes levied and total collections of state sales and other taxes within each county. In fiscal year 1991-1992, Gila County received $3,210,870 from the state through such disbursements, while Pinal County received

Table 3-72. Assessed Valuation by Jurisdiction (in thousands of dollars)

County/City	1992-93 Tax Rate/ $100 Assessed Valuation	1990-91	1991-92	1992-93	Percent Increase	Average Annual Increase
Gila County	3.40	248,421	253,726	275,958	11.0	5.4
Globe	1.53	17,027	17,135	17,078	0.3	0.2
Miami	3.98	3,535	3,489	3,395	(4.0)	(2.0)
Pinal County	4.32	546,869	552,282	559,031	2.2	1.1
Superior	None	3,387	3,989	3,507	3.5	1 .8

Source: Hom (1993) and Pinal County Assessor (1993)

$6,941,000. That same year, Gila County collected $8,917,356 in county property taxes, while Pinal County collected $24,394,000. The incorporated municipalities of Globe, Miami, and Superior get their revenues from local sales taxes, local property taxes, and the disbursement of state sales, severance, and other taxes based on population. Property taxes form a relatively small part of municipal government revenues.

School districts obtain their revenues from taxes levied on the property within their jurisdictions and through disbursements of state sales and other taxes, including mining severance taxes, according to a formula established by law and based on average daily student enrollment. *Tables 3-73* and *3-74* show expenditures and revenues for Gila and Pinal Counties from 1989 to the current budget year.

3.7.1.6 Social Impact Assessment

The social setting of the area can typically be described as composed of small communities, historically dependent on mining and mining-related manufacturing for growth and economic viability. Mining continues to finance the local economies and provide the major source of stability in the region, although tourism is becoming an increasing economic factor.

The area has undergone numerous boom and bust periods with the copper mining industry; populations and unemployment rates have fluctuated throughout the history of the towns of Globe, Miami, and Superior.

Cultural diversity exists in the study area, with three prevalent cultures represented, including Caucasians, Native Americans, and Hispanics. The population is largely working class; however, there are a number of retirees who are moving into the area, representing a larger portion of the overall population. Lifestyles, social organizations, beliefs, values, and attitudes are representative of "small town America" with a strong work ethic. Each of the cultures represented maintains the general lifestyle that is representative of that particular culture living in a small urban/rural environment. There does not appear to be any major cultural conflicts between the diverse groups.

The San Carlos Indian Reservation currently has a very high unemployment rate; the Tribal government and the Bureau of Indian Affairs are working to create a more stable economic situation for the Apache population on the Reservation.

3.7.1.7 Environmental Justice

In February 1994, President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The Executive Order promotes environmental justice by directing federal agencies to coordinate and formulate agency strategies that identify and address, as appropriate, disproportionately high and adverse human health or environmental effects on minority and low-income populations.

The Forest Service has adopted USDA guidelines, which are based on the draft guidance for the EPA

Table 3-73. Gila County - Expenditures and Revenues 1989 to 1993 (in thousands of dollars)

	1989 to 1990	1990 to 1991	1991 to 1992	1992 to 1993	Average Annual Income (percentage)	1992 to 1993 Percent of Total
Expenditures:						
General Government	2,387	2,551	2,760	3,217	10.5	13.3
Public Safety	2,721	3,194	3,497	3,585	9.6	14.8
Courts	2,331	2,580	3,037	3,386	13.2	14.0
Community Development	558	594	772	1,097	25.3	4.5
Education	640	719	705	720	3.6	3.0
Health and Welfare	4,124	4,308	2,094	2,108	(20.0)	8.7
Solid Waste	580	961	834	621	2.3	2.6
Contingency	395	446	273	93	n/a	<1
Special Revenue	6,439	7,132	7,571	9,277	12.9	38.2
Special District	156	23	13	13	n/a	<1
Enterprise/Other	6,734	5,526	1,417	149	n/a	<1
TOTAL	27,065	28,034	22,973	24,266		100.0
Revenues:						
Property Taxes	7,757	8,834	8,917	10,071	9.1	40.0
General Fund Revenues:						
Other Taxes	3,075	4,393	3,211	3,555	5.0	14.1
Licenses/Permits	59	55	58	80	10.7	<1
Intergovernmental	1,836	2,753	2,160	2,491	10.7	9.9
Charges for Services	378	422	815	657	20.2	2.6
Lines/Tel/Misc	1,310	1,657	1,392	1,357	1.2	5.4
Special Revenue Funds	5,573	6,666	6,248	6,939	7.6	27.6
Other Funds	6,303	4,424	760	20	n/a	<1
Expenditures over (under) Revenues	774	(1,170)	(587)	(904)	n/a	
TOTAL	27,065	28,034	22,974	24,266		100.0

Source: Gila County (1989-1993) and Pinal County (1989-1993)

NEPA compliance program. These guidelines (1) ensure that the Forest Service has fully analyzed environmental effects on minority and low-income communities, including human health, social, and economic effects; and (2) assist in achieving the goals of NEPA by identifying project impacts, a range of reasonable alternatives, and mitigation measures that avoid or minimize adverse environmental effects, including identifying and addressing impacts to minority communities and low-income communities.

In the case of the Carlota Copper Project, the potentially affected minority communities include the Hispanic and the Native American populations that comprise approximately 18 percent and 12 percent, respectively, of the current study area population. Both of these minority communities also represent some of the low-income population in the area.

The most comprehensive statistics available on minority and low-income families come from the 1990 Census of Population and Housing, Summary Tape File 3A. More recent data are not available. Census Tract and Block Group population, income, and occupation information was collected for areas potentially affected by the proposed project. Miami,

Table 3-74. Pinal County - Expenditures and Revenues 1989 to 1993 (in thousands of dollars)

	Actual 1989 to 1990	Estimated 1990 to 1991	Estimated 1991 to 1992	Budgeted 1992 to 1993	Average Annual Income (percentage)	1992 to 1993 Percent of Total
Expenditures:						
General Government	16,111	19,674	13,417	16,896	1.6	22.6
Public Safety	6,692	7499	12,552	13,231	25.5	17.1
Highway and Streets	10,930	11,839	11,195	9,061	(6.1)	12.1
Sanitation	1,039	796	713	1,048	0.3	1.4
Health	12,325	11,450	2,636	2,862	n/a	3.8
Welfare	2,408	1,464	5,462	4,994	27.5	6.7
Culture and Recreation	291	321	448	697	33.8	1.0
Education	312	337	341	346	3.5	0.5
Special Revenue Funds[1]	6,766	6,997	8,316	11,890	20.7	16.0
Debt Service	0	447	778	1,338	n/a	1.8
Enterprise Fund	9,256	6,921	8,730	11,735	8.2	15.7
Special Districts	436	436	523	522	6.2	0.7
TOTAL	66,566	68,181	65,111	74,620	3.9	100.0
Revenues:						
Property Taxes	23,869	23,331	24,394	25,836	2.7	34.6
Other Taxes	3,844	3,896	4,644	4,478	5.2	6.0
Intergovernmental (including sales tax)	24,953	23,246	18,898	21,845	(43.6)	29.3
Licenses and Permits	492	522	513	513	3.3	0.7
Charges for Services	3,069	3,532	2,444	3,256	2.0	4.4
Lines/Tel/Misc	2,351	2,379	3,015	2,477	1.8	3.3
Other Funds	6,654	2,369	8,595	11,085	18.6	14.9
Expenditures Over (under) Revenues	1,334	8,906	2,608	5,100		6.8
TOTAL	66,566	68,181	65,111	74,620	3.9	100.0

[1]Except "Highway and Streets" and "Culture and Recreation" (General Fund and Special Revenue Fund)
Source: Pinal County (1989-1993)

Globe, Claypool, Midland, and surrounding rural areas were represented by five census tracts. The Hispanic and Native American population represented 29.2 percent and 1.5 percent respectively of the total 1990 census population of 18,106 within these five census tracts. The San Carlos Indian Reservation is also broken out as a census tract. Although the San Carlos Indian Reservation is outside the geographically defined study area, some Native Americans living on the Reservation may become employed either directly or indirectly because of mine development. The Native American population represents approximately 93 percent of the total 1990 population of 3,616 in this census tract. The Top-of-the-World subdivision, which is located directly south of the proposed project, is located in Pinal County, Census Tract 2, Block Group 2.This Block Group encompasses approximately 200 square miles; it also includes areas not included in the study area. However, this Block Group provides the best available data on Top-of-the-World. The Hispanic population represents only 4 percent and the Native American population represents only 1.2 percent of the total 1990 population of 1,284 in this Block Group.

Poverty status by race and by census tract was also evaluated for environmental justice. Of the 5,293 Hispanic individuals in the census tract representing

Globe/Miami and the surrounding area, an estimated 764 (14 percent) were below the poverty level. In the same area, approximately 111 (40 percent) of the 279 Native Americans were below the poverty level (Summary Tape File 3A, 1990 Census of Population and Housing). On the San Carlos Indian Reservation, 2,099 (62 percent) of the 3,382 Native Americans were below the poverty level. In Census Block 2, Block Group 2, which includes the Top-of-the-World subdivision, an estimated 235 (18 percent) of the 1,284 people were below the poverty level.

Table 3-75 shows 1990 minority and low-income populations that would potentially be affected by the proposed project. It is assumed that a similar percentage of the minority and low-income population would be represented in the census tracts and blocks described in *Table 3-75.*

3.7.2 Environmental Consequences

The primary socioeconomic issues addressed relative to the Carlota Copper Project included the following: (1) beneficial and adverse impacts of the project on the local labor market; (2) beneficial and adverse impacts to the local housing market and property values at Top-of-the-World; and (3) beneficial and adverse effects from the project to state, county, and local community economies from tax revenue generation and the demand for public services. This section complies with the requirements of FSM Section 1970 concerning economic and social impact analyses.

Evaluation criteria that were used to analyze socioeconomic impacts included the following:

- Change in short-term and long-term employment associated with the project in a number of primary and secondary jobs
- Change in demand for temporary and permanent housing during construction and operations based on estimated changes in population
- Change in property values in project vicinity
- Change in economic base from recreation and ranching to mining
- Change in demand for public services based on estimated changes in population
- Change in annual tax revenues directly related to project expenditures

This section evaluates potential social and economic impacts of the proposed Carlota Copper Project. The existing social and economic environment of the local area, including the economic slowdown evident during the past decade, was considered as part of the evaluation of the impacts associated with the proposed project. The project-related impacts, both temporary and permanent, were related to changes in the overall economic conditions in the area, including continued mining exploration, potential expansion, development, lay-offs, and construction of other proposed projects.

An economic base model was designed to evaluate the socioeconomic impacts of mining in the west (Kathol 1985). This model has been calibrated to reflect the most current conditions and to make projections of future impacts based on local and regional parameters. The model estimates the direct and indirect employment effects of the proposed project, population impacts, housing demand by type and location, and the number of new school age children in each affected school district.

Impact analyses were based on known characteristics of the affected area, supported by professional planning standards and empirical data from other mining projects. In addition, employment and income multipliers from recent mining economic impact analyses were used to make the most reasonable projections.

Continuous operation of the Carlota Copper Project would depend on the future market price of copper. In the past, mines have experienced temporary and long-term shutdowns because of declining markets and prices of the mineral produced. If the price of copper declines below a break-even operations cost, management could shut down the Carlota operation. If this situation occurred, both the beneficial and adverse impacts discussed in the following sections would be reversed until the price of copper increased and operations resumed.

Table 3-75. 1990 Minority and Low-Income Population

Census Location	Total Population	Population Below Poverty	Percent Below Poverty	Hispanic Population	Percent of Total Population	Hispanic Population Below Poverty	Percent[1] Below Poverty	Native American Poverty	Percent of Total Population	Native American Below Poverty	Percent[1] Below Poverty
Gila County											
Census Tract 9808-9812	18,106	2,404	13.3	5,293	29.2	764	4.2 14.4	279	1.5	111	<1.0 39.8
9850-San Carlos Indian Reservation	3,616	2,162	59.7	95	2.6	38	1.1 40.0	3,382	93	2,099	58.0 62.1
Pinal County											
Census Tract 2 Block Group 2 (includes Top-of-the-World)	1,284	235	18.3	53	4.1	NA	NA	16	1.2	NA	NA
TOTAL	23,006	4,801	20.9	5,441	23.7	802	3.4 14.7	3,677	16.0	2,210	9.6 60.1

[1]The first values represent percent of total population; the second value represents percent of specific minority population.

NA = Not available

Source: Arizona Department of Economic Security (1993a)

3.7.2.1 Proposed Action

Population and Demographics

The population in Gila and Pinal Counties is primarily dependent on two industries: mining and government. Non-basic sectors, such as services and trade primarily related to the mining industry, have also contributed to the population base. Fluctuations in population are likely to occur because of the uncertainty of the market for copper metals, as evident in the slowdown in the industry since the early 1980s. To date, exploration and mining activity continue at a limited level. An additional impact on population would occur primarily in the Gila County area during the period of construction of the Carlota Copper Project.

Construction. The effect of the project on the area population will depend largely on the number of in-migrating workers and the characteristics of their families. Another factor affecting construction impacts is the management style of the construction contractor. The construction company for the Carlota Copper Project has not yet been selected. Most contractors try to hire locally; however, depending upon the skill level required, some contractors bring a portion of their workforce with them. If the construction contractor is hired from the Phoenix or Tucson area, it is more likely that the workers would commute daily from their places of residence. If the contractor is hired from outside the area, more of the construction workforce is likely to come from outside the study area.

A best estimate of in-migrating construction workers has been incorporated into the analysis based on recent employment statistics from the local area Arizona Employment Security Division. The peak construction workforce is estimated at 177 workers in the fifth month of construction. The majority of the construction workforce (approximately 70 to 80 percent) would need to be skilled workers. During the peak construction period, this computes to an estimated 123 to 142 skilled workers. The impact scenario would suggest that approximately 40 percent (71) of the workforce would come from outside the area (*Table 3-76*), based on other ongoing construction projects in the area and the availability of a local skilled labor force.

Since there is limited housing available, it is anticipated that only a small number of construction workers would relocate or bring their families. The resulting peak, non-local, construction-related population, including families of construction workers and indirect labor, would be an estimated 92 people. This population level would continue for approximately 2 months and then decline.

The construction workforce would average 91 workers over the 10-month construction period (*Table 3-77*). Because of the limited availability of housing throughout the study area (i.e., Globe, Miami, Claypool, Midland, and Superior), indirect employment is estimated to be minor for the construction phase. Non-local, indirect employees are estimated at four during peak construction and two during the overall construction period based on an employment multiplier of 1.2. This multiplier suggests that for every new construction job, an additional 0.2 indirect jobs would be created (Dobra 1993). The construction of the mine would provide additional jobs to the local employment base, which would be considered a beneficial impact.

Operations. Employment during operation of the project would average 282 workers during the first 8 years, with a maximum of approximately 301 workers. In the following 7 years of operations, the employment level would decline to an average of 255. Subsequent decreases in employment would occur the last 7 years during recovery, closure, and reclamation.

The operations labor force would consist of more than 90 percent skilled labor and less than 10 percent unskilled labor. Because of the uncertainty of the timing of operations start-up, low-impact (*Table 3-78*) and high-impact (*Table 3-79*) scenarios were made to reflect the uncertainty of the availability of local labor. Conversations with local mining representatives are mixed with respect to the level of skilled workers in the Globe-Miami area. Some say it is extremely difficult to find skilled labor within the local labor pool (Benson 1993, Hetrick 1993, Burrell, 1994). Others suggest that most trades are available locally, except for electricians and operating engineers (Palmer 1993). The Arizona Department of Economic Security concluded that skilled labor for specific construction and

Table 3-76. Projected Employment, Population, Housing, and School-Age Children (Peak Construction Phase)

Employment:

	Peak Annual Employment[1]	Local Direct[2]	Non-Local Direct	Total Direct	Local Indirect	Non-Local Indirect	Total Indirect[3]	Total New Employment
New Employment	177	106	71	177	10	4	14	191

Housing:

	Non-Local Direct	Non-Local Indirect	New Households
New Households[4]			
New Workers	71	4	
Single[5]	64	2	33
Married (1 Worker)	7	1	8
Married (2 Workers)[6]	0	1	1
Total New Households	39	3	42

Population and School-Age Children:

	Globe	Miami	Other[7]	Total
New Household Allocation	34	6	2	
New Population[8]				
Single Household	53	10	3	
Married Household	2[illegible]	4	1	
TOTAL	75	14	1	93
New School Children[9]				
Secondary	2	0	2	
Primary	3	4	0	
TOTAL	5	4	2	6
Housing Preference[10]				
Single-Family	5	[illegible]		
Multi-Family	2	0		
Mobile Home	7	4	1	
Other (RV or Motel)	20	4	1	
TOTAL	34	6	2	42

[1]The average construction workforce is 91 over the 10-month construction period. The peak workforce of 177 would commence in the fifth month.

[2]The construction workforce is assumed to be 60 percent local and 40 percent non-local. Local workers would commute to and from their places of residence to work on a daily basis.

[3]Indirect construction employment is calculated using a construction employment multiplier of 1.2 based on 1978 employment location quotients and basic/non-basic employment. It is assumed that 70 percent of the members of the indirect labor force are second persons in the direct labor households or current residents of the study area.

[4]The construction workforce is composed of 90 percent single workers or married without family, and 10 percent married workers with family. For indirect workers, it is assumed 50 percent are single or without family present and 50 percent are married with family present.

[5]It is assumed that single-worker households would average 1.5 members because of the lack of rental housing in the project area.

[6]Both husband and wife of 10 percent of the married workforce are assumed to work at the mine during construction; for indirect workers, 30 percent are assumed to be two-worker households.

[7]"Other" represents areas in or around Superior.

[8]Population estimates are based on 1.5 persons per household for single households with direct workers, 1.5 persons per household for single households with indirect workers, 3.1 persons per household for married households in Globe, and 3.3 persons per household for married households in Miami or Superior.

[9]School-age children are estimated at 0.75 per married household. Fifty-five percent of school-age children are primary students, and 45 percent are secondary students.

[10]Housing preferences are shown based on the following percentage distribution:

	Globe (80%)	Miami (15%)	Other (5%)
Single-Family (SF)	15	15	15
Multi-Family (MF)	5	5	5
Mobile Home (MH)	20	20	20
Other (RV Site or Motel)	60	60	60

Note: All projections in this table are estimates and do not represent actual figures.

Table 3-77. Projected Employment, Population, Housing, and School-Age Children (Average Construction Phase)

Employment:

	Annual Employment[1]	Local Direct[2]	Non-Local Direct	Total Direct	Local Indirect	Non-Local Indirect	Total Indirect[3]	Total New Employment
New Employment	91	55	36	91	5	2	7	98

Housing:

	Non-Local Direct	Non-Local Indirect	New Households
New Households[4]			
New Workers	36	2	
Single[5]	33	1	17
Married (1 Worker)	4	1	4
Married (2 Workers)[6]	0	0	0
Total New Households	20	1	21

Population and School-Age Children:

	Globe	Miami	Other[7]	Total
New Household Allocation	1[illegible]	3	1	
New Population[8]				
Single Household	27	5	2	
Married Household	11	[illegible]	0	
TOTAL	38	7	2	47
New School Children[9]				
Secondary	1	5	0	
Primary	2	1	0	
TOTAL	3	1	0	4
Housing Preference[10]				
Single-Family	3	5	0	
Multi-Family	1	0	0	
Mobile Home	3	1	0	
Other (RV or Motel)	10	2	1	
TOTAL	17	3	1	21

[1]The average construction workforce is 91 over the 10-month construction period. The peak workforce of 177 would commence in the fifth month.

[2]The construction workforce is assumed to be 60 percent local and 40 percent non-local. Local workers would commute to and from their places of residence to work on a daily basis.

[3]Indirect construction employment is calculated using a construction employment multiplier of 1.2 based on 1978 employment location quotients and basic/non-basic employment. It is assumed that 70 percent of the members of the indirect labor force are second persons in the direct labor households or current residents of the study area.

[4]The construction workforce is composed of 90 percent single workers or married without family, and 10 percent married workers with family. For indirect workers, it is assumed 50 percent are single or without family present and 50 percent are married with family present.

[5]It is assumed that single-worker households would average 1.5 members because of the lack of rental housing in the project area.

[6]Both husband and wife of 10 percent of the married workforce are assumed to work at the mine during construction; for indirect workers, 30 percent are assumed to be two-worker households.

[7]"Other" represents areas in or around Superior.

[8]Population estimates are based on 1.5 persons per household for single households with direct workers, 1.5 persons per household for single households with indirect workers, 3.1 persons per household for married households in Globe, and 3.3 persons per household for married households in Miami or Superior.

[9]School-age children are estimated at 0.75 per married household. Fifty-five percent of school-age children are primary students, and 45 percent are secondary students.

[10]Housing preferences are shown based on the following percentage distribution:

	Globe (80%)	Miami (15%)	Other (5%)
Single-Family	15	15	15
Multi-Family	5	5	5
Mobile Home	20	20	20
Other (RV Site or Motel)	60	60	60

Note: All projections in this table are estimates and do not represent actual figures.

Table 3-78. Projected Employment, Population, Housing, and School-Age Children (Operations Phase/Low-Impact [Larger Local Workforce] Scenario)

Employment:

	Annual Employment	Local Direct[1]	Non-Local Direct	Total Direct	Local Indirect	Non-Local Indirect	Total Indirect[2]	Total New Employment
New Employment	282	225	57	282	29	13	42	324

Housing:

	Non-Local Direct	Non-Local Indirect	New Households
New Households			
New Workers[3]	57	13	
Single	11	5	11
Married (1 Worker)	36	3	39
Married (2 Workers)[4]	5	2	7
Total New Households	48	9	57

Population and School-Age Children:

	Globe	Miami	Other[5]	Total
New Household Allocation[6]	46	8	3	
New Population[7]				
Single Household	13	2	3	
Married Household	115	23	8	
TOTAL	128	25	8	161
New School Children[8]				
Secondary	13	2	1	
Primary	15	3	1	
TOTAL	28	5	2	35
Housing Preference[9]				
Single-Family	34	6	2	
Multi-Family	8	1	1	
Mobile Home	6	1	0	
Other (RV or Motel)	1	0	0	
TOTAL	46	8	3	57

[1]For the low-impact scenario, the operations workforce is assumed to be 80 percent local and 20 percent non-local.

[2]Indirect operations employment is calculated using an operations employment multiplier of 1.74 (Dobra 1993). It is assumed that 70 percent of the members of the indirect labor force are second persons in the direct labor households or current residents of the study area.

[3]The operations workforce is composed of 20 percent single workers and 80 percent married workers. The indirect workforce is composed of 40 percent single workers and 60 percent married-with-family workers.

[4]Both husband and wife of 10 percent of the married workforce are assumed to work at the mine.

[5]"Other" represents areas in or around the town of Superior.

[6]During operations, it is assumed that 80 percent of the new employees would live in the Globe area, 15 percent in the Miami area, and 5 percent in Superior or areas around Superior.

[7]Population estimates are based on 1.5 persons per household for single households, 3.1 persons per household for married households in Globe, and 3.3 persons per household in Miami and Superior.

[8]School-age children are estimated at 0.75 per household. Fifty-five percent of school-age children are primary students, and 45 percent are secondary students.

[9]Housing preferences shown are based on the following percentage distribution:

	Globe (80%)	Miami (15%)	Other (5%)
Single-Family	75	75	75
Multi-Family	10	10	10
Mobile Home	13	13	13
Other (RV site or Motel)	2	2	2

Note: All projections in this table are estimates and do not represent actual figures.

Table 3-79. Projected Employment, Population, Housing, and School-Age Children (Operations Phase/High-Impact [Smaller Local Workforce] Scenario)

Employment:

	Annual Employment	Local Direct[1]	Non-Local Direct	Total Direct	Local Indirect	Non-Local Indirect	Total Indirect[2]	Total New Employment
New Employment	282	168	114	282	59	25	84	368

Housing:

	Non-Local Direct	Non-Local Indirect	New Households
New Households			
New Workers[3]	114	25	
Single	23	10	22
Married (1 Worker)	73	6	79
Married (2 Workers)[4]	9	5	14
Total New Households	97	17	114

Population and School-Age Children:

	Globe	Miami	Other[5]	Total
New Household Allocation[6]	91	17	6	
New Population[7]				
Single Household	26	5	2	
Married Household	229	46	15	
TOTAL	255	51	17	323
New School Children[8]				
Secondary	25	4	1	
Primary	30	6	2	
TOTAL	55	10	3	68
Housing Preference[9]				
Single-Family	68	13	4	
Multi-Family	9	2	1	
Mobile Home	12	2	1	
Other (RV or Motel)	2	0	0	
TOTAL	91	17	6	114

[1]The new operations workforce is assumed to be 60 percent local and 40 percent non-local for the high-impact scenario.

[2]Indirect operations employment is calculated using an operations employment multiplier of 1.74 (Dobra 1993). It is assumed that 70 percent of the members of the indirect labor force are second persons in the direct labor households or current residents of the study area.

[3]The operations workforce is composed of 20 percent single workers and 80 percent married workers. The indirect workforce is composed of 40 percent single workers and 60 percent married-with-family workers.

[4]Both husband and wife of 10 percent of the married workforce are assumed to work at the mine.

[5]"Other" represents areas in or around the town of Superior.

[6]During operations, it is assumed that 80 percent of the new employees would live in the Globe area, 15 percent in the Miami area, and 5 percent in Superior or areas around Superior.

[7]Population estimates are based on 1.5 persons per household for single households, 3.1 persons per household for married households in Globe, and 3.3 persons per household in Miami and Superior.

[8]School-age children are estimated at 0.75 per household. Fifty-five percent of school-age children are primary students, and 45 percent are secondary students.

[9]Housing preferences shown are based on the following percentage distribution:

	Globe (80%)	Miami (15%)	Other (5%)
Single-Family	75	75	75
Multi-Family	10	10	10
Mobile Home	13	13	13
Other (RV site or Motel)	2	2	2

Note: All projections in this table are estimates and do not represent actual figures.

mining-related job categories was limited in the area (Jenkins 1993).

Based on these findings, a low-impact scenario (*Table 3-78*) would represent 80 percent (225) of the operations labor force coming from the local area. For the high-impact scenario (*Table 3-79*), an estimated 60 percent (168) of the total labor force would be from the area. The more training programs provided by Carlota, the higher the likelihood that jobs can be filled by local labor. For example, the San Carlos Indian Reservation provides a large, principally unemployed, unskilled labor force that could be used if trained appropriately.

From 1995 through approximately 2010, the new population associated with this level of operations employment is estimated at 161 for the low-impact scenario and 323 for the high-impact scenario. The projected population increase for the high-impact scenario represents a less than 1 percent increase for Gila County, and substantially below 1 percent for Pinal County. The population increase related to operations is expected to primarily affect the Globe-Miami areas, including Claypool and Midland (306), with fewer operations workers locating in Superior or rural areas (17).

For the Globe-Miami area, the 3.6 percent population increase would be considerably higher than the growth rate for the past 6 years, where population has either declined or grown at a very slow rate of less than 1 percent. Superior would show minor growth (0.5 percent), which is a change from the average annual decline in population of 1.4 percent since 1987. This growth in population would have a positive impact on the economic vitality of the area.

Following the completion of mine production, there would be a reduction in the workforce. The reclamation workforce would be considerably smaller than the operations workforce, and if no additional activities were occurring in mining or related fields in Gila and Pinal Counties, people directly and indirectly employed by the project would probably leave the area.

Employment and Economy

The principal economic effect of the proposed project would be an increase in mining employment in Gila and Pinal Counties, as well as some growth in the retail and service sectors—potentially in Globe, Miami, and Superior. There would be a relative increase in the economic base due to the change from recreation and ranching to mining.

Total income in the area would increase, since the mining sector provides the highest wage rate of any wage and salary employment sector in Arizona (Arizona Department of Economic Security 1993). Most of the economic impact would occur in Globe, where the influx of new employment and population would stimulate the local economy. Employment impacts of the proposed project are listed in *Tables 3-78 and 3-79.*

There is a skilled labor force in the Globe-Miami area that is currently underutilized. Some skilled mine workers have stayed in the area and have taken other types of jobs. When Carlota starts mining, there will likely be a transfer of workers from other mining jobs or lower paying jobs to positions offered by Carlota.

Despite the large unemployed labor force at the San Carlos Indian Reservation, it is not anticipated that there would be a large number of Native Americans working at the new mine unless Carlota decides to create an intensive recruitment and training program for the Native American population. Traditionally, there has been a very small percentage of Native Americans employed in the mines (Noline 1993, Hetrick 1993). If the Native American population is strongly recruited and trained, there is potentially a local labor force of 1,000 to 2,000 workers. However, according to the TERO representative, long-term employment for Native Americans usually is not pursued. These employment issues have to do with cultural differences and may require active participation by the TERO office in proposed training programs.

As shown in *Tables 3-76* through *3-79*, local indirect employment would also be generated from the development of the proposed project. Indirect employment is typically generated in the services and trade sectors. These jobs may attract some of the Native American population on the San Carlos Reservation, as well as the population that lives in the surrounding area. The increase in secondary jobs would be considered a positive impact to this minority population.

Construction. As discussed in Section 3.7.1.1, Socioeconomics - Population and Demography, the majority of the construction workforce would likely come from the local labor market. Inmigrant labor would primarily come from other areas around the state and throughout the west (Hertzog 1992). Secondary employment related to constructing the project would average 14 based on a multiplier of 0.2 indirect local jobs per direct job (Dobra 1993). The majority of these jobs are expected to be filled by local residents or second persons in a direct worker household. The increased level of employment during the construction phase would be regarded as a beneficial impact, given that the study area unemployment rate is over 9 percent.

Operations. The permanent operations workforce is expected to average 282 workers the first 8 years and peak at 301 in Year 8. The new jobs would represent a 22 percent increase in comparison to the 1993 estimated mining employment in Gila County. In the following 7 years of operations, the employment level would decline to an average of 255, a 19.6 percent increase in employment as compared to the 1993 estimated mining employment level. Subsequent decreases in employment would occur the last 7 years during recovery, closure, and reclamation. This overall increase in employment would be considered a positive impact. Indirect employment is estimated at 84 new workers. These jobs represent a 2 percent increase in total services and trade sector employment in the Gila County area.

The indirect employment generated during operations was estimated using an employment multiplier of 1.74 (0.74 indirect local jobs per one permanent mining position). The 1.74 multiplier was a variation on the multipliers defined in studies by Dobra (1993), and the U.S. Department of Commerce (1991). The updated employment multiplier for the gold mining sector is 19 jobs per million dollars of direct expenditure, which represents an employment multiplier of 3.0. This multiplier means that 2.0 indirect and induced jobs are created statewide from one permanent mining job. In the 1988 study, the statewide multiplier was further disaggregated to the local rural (60 percent) and statewide urban areas (40 percent). Applying this split suggests a local rural indirect job impact of 1.2 and a statewide urban indirect job impact of 0.8 for each permanent mining position created. These are the employment multipliers that were used in *Tables 3-78* and *3-79* to estimate indirect impacts from the mine development.

Despite the local and non-local employment estimates shown in *Tables 3-78* and *3-79*, the production status of other mining projects in the near future would determine the availability of local labor that could be hired by Carlota for the Carlota Copper Project. If mineral exploration and production has stabilized at the time of project development, a higher percentage of local labor may be available. If the reverse is true, the overall non-local impact of the proposed project would be greater. Conversations with area mines (Morano 1993, Brown 1993, James 1993) indicate that employment levels should remain somewhat static since expansions have recently been completed (Morano 1993). Some mines may increase employment while others are uncertain about future employment levels. Gains in area-wide permanent employment for the duration of the project would be considered a beneficial impact.

Higher direct cumulative employment figures may increase the indirect employment multiplier. Losses in direct and indirect employment would result upon project completion in 2010.

Personal Income

The proposed project would generate an annual payroll averaging $10,114,000 over the 15 years of mining. This total personal income from the Carlota Copper Project would represent 2.2 percent of all personal income received by Gila County residents (Carlota Copper Company 1993a). A large portion of this total income would be spent in the area and would result in increased sales tax receipts throughout the area. Personal income effects would be considered beneficial to the area.

Housing

As described in Section 3.7.1.4, Socioeconomics - Housing, the existing housing market throughout the study area is very limited, especially for rental units and single-family housing. Prospects for increased numbers of rental units within the study area are low. Development is difficult because of the topography of the private land in the area and the large percentage of publicly held property. The permanent housing market is also very limited, with a strong, existing demand for new housing. If there is a large influx of people seeking permanent housing, demand will most likely exceed the supply.

Construction. Assumptions used in the housing impact assessment are listed in *Tables 3-76* through *3-79.*

The Carlota Copper Project would create an estimated 42 new households from construction during the peak period and 21 households for the overall average construction period. These estimates are based on an assumption of 1.5 single construction workers per household because of the lack of rental housing in the study area. If workers prefer not to share housing, the estimated demand for temporary housing would be greater.

If the temporary rental housing supply remains at the current level, construction workers would have a difficult time finding housing for rent throughout the study area, including Globe, Miami, and Superior. There are a few RV parks with spaces available; however, these spaces fill up rapidly, especially during the winter months. If rentals continue to remain fully occupied, the primary source of housing in Globe-Miami would be motels. Motels could accommodate much of the workforce, provided that blocks of rooms throughout the area are reserved in advance. In Globe-Miami, there are eight motels that would rent some rooms on a weekly basis. Over 296 rooms could potentially be available for construction workers. If motels were to provide the majority of construction workers' accommodations, the tourist business could be adversely affected, particularly during the winter months. A shortage of housing creates several related problems if not resolved in a timely manner. Overcrowding in units that are available may cause worker dissatisfaction and higher employment turnover rates; both situations are expensive and potentially socially disruptive.

Most construction workers prefer rental units that provide some kitchen facilities, so motel rooms are generally less desirable than RV parks or mobile homes. *Tables 3-76* through *3-79* show potential housing demand during the peak and average construction period.

Operations. The availability of housing for sale also appears to be inadequate for the permanent operations workforce, according to local representatives and realtors (Long 1993, Globe/Miami Chamber of Commerce 1993, McGinley 1993, Cagalj 1993). The housing market is very tight in Globe, Miami, Claypool, Midland, and Superior. Five out of the seven real estate offices in the Globe-Miami area showed a total of 60 listings in November 1993. The median price range of housing is $50,000 to $60,000, with housing costs ranging from $10,000 to $180,000. Lot availability is limited because of the scarcity of private land that is developable. *Tables 3-78* and *3-79* show potential housing demand and distribution during operations. In order to meet the projected low (57) and high (114) demand for housing units, there would need to be a substantial increase in the current level of building activity in the study area.

In regard to the effect the project would have on the residential properties located in Top-of-the-World, there are two possible changes: (1) property would increase in value given its proximity to the project (Long 1993), or (2) the increased noise, traffic, and visual impacts would reduce the value of the property.

Based on professional opinion and current conditions in the Globe-Miami area, it is difficult to predict whether the property values would increase or decrease substantially in this area because of the Carlota Copper Project. The properties immediately adjacent to the project area are considered small-acreage ranchettes. These properties are located close to a large transmission line, and there are no covenants restricting animals, junk cars, or types of housing, although zoning is limited. The properties are moderately priced, but they are not currently in demand. There would be no direct visual impact to the properties, except for one current commercial property, although views of the mine would dominate over the ridge top. Noise impacts could affect the properties; however, the associated economic impact cannot be measured directly. If drawdown of water levels occurs in residential water supply wells from pit dewatering, decreases in property values may occur; further residential development at Top-of-the-World may also be limited if ground water availability decreases.

Based on research related to other residential properties and new development throughout the Globe-Miami Mining District, proximity to mine operations from both a visual and a noise standpoint has not resulted in obvious impacts to property values. The Chaparral development, in particular, was recently built close to the Cyprus-Miami mine tailings (approximately 1 mile from the tailings). The price of these homes exceeds $100,000.

Public Facilities and Services

Public Safety. The following list summarizes impacts of the Carlota Copper Project on public safety. The Globe, Miami, and Superior municipal law enforcement departments feel that they have adequate facilities, personnel, and equipment to provide services to additional population.

- The Gila County Sheriff's Department feels that the staff has a current shortage of three officers in the Globe District given the size of the jurisdictions. This shortage would be aggravated with the addition of 93 new people during the peak construction period and 161 to 323 new people during the operations phase.
- The Pinal County Sheriff's Department would not be adversely affected by the additional population resulting from the project.
- Throughout the project area, there are seven municipal or volunteer fire departments that provide fire protection and mutual aid. Based on conversations with these departments, it does not appear that the influx of new people would have an adverse impact on service delivery in their service areas, except for the Miami Fire Department.

Public Utilities. Growth-related impacts to utilities and services depend on the capacities of the systems affected, current demand, and projected growth.

In Globe, there is adequate capacity to supply water to the estimated population related to the proposed project. The Globe public works director feels that the area has adequate water for the next 50 years. Currently the Globe wastewater treatment facility is operating at 50 percent of total capacity; there is adequate capacity to accommodate growth from the proposed project.

Water is supplied to Miami by the Arizona Water Company. The existing water supply is inadequate for the existing population and additional growth in the area. Information on the Miami sewer system and sewer treatment facility is unavailable at this time.

The Superior water supply system operates at 82 percent of capacity; the wastewater treatment system operates at 33 percent of capacity. Additional demand from project-related growth could easily be accommodated.

Rural areas within the two-county region have individual wells and septic systems.

- The water supply at Top-of-the-World comes solely from individual water supply wells. The wells in the area have experienced declining water levels and decreased yields. These problems are described in Section 3.3.2.1, Water Resources - Proposed Action. Dewatering at the Carlota/Cactus and Eder South pits could potentially have an impact on the supply of water available to existing and proposed housing in the area. Pit dewatering and water supply well field development used in project operations could potentially draw down the well water levels below acceptable levels. Comprehensive monitoring and mitigation for potential impacts to water supply wells are proposed in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures, to attempt to mitigate water supply problems at Top-of-the-World and other rural residences in the vicinity of the project attributable to Carlota's operations.

- Existing solid waste disposal capacity in Gila County is adequate to serve the estimated project-generated population. The remaining life of the landfill is 8 to 10 years. However, the life of the landfill may be shortened depending upon the level of use.
- The solid waste transfer system in Superior has adequate capacity to serve the project-related population.
- All growth-related impacts from the proposed project to the supply of natural gas, electricity, and telephone service could be accommodated by the existing systems in all affected areas.
- Additional supplies of propane are available from local sources.

Health Care and Social Services. Health care facilities and personnel are expected to be adequate to accommodate population growth related to the proposed project. Most major health care services for area residents are provided by Cobre Valley Community Hospital in Globe or major hospitals in the Phoenix metropolitan area. Current occupancy at the Cobre Valley Community Hospital averages 22 percent, which suggests sufficient excess capacity to handle the population growth related to the project. Other social services provided by Gila County are adequate to serve the new population. No major impacts on health care are anticipated in the Superior area. Other social services provided by Pinal County are adequate to serve the new population.

Recreational and Cultural Services. The following impacts would occur for recreational and cultural services:

- Recreational and cultural programs and facilities provided by the town of Globe, with some assistance from Gila County, are perceived to be adequate to serve additional population. In the past, the mines have contributed land or in-kind services to the recreation department to build parks and ball fields. These contributions have provided facilities that the town would not otherwise be able to construct and operate.
- Library services are not expected to be adversely affected by the project-related population.
- The Superior Recreation Department operates only in the summer. The town representative feels that two parks and summer programming would be adequate for the population growth related to the Carlota Copper Project.
- Local community facilities, including parks and libraries, are believed to be adequate to accommodate project-related population growth.

Education. Impacts on education would include the following:

- Based on construction and operations projections listed in *Tables 3-76* through *3-79,* the estimated number of school-age children for the proposed project would not adversely affect the Globe Unified or Miami Unified School Districts. As shown in *Table 3-71*, all schools in the two districts have adequate capacity for the projected new school-age children.
- With the high-impact scenario (*Table 3-79*), two new teachers would be required based on the projected 55 new students in the Globe Unified School District. The Globe Unified School District superintendent suggested new staffing requirements for increments of 25 students.
- As shown in *Tables 3-76* through *3-79*, the projected impacts to the Superior Unified School District during construction and operations would be minor. The school district has more than adequate capacity for the estimated new school children during both construction and operations.

Government and Public Finance. With the influx of new population to an area, there would be certain associated costs and revenues. Typically, new population requires incremental increases in services from municipal and county service providers. However, in the case of the Globe-Miami and Superior areas, much of the infrastructure is in place to serve a larger population because of peak growth in the 1960s through early 1980s. Although the basic infrastructure exists to provide services to a larger population, it has aged and deteriorated to some extent. Funding is no longer available to hire personnel to maintain and operate the systems. Nevertheless, in many cases, upgrading the existing facilities and adding staff would be adequate to provide services to the additional population related to the Carlota Copper Project. The capital investment would typically be much less because the towns have supported larger populations in the past. Annual operating costs would increase, given the necessary additions of personnel and equipment to serve an increased population.

The following information summarizes impacts of the Carlota Copper Project on government and public finances:

- Based on its expected rate of production, expected 1995 copper prices, and existing Arizona tax rates, it is expected that the Carlota Copper Project would pay an average of approximately $700,000 per year in severance taxes to the State of Arizona. Part of this annual severance tax payment would be retained by the state, but part would be distributed to county and municipal governments, as well as school districts throughout the state, including those in Gila and Pinal Counties. These increased revenues would be considered a beneficial impact.

- It is estimated that the Carlota Copper Project would pay annual property taxes of approximately $1,160,000 to Gila and Pinal Counties (as collectors) for the State of Arizona, the counties themselves, the Miami Unified and Superior Unified School Districts, the Gila Pueblo Campus of Eastern Arizona College, the Central Arizona College, and other local taxing jurisdictions. Because of the location of the known ore reserves, it is expected that 74 percent of the assessed property valuation would be assigned to the Miami Unified School District of Gila County, with the other 26 percent assigned to the Superior Unified School District of Pinal County. In addition, Carlota would pay annual corporate income taxes, sales taxes, unemployment compensation and workers' compensation taxes, and miscellaneous other taxes and fees, primarily to the State of Arizona. These increased revenues would be considered beneficial.

- Estimates of corporate income taxes payable to the State of Arizona would average $584,000 per year. Most of the taxes would be retained by the state, but a portion would be distributed to Arizona's incorporated cities and towns under the state's Urban Revenue Sharing Program. These increased revenues would be considered a positive impact.

- Many of the products and services purchased by Carlota for the proposed project in Arizona would be subject to the state sales tax. Based on the expected quantity of products and supplies purchased in Arizona ($15,876,000), it is estimated that the Carlota Copper Project would pay state sales taxes averaging $563,000. The largest share ($7,081,000, 44.6 percent) of these supplies and products would be purchased from suppliers located in the Phoenix metropolitan area. Other suppliers in the Tucson metropolitan area ($4,573,000, 28.8 percent), the Globe-Miami area ($3,380,000, 21.2 percent), and Pinal County ($413,000, 2.6 percent) would also be used. These increased purchases would be considered positive.

- The municipal governments of Globe, Miami, and Superior would receive minimal sales, severance, and corporate tax distributions from the state. The Globe Unified School District would not receive any tax distribution from the project, since the project is not located in this school district.

- With the increase in population and school-age children, there would be increases in government service and facility demands requiring town and school district expenditures. The town of Globe and the Globe Unified School District would experience increased expenditures, with minor increases in direct tax revenues from the mine. These expenditure/revenue imbalances would occur in both the construction and operation phases of the project. There would likely be a financial shortfall for these government entities during the life of the project.

- Operation and maintenance costs for school districts throughout Arizona are equalized by the state on a per student basis. However, capital costs have historically been funded solely by the school district property tax. Recently (July 1994), the Arizona Supreme Court ruled that the capital fund inequities need to be rectified to equalize bonding capacities for capital projects throughout all state school districts. The legislature will provide a more equitable funding plan in due time (Supreme Court of Arizona 1994).

Social Impact Assessment

It is not anticipated that there would be major changes in lifestyles, social organizations, attitudes, beliefs, or values associated with the proposed project. There could be minor changes in population characteristics caused by the number of in-migrating construction and operations workers; however, these changes would not affect the social characteristics of the area. If adequate housing is not available, there may be some worker dissatisfaction, and potential conflicts could occur.

Environmental Justice

The potential impacts described in Sections 3.7.2.1 through 3.7.2.5 represent both positive and adverse impacts that would affect the entire population, not exclusively the minority or low-income populations described in Section 3.7.1.7, Environmental Justice. It is evident from reviewing the minority and low-income population statistics that these population bases do not represent a large percentage of the overall population affected by the proposed project. It appears that all population segments in Globe/Miami and surrounding areas would be affected equally. In Pinal County, the Block Group that includes Top-of-the-World has a minority population of only 5 percent of the total population and a low-income population of 18 percent. This population would not be disproportionately affected by the proposed project. In particular, the potential site-specific impacts to the population residing at Top-of-the-World are primarily related to water resources and air quality; these impacts would not affect one segment of the population more than another.

3.7.2.2 Alternatives

Most of the socioeconomic impacts discussed in this section are common to all of the alternatives. These impacts include the following:

- At least 60 percent of the workforce would likely come from within the study area. There would be some transfer to the Carlota Copper Project of skilled workers currently working in lower paying jobs. Those currently employed at other mines at comparable wages would not likely apply for jobs at the Carlota Copper Project. Increased employment levels would benefit the overall economic condition of the area.
- Personal income in the area would increase, which would beneficially affect the local and regional economic climate.
- Temporary rental housing availability would be limited for all surrounding towns (Globe, Miami, Claypool, Midland, and Superior). There would be some motel units and RV/mobile home spaces available, but these would not be sufficient for the in-migrating construction workforce. Permanent housing may also be a problem. Carlota may need to provide incentives to area builders to ensure an adequate market for speculative building.
- School capacity would be available throughout the study area. The Globe Unified School District has the greatest capacity, while the Miami Unified School District has a lesser capacity.
- Public utility infrastructure appears to be adequate for additional growth in Globe and Miami.
- Additional law enforcement personnel may be required in Gila County.

Mine Rock Disposal Alternatives

Alternative Mine Rock Disposal Sites. The impacts associated with the alternative mine rock disposal sites would be similar to the impacts discussed for the proposed action. However, the additional backfill of the Carlota/Cactus pit and the additional backfill of the Eder South pit would differ from the impacts discussed for the proposed action because of the additional personnel required for backfilling activities and the extended project life.

Additional Backfill of the Carlota/Cactus Pit. This alternative would require an estimated 190 workers for 3 or 4 additional years of operation to fill the pit. Mining costs would increase because of additional work.

Additional Backfill of the Eder South Pit. This alternative would require a workforce of 190 for 2.3 months.

These alternatives would affect the population, employment, housing, public facilities and services, and fiscal conditions of the affected communities of Globe, Miami, and Superior for the period required for pit backfilling. Additional property tax revenues would be generated for Pinal and Gila Counties and the Miami Unified and Superior Unified School Districts from these alternatives because of the additional capital cost associated with these activities in each respective county.

Eder Side-Hill Leach Pad Alternative

The impacts associated with the Eder side-hill leach pad alternative would be similar to the impacts discussed for the proposed action. However, this alternative would have more visual and noise impacts to the Top-of-the-World area, which may adversely impact property values more than the proposed action. In addition, project costs would increase by constructing this alternative.

Water Supply Alternative

The impacts associated with the water supply alternative would be similar to the impacts discussed for the proposed action. The low-quality water pipeline would increase the total project cost, which would increase assessed valuation and total property tax revenues in the region.

Alternative Water Supply Well Field Access Roads

The impacts associated with the alternative water supply well access roads would be similar to the access road components of the proposed action.

No Action Alternative

The no action alternative would preclude the development of the Carlota Copper Project. Thus, both the beneficial and adverse socioeconomic impacts associated with the proposed action and the other development alternatives would not occur. The estimated workforce of 282 operations workers would not be employed within the study area, adding no new employment, income, population, or revenues to the region.

The adverse impacts associated with the in-migrant population would not occur with the no action alternative. The already limited rental and temporary housing market would not experience the increased project-related demand of 42 units during peak construction, 21 units during the average construction period, and between 57 and 114 units during operations.

Potential project-related impacts to water supply wells at Top-of-the-World would not occur.

Fiscal impacts to local governments from increased demands on public services and facilities would be avoided with the no action alternative.

The beneficial impacts of increased employment during both the 8- to 10-month construction period and the 23-year project operations period would not occur. An estimated average of 91 jobs during the construction period and 177 direct jobs during peak construction would not be created. An estimated average 282 direct jobs during operations would not be created.

Increased incremental annual income from operations employment payroll (an estimated $10 million during operations) would not be generated in the local area. The associated induced economic effects of local spending by construction and operations workers would not occur.

Additional Carlota Copper Company expenditures in the local area would also not occur, which would preclude collection of additional sales and use taxes for the state, counties, and communities. Estimated annual property tax revenues of approximately $1.2 million to Gila and Pinal Counties and other taxing jurisdictions would not occur.

3.7.3 Cumulative Impacts

Cumulative socioeconomic impacts would result from the construction or operation of other projects that contribute to changes in local population, employment, housing, public services and facilities, the economy, and the transportation network. Most of the interrelated actions discussed in

Section 1.6, Introduction and Purpose and Need - Interrelated Actions, would affect the overall socio-economic environment of the project area, primarily in the areas of increased population and employment, increased demand for scarce temporary and permanent housing, increased income in the study area, and increased revenues generated in Gila and Pinal Counties and the town of Globe.

The specific projects that would affect the socio-economic character of the study area include the ongoing construction of the electrorefinery at the Cyprus Miami Mining Company and the proposed leach facility and supportive facilities expansion at the Cyprus Miami Mine. No new permanent workforce is projected for either of these projects. Other cumulative projects that would affect socioeconomic conditions include the following: the Magma Pinto Valley Land Exchange; the Nugget Wash Land Exchange; the Upper Queen Creek Limestone Mine, which is projected to have a permanent workforce of 15 or more; the Magma Copper Florence Project, which may have some impact on the Superior/Globe/Miami area; the Coolidge Dam Safety Project on the San Carlos Navajo Reservation; the Roosevelt Dam improvements and the Roosevelt Dam Plan 6 recreation improvements; highway improvements to U.S. Highway 60/70, Arizona State Highway 88, and Arizona State Highway 188, which would improve access to the area for tourists; commercial and residential development activity in rural areas of Pinal and Gila Counties and the town of Globe; and changes in grazing management practices associated with National Forest lands.

If each of the interrelated actions listed in *Table 1-1* would occur during the construction and operation phases of the Carlota Copper Project, the following beneficial impacts would be expected:

- Demand for employment could reduce the unemployment rate in the area.
- The sluggish economy would be stimulated.
- Personal income areawide would increase because of increased employment.
- Direct expenditures from development activity and indirect expenditures from the employment workforce to the local area businesses would occur.
- Revenues to local and state government budgets would increase from increased property, income, and sales taxes.

In addition to these positive impacts, the potential influx of new population would put extra pressure on an already limited housing market for both short-term rentals and permanent housing in the Globe-Miami area. Certain cumulative projects could affect the provision of services by the local governments.

Most of the interrelated actions mentioned herein would have a greater direct impact during the construction phase; however, it is difficult to identify the secondary growth effects related to improved transportation systems in the region, additional recreational opportunities, expansion of operations on mining projects, and increased growth in commercial and residential activity.

The lack of more specific information regarding projected construction and operations schedules, workforce requirements, and fiscal data precludes a quantitative assessment of cumulative impacts based on existing and reasonably foreseeable projects in the affected area.

3.7.4 Monitoring and Mitigation Measures

Two adverse socioeconomic impacts have been identified for which mitigation is recommended: (1) inmigration of workers, given the relatively high level of unskilled, unemployed workers within the local labor force; and (2) a housing shortfall for both the construction and operations phases of the Carlota Copper Project. The following measures have been identified to provide a range of available options that could be implemented to mitigate adverse impacts.

SE-1: Carlota would provide recruitment and training opportunities for the Native American workforce of the San Carlos Indian Reservation and for other local unskilled labor in order to ensure the use of the largest possible percentage of local labor during construction and operations.

Cooperative training programs with the Arizona Department of Economic Security and the San Carlos Reservation (TERO) already exist.

SE-2: In order to mitigate potential housing impacts, Carlota would work through local government agencies to provide a schedule of project development. Furthermore, Carlota should encourage permanent housing construction in the Globe-Miami area. Mitigation measures related to the potential impacts to residential well water at Top-of-the-World are discussed in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

3.8 Land Use

3.8.1 Affected Environment

3.8.1.1 Land Status/Ownership

Gila County contains approximately 2,865,920 acres, for a total area of 4,752 square miles. Land ownership in Gila County is shown in *Table 3-80.*

Table 3-80. Summary of Land Ownership in Gila County

Ownership	Square Miles	Percent
Forest Service	2,661	56
Indian	1,758	37
Private	143	3
BLM	95	2
State	48	1
Other Public	47	1

Source: Bigando (1993)

The land ownership pattern of Gila County is generally consolidated. The majority of the land is within the administrative boundary of the Tonto National Forest with a lesser amount within a portion of the San Carlos Indian Reservation. There are two areas of the county not within these administrative boundaries, the Globe-Miami area and the southern tip in the Hayden-Winkelman area. These county areas are interspersed private, state, and BLM lands. Within the Tonto National Forest, concentrations of private lands are found in the mining area north and west of Globe, in the Wheatfields area along State Route 88, in Tonto Basin near the community of Young, and in the vicinity of the town of Payson.

Pinal County contains approximately 3,447,000 acres, for a total area of 5,386 square miles. Land ownership in Pinal County is shown in *Table 3-81.*

Table 3-81. Summary of Land Ownership in Pinal County

Ownership	Square Miles	Percent
Forest Service	346	6.4
Indian	1,098	20.4
BLM	634	11.8
Other Public/Private	3,308	61.4

Source: Felix (1993)

The Carlota Copper Project is located within both Gila and Pinal Counties. The heap-leach pad for the project is located on the county line. The land in the vicinity of the project area is within the administrative boundary of the Tonto National Forest. Eighty-one percent of the project area is Forest land and 19 percent, including the major portion of the Carlota/Cactus pit and all of the Pinto Creek diversion, is private land that was purchased by the Carlota Copper Company from Magma Copper Company. A 20-acre patented mining claim owned by another party is located partially within the southwestern portion of the project area. Private land owned by BHP Copper is located adjacent to the Carlota land to the northeast and is the site of the Pinto Valley Mine. Eight hundred and fifteen acres of private land, known as Top-of-the-World, are located southwest of the project area. This land has multiple ownership, and the eastern portion has been subdivided for residential purposes. Another tract of patented (private) mining claims is located south of U.S. Highway 60 around Five Points Mountain. *Figure 3-33* illustrates the project vicinity.

The Carlota Copper Project is located approximately 6 miles due west of the town of Miami, within the western portion of the Globe-Miami Mining District. Property holdings consist of 12 unpatented claims under lease from Sherwood Owens covering the Carlota/Cactus ore body, and 23 patented and 252 unpatented claims owned by the Carlota Copper Company covering the Carlota/Cactus pit and surrounding area.

The project area covers approximately 3,050 acres (4.8 square miles) and is located in the Globe Ranger District of the Tonto National Forest. The project area is dissected by two principal drainages. Pinto Creek, the larger of the two, is on the east side of the area, and Powers Gulch is on the west side. The total area affected by all of the project features is approximately 1,428 acres.

3.8.1.2 Land Use Plans

Given the large percentage of federal lands in Pinal and Gila Counties, federal management programs, particularly those administered by the Forest Service, significantly influence land use in the area. In addition, since the Carlota Copper Project includes unpatented mining claims on lands administered by the Tonto National Forest, and is dependent upon those lands for implementation of the project, Forest Service land use plans, policies, and regulations have primary jurisdiction over land use activities on these parcels. The Forest Service has developed the *Tonto National Forest Plan* to guide the long-term management of these lands.

The Carlota Copper Project is located in Management Area 2F, which consists of over 385,840 acres. The emphasis placed on land management within this area is to promote a variety of renewable resources, such as wildlife habitat improvement, water quality maintenance, livestock forage production, and dispersed recreation. The management direction in the Forest Service management plan is to allow uses of available National Forest lands for appropriate public or private interests consistent with National Forest policies. One of the goals of the management direction that the Tonto National Forest has identified is to support environmentally sound energy and minerals development. The *Tonto National Forest Plan* (USDA Forest Service 1985) states that "...minerals activities will be managed through Plans of Operation to ensure environmental and other resource needs are provided for while also developing the National Forest potential for contributing to the nation's mineral resource needs."

Gila and Pinal Counties have limited jurisdiction over the proposed Carlota Copper Project; Carlota will be subject to Gila County ordinances on the private land within the project boundary. The Forest Service also will require that Carlota meets any applicable County requirements for drinking water systems, wastewater treatment systems, solid waste disposal, and building codes. The Arizona Revised Statutes (ARS 11-830 Paragraph A, Sub 2) state that nothing will "...prevent, restrict, or otherwise regulate the use or occupation of land or improvements for railroad, mining, metallurgical, grazing, or general agricultural purposes, if tract is five or more contiguous acres." This statute was incorporated verbatim into the Gila County and Pinal County zoning ordinances.

3.8.1.3 Land Use

Land use in the vicinity of the project area reflects typical land use patterns throughout the Globe-Miami area, and primarily consists of copper and other mining, dispersed recreation (i.e., horseback riding, hunting, trapping, hiking), and livestock grazing. The project area is characterized by mountainous terrain covered with chaparral vegetation common to the high desert.

Adjacent land use includes residential uses at the Top-of-the-World area. Pinal County zoning at Top-of-the-World includes mobile home parks, mobile home subdivisions, suburban 2-acre homesteads, local business CB-1, and general business CB-2.

Mining

The Globe-Miami Mining District is one of the oldest and largest in the State of Arizona. Valid claims under the U.S. Mining Laws establish private rights to the ore, and those rights are essentially property rights. Currently, two major mines operate in the vicinity of the proposed project: the Pinto Valley Mine adjacent to the project site and Miami Mine. The Superior Mine went on stand-by and shut-down status in 1996. Other operating mines in the region include the ASARCO Ray complex and other small mining interests throughout the area. There are other proposals and exploration activities for small copper or gold operations throughout the study area.

Currently, there are some expansion plans for the area. Cyprus-Miami has proposed an expansion of its leach facilities at the Miami Mine with a planned start-up of 1997. In addition, BHP Copper has proposed an expansion of its facilities with a planned start-up of 1997. Also, ASARCO completed a major expansion of its Ray Mine in 1992.

Magma Copper Company (now BHP Copper) proposed a land exchange with the Forest Service that would involve BHP acquiring through the exchange process eight selected parcels in the vicinity of the Pinto Valley Mine operations. Over 50 percent of the selected 1,200 acres of land is under a mining plan of operations or has previously been affected by mining operations, primarily with tailings and overburden piles. It is reasonably foreseeable that the acquired lands would be used to expand mine facilities, such as mine rock disposal areas, tailings impoundments, or sediment collection ponds. The land being offered to the Forest Service is located in the Apache-Sitgreaves National Forest, in

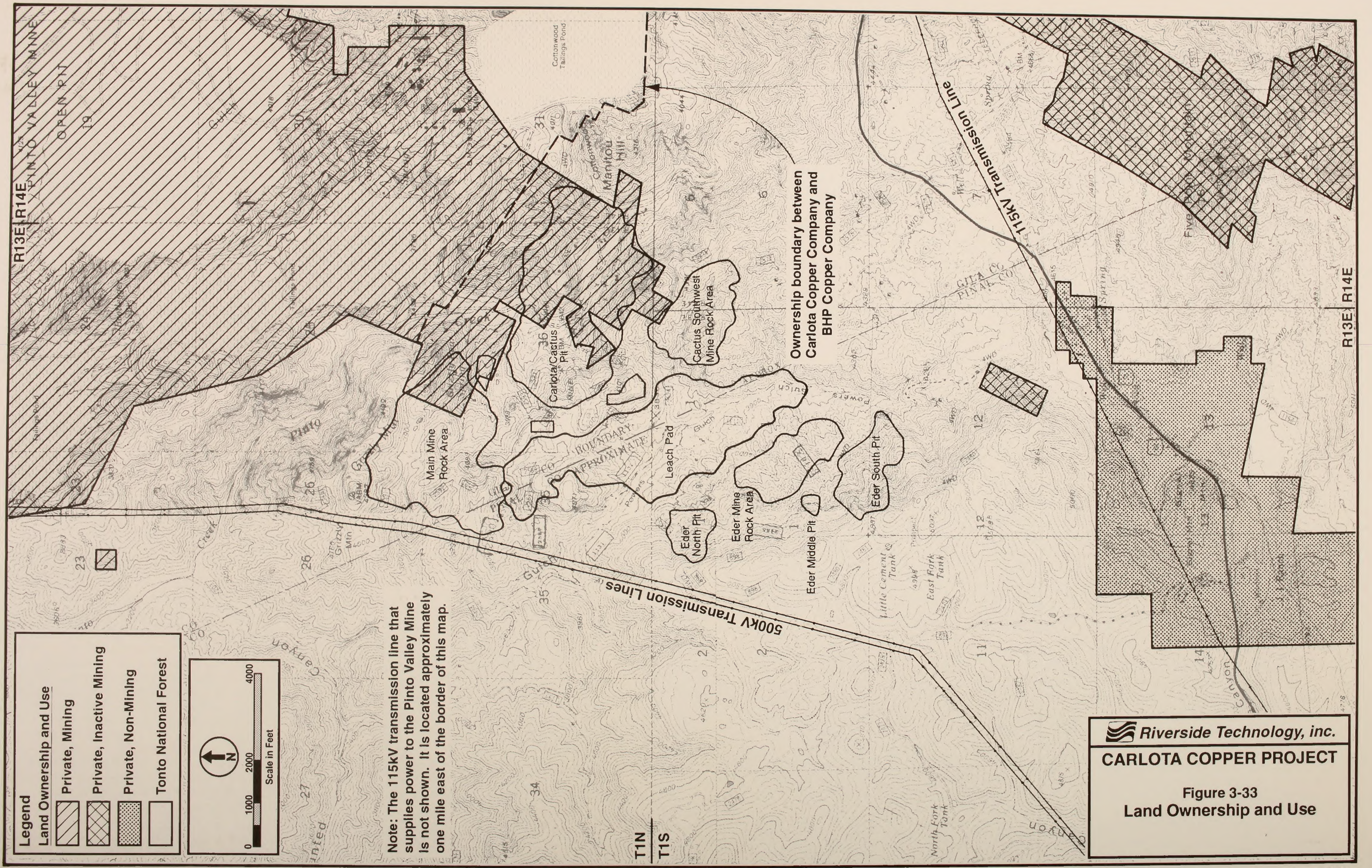


Figure 3-33
Land Ownership and Use

Coconino County, Arizona; approximately 465 acres is being offered. The offered lands are generally forested lands, primarily ponderosa pine, with meadows and riparian areas highly suitable for wildlife habitat. According to the Forest Service, this land exchange would be consistent with the *Tonto National Forest Plan* (USDA Forest Service 1985).

Grazing

There are portions of three grazing allotments located within the project area in the Globe Ranger District.

- The Bellevue allotment has 17,539 acres and three permittees (one of the permittees is Cyprus Miami Mining Corporation). It is a year-round yearling and cow/calf operation for a total of 1,388 animal unit months (AUMs).
- The permittee on the Bohme allotment is Cyprus Miami Mining Corporation with 1,576 AUMs as a year-round cow/calf operation. The allotment has a total of 5,740 forest administered acres, as well as a large portion of private land.
- The Pinto Creek allotment has 31,063 Forest-administered acres and 1 permittee. However, only the well field will be within this allotment.

Six grazing allotments are located in the Pinto Creek watershed adjacent to the project area: Bohme, Bellevue, Devils Canyon, Pinto Creek, and Brushiest, and Hobbs (*Figure 3-34*). Current allotment management plans are in place for the Devil's Canyon, Pinto Creek, and Brushiest allotments. The Brushiest allotment is currently ungrazed by livestock and is not scheduled to be grazed until such time as further analysis is completed to determine future feasibility. The Forest Service completed an Allotment Management Plan for the Bellevue allotment in 1996 and is scheduled to develop an Allotment Management Plan for the Bohme allotment in the near future. The Bellevue Allotment Management Plan now includes a rest-rotation method of grazing.

In addition, three grazing allotments occur within the Tonto Basin Ranger District in the downstream portion of the Pinto Creek drainage. The Havens allotment has 4,345 acres and has been ungrazed by the permittee for the past several years. In the past, it has been a yearling operation with 100 yearlings for a 5-month period. The Poison Springs allotment is 31,275 acres and is currently active. It is a year-round, cow/calf operation with 340 AUMs. The Campaign/Bar V Bar allotment has 34,158 acres and operates as a year-round cow/calf operation with 575 AUMs.

Recreation

Activity within the project area includes dispersed recreational uses, such as hiking, hunting, sightseeing, and horseback riding. The Superstition Wilderness is near to the project area boundary; Section 3.9, Recreation, describes existing recreational use in more detail.

Utilities

There are currently four transmission lines that traverse the project site: two existing 115-kv Salt River Project transmission lines near U.S. Highway 60, a 500-kv Salt River line, and a 500-kv Arizona Public Service line (Adams 1993). The two 500-kv lines are within the same corridor (*Figure 3-33*).

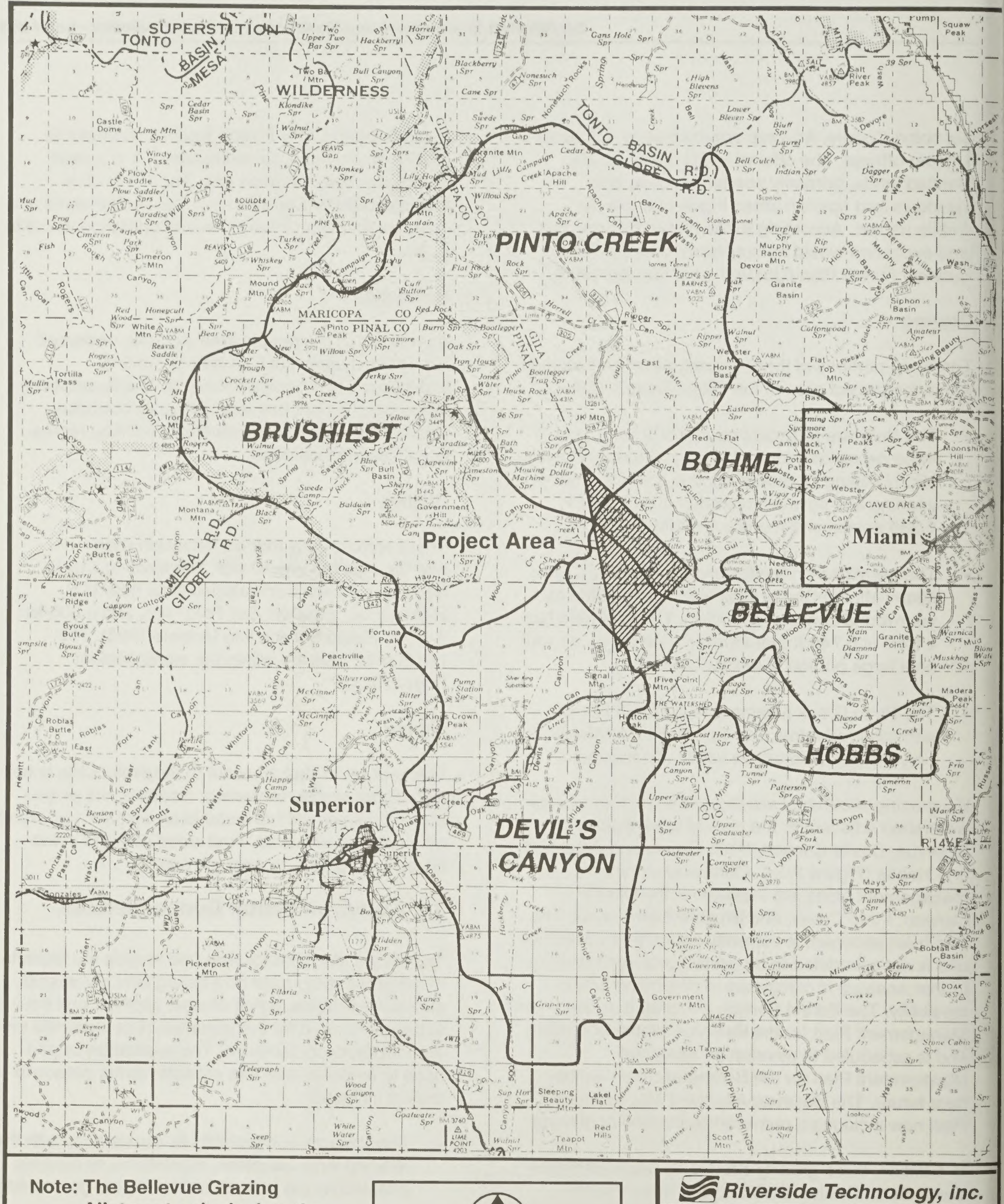
Timber

The land within and adjacent to the project site is not suitable for timber harvesting; however, the project areas does contain harvestable amounts of fuel wood for local area residents. Fuel wood demand in the Globe area generally exceeds supply.

3.8.2 Environmental Consequences

The issues identified for land use include the impacts of the proposed project on existing land ownership status, easements, rights-of-way, permits, and the subsequent need for the issuance of new permits or authorizations for land use. The evaluation criteria used to evaluate land use impacts for the proposed project included:

- The project's compatibility or consistency with the existing land use plans, regulations, or controls adopted by the federal, state, or local government
- Impacts on the continuance of existing permits or other authorizations and the need for issuance of new permits or authorizations



Note: The Bellevue Grazing Allotment only depicts the area administered by the U.S. Forest Service.

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Figure 3-34
Locations of Grazing Allotments

3.8.2.1 Proposed Action

Land Status and Ownership

The proposed action would affect both private land and unpatented mining and mill site claims. The majority of the project would be located on unpatented mining and mill site claims administered by the Forest Service pursuant to 36 CFR 228, the Forest Service's regulations governing mining on public lands. Carlota currently maintains lode mining and/or mill site claims on approximately 5,900 acres of National Forest system lands in the general project area. The proposed action would not change the land status or ownership in the project area. However, patenting of land by Carlota, under a separate legal process, could affect the land status.

Land Use Plans

The proposed action would be consistent with the *Tonto National Forest Plan.* The Plan is required by the Forest and Rangeland Renewable Resources Planning Act (RPA), as amended by the National Forest Management Act (NFMA). It describes management direction, prescriptions for management areas, and standards and guidelines for those activities for which the Forest Service has management authority. One of the goals for the Tonto National Forest is to support environmentally sound energy and minerals development. The management prescription for all areas is to process operating plans filed under the U.S. Mining Laws, as amended, and federal regulations. Management Area 2F of the Plan, within which the project is located, has a management emphasis on wildlife habitat improvement, water quality maintenance, livestock forage production, and dispersed recreation. The Forest Service must therefore respond to the operating plan and, where feasible, require mitigation that would minimize adverse environmental impacts on Forest Service surface resources, with specific emphasis on those resources identified in the management prescription. The proposed action meets standards established by regulation and policy, and the appropriate guidelines were considered in developing alternatives and mitigation.

However, the proposed action is expected to require the amendment of an existing special use permit to the Salt River Project for a power line and substation; new permits for water and power facilities sites or corridors as appropriate to Carlota; amendments to existing grazing permits because of loss or relocation of range structural improvements and maintenance responsibilities; permit(s) for fuel wood salvage; possible state permits for the salvage and relocation of state-protected species, such as cacti; and a commercial road-use agreement with the Forest Service or Gila County for Forest Service Road 287.

Gila and Pinal Counties have limited jurisdiction over the proposed Carlota Copper Project. The proposed action conforms with the Arizona Revised Statute 11-830 Paragraph A, Sub 2, regarding mining purposes. The proposed project is not anticipated to require additional permits or authorizations for the existing land uses (i.e., grazing permits or modifications to the *Tonto National Forest Plan*).

Land Use

The principal land uses in the immediate vicinity of the Carlota Copper Project include copper and other mining, and dispersed recreational activities and grazing. Historical uses of the project area, other than mining uses (e.g., grazing, wildlife habitat, open space, dispersed recreation, particularly horseback riding and hunting) would be limited or eliminated over the life of the project and possibly beyond.

Mining. The proposed action would result in the expansion of the current area affected by mining activity. The project area encompasses an estimated 3,050 acres, with an estimated disturbed acreage of 1,428. The immediate mining area would generally preclude public use of the affected lands. For both safety and security reasons, public access to the active mining and processing areas within the project area would be precluded to the maximum extent permitted by law during the life of the project. In addition, the closed area would affect currently used access routes into areas that would not be closed. The construction of the waste rock disposal areas and leach pad could also inhibit or preclude future surface mining of other mineral resources, if any were discovered, that are located beneath or adjacent to such facilities. However, condemnation drilling was performed, and it was determined that potentially commercial ore reserves are not likely to be found beneath project facilities.

Grazing. The proposed action would affect portions of the Bellevue and Bohme allotments. The primary effect would be from clearing forage from areas of disturbance. An estimated 920 acres of the Bellevue allotment (5 percent) would be affected by the proposed action, which equates to approximately 73 AUMs. An estimated 580 acres of the Bohme allotment (10 percent of the Forest acres) would be affected. This cannot be directly equated to loss of AUMs since a considerable amount of private land is also grazed, and the cattle are used for reclamation purposes on the private land. However, the effect on grazing is not limited to areas of disturbance. If the pits and leach pad were excluded from grazing, the affected area would be greater than the disturbance area because areas of the allotments would be inaccessible or implementing management would not be practicable. Lowering livestock numbers in their term grazing permits would result in economic losses to the permittees. Structural range facilities, including fences, water developments, and possibly corrals would need to be relocated in order for permittees to effectively graze the remaining portions of their allotments. Grazing permits would also have to be amended, as needed. As a result, additional mitigation is recommended in Section 3.8.4.

Recreation. Horseback riding along Powers Gulch to access the Haunted Canyon Trail, which leads to the Superstition Wilderness, would be affected by the proposed action. An analysis of this impact can be found in Section 3.9.2, Recreation - Environmental Consequences. Dispersed recreational uses within the project area would be curtailed. Access to additional recreational areas would also be affected.

Forest Service Trail 203 would be impacted by Carlota's proposed well field. Continued use of this road as a mine facility would likely degrade the recreational experience of hikers and horseback riders and would encourage vehicular use.

Utilities. The Forest Service would amend the existing permit to the Salt River Project to include the new substation.

Timber. The proposed action would result in the removal of trees and down material desirable as fuelwood and would limit public access to fuelwood collection. To address demand for fuelwood, mitigation is recommended in Section 3.8.4.

3.8.2.2 Alternatives

The alternative component locations would result in some similar impacts to the existing land status and ownership, land use plans, and land use as described for the proposed action. The following sections describe several potential differences in impacts from the various facility location alternatives in terms of areas disturbed and type of impact.

<u>**Mine Rock Disposal Alternatives**</u>

Alternative Mine Rock Disposal Sites. This alternative would increase the total disturbed area affected by the project by an additional 44 acres. One of the 22-acre mine rock disposal sites would be located on National Forest land; the other 22-acre site would be located on private land. Other than increasing the total amount of disturbed acreage, this alternative would not change the land use patterns suggested in the proposed action.

Additional Backfill of the Carlota/Cactus Pit. This alternative would result in an increase in reclaimed areas to approximately 194 acres for the Carlota/ Cactus pit and 177 acres for the Main mine rock area.

Additional Backfill of the Eder South Pit. This alternative would also result in an increase in reclaimed areas by creating more flat or gently sloping areas than described for the proposed action. The reclaimed area for the Eder South pit would increase by 16 acres to approximately 42 acres. The reclaimed area for the Eder mine rock disposal area would increase from approximately 40 acres to 73 acres.

<u>**Eder Side-Hill Leach Pad Alternative**</u>

The impacts associated with the Eder side-hill leach pad alternative include an additional total disturbance of approximately 134 acres near the Powers Gulch drainage channel. The land use impacts would be similar to those described for the proposed action except for a decrease of 134 acres for dispersed recreational uses, compared to the proposed action.

Water Supply Alternative

This alternative would potentially impact the land use in the area, depending upon the level of disturbance associated with pipelines, pumping stations, access roads, and power lines necessary for this alternative. Most of the pipelines would be located in an existing corridor adjacent to the BHP Copper pipeline to the Pinto Valley Mine.

Alternative Water Supply Well Field Access Roads

The land use impacts associated with the alternative water supply well access roads would be similar to the access road component of the proposed action. Use of the Alternative A access road would preclude access during periods of high flow in Pinto Creek.

No Action Alternative

Under the no action alternative, Carlota would not disturb the 1,428 acres associated with the Carlota Copper Project. Access to the 3,050-acre project area would be preserved. The existing land uses would be maintained, including grazing on the Bohme and Bellevue allotments and horseback access to Haunted Canyon through Powers Gulch.

3.8.3 Cumulative Impacts

The interrelated actions discussed in Section 1.6, Interrelated Actions, would potentially affect land use in the project area. The potential impacts would be associated with disturbing land for mining, energy and transmission systems, commercial and residential land development, highway improvements, land exchanges, dam modifications, and recreational facilities.

These interrelated actions would change existing land uses to alternate uses, or preclude the future development of the land for any future alternate use. In the case of the Coolidge Dam improvements, safety is the primary purpose for this project, which will ensure future protection for downstream land uses, and may actually stimulate alternate uses of land downstream.

Cumulative effects of changes in grazing management practices, as well as the potential designation of a segment of Pinto Creek downstream of the project site as a Scenic river, would have an indirect land use effect. Such changes could result in some existing land uses being restricted and/or redirected in order to maintain and preserve the natural ecological condition of the land. Land use throughout the area will continue to be affected by interrelated projects associated with increased economic activity, resource development, and population growth.

3.8.4 Monitoring and Mitigation Measures

A mitigation measure for land use would involve alternate access for horseback riding in Powers Gulch. This measure (R-1) is discussed in Section 3.9.4, Recreation - Monitoring and Mitigation Measures.

Suggested mitigation includes the following:

LU-1: Relocate allotment boundary fences and implement range structural improvements within the project boundary according to a plan developed by Carlota, the affected permittees, and the Forest Service to reflect adjusted allotment boundaries (see also mitigation measure TB-6 in Section 3.5.4 relative to biological impacts). Consider using wells developed by Carlota to satisfy structural improvement needs both during operation and at closure.

LU-2: Construct fences to exclude livestock from active mining and processing areas [part of above plan(s)].

LU-3: Develop a plan with the Forest Service to salvage fuel wood from disturbed areas.

LU-4: Work with Bellevue and Bohme grazing permittees to develop a plan to minimize economic losses to their existing permits.

3.9 Recreation

3.9.1 Affected Environment

In general, the Carlota Copper Project area has not been developed or improved for recreational activity except for Forest Service Trail 203, which accesses the Haunted Canyon portion of the Superstition Wilderness from Forest Service Road 287. Virtually all of the landscape modifications are related to resource development, primarily mining activity in the Globe-Miami Mining District, and grazing.

The following information summarizes the Forest Service management directives and recreational activities that occur in the project area.

3.9.1.1 Forest Management Directives

The recreational character of the area can be defined by the Recreation Opportunity Spectrum (ROS) system discussed in the *Tonto National Forest Plan* (USDA Forest Service 1985). The land within, as well as surrounding, the Carlota Copper Project area is classified using four primary ROS classes, which are defined below, in declining order from most natural to most modified, by human activity.

Semi-Primitive Non-Motorized (SPNM)

These areas are characterized by an environment that appears predominately natural. Evidence of other users is present, but there is little interaction. Motorized use is not permitted. SPNM areas differ from primitive areas only in the degree and type of recreational experience users enjoy. The probability of experiencing isolation, independence, closeness to nature, tranquillity, and self-reliance in an environment of challenge and risk is high, although not as high as in a primitive area.

Semi-Primitive Motorized (SPM)

The character of these areas includes a predominately natural-appearing environment within roaded areas and moderate evidence of other users. Access by motor vehicles is permitted on roads and trails. The areas are managed in such a way that minimum on-site controls and restrictions may be present, but they are subtle. User expectations are similar to those for SPNM areas, but the probability of experiencing isolation and related backwoods senses is reduced by the increased accessibility for motor vehicles. The opportunity for interaction with the natural environment remains high, and the opportunity to use motorized equipment is available.

Roaded Natural (RNA)

The characteristics of this classification include a natural-appearing environment within roaded areas, prevalent evidence of other users, and evidence of past resource management activities. RNA areas are predominately natural in appearance, but they are readily accessible to vehicles.

Urban (U)

Characteristics of this classification include a setting that is strongly dominated by structures and/or resource development. Natural-appearing elements may be present but are subordinate. There is strong evidence of designed roads and human activity both on the sites and in nearby areas. Motorized access to the areas is available.

The project area is classified under two ROS ratings: U and RNA. Existing mining activity is classified U because of the extreme change to the natural setting. *Table 3-82* shows the current project area ROS classification.

Table 3-82. Existing ROS Classification - Carlota Copper Project Area

ROS Class	Acres	Percent of Project Area
RNA	2,854	94
U	196	6
TOTAL	3,050	100

The project area is located in Management Area 2F of the *Tonto National Forest Plan.* As stated in Section 3.8, Land Use, Management Area 2F contains approximately 385,843 acres, which represents over 85 percent of the total 450,863 acres in the Globe Ranger District. The management objective for Area 2F is to manage for a variety of renewable natural resources, with the primary emphasis on wildlife habitat, water quality maintenance, livestock forage production, and dispersed recreation. Watersheds will be managed so as to maintain or improve their quality to a satisfactory or better condition. Riparian areas will be improved and managed (as defined by Forest Service Manual 2526) to benefit riparian-dependent resources. Wildfires will be managed to improve livestock forage production and wildlife habitat, as well as to achieve the desired resource condition, which includes a mixture of vegetation successional stages (USDA Forest Service 1985).

3.9.1.2 Recreation Activities

The area surrounding the Carlota Copper Project attracts a variety of recreational uses. Essentially all of the area's recreational use is undeveloped and dispersed in nature. This type of recreational use attracts relatively few participants compared to developed areas, but is preferred by hunters, many horseback riders, and others. The majority of the dispersed recreational activities that take place in the vicinity of the project area includes horseback riding; sight-seeing; picnicking; birdwatching; small game (quail), javelina, and deer hunting; and hiking. Horseback riders use the Powers Gulch Haunted Canyon areas. Oak Flat Campground, on U.S. Highway 60 between Miami and Superior, is the only developed recreation site in the project vicinity.

There are no designated trails located within the mine area, although Forest Trail 203 passes through the well field area along Pinto Creek and Haunted Canyon. This trail provides access to the Superstition Wilderness. There are a number of four-wheel-drive roads within or passing through the project area that were constructed primarily for mineral exploration or power line construction access. These roads are used by four-wheel drivers and sightseers.

Most of the recreationists that come to the project area are from the local area or the Phoenix metropolitan area. The Superstition Horseman's Association uses the Powers Gulch access to Haunted Canyon and the Superstition Wilderness two to three times per year, but individuals use the access more often (Kilpatrick 1993).

Overall, recreational use within the project area is low; however, the east side of the Superstition Wilderness is experiencing increased use from the Phoenix metropolitan area. The popular dispersed recreational activities include prime white-tail deer hunting, birdwatching, and wildlife viewing. In 1992, the estimated total recreational visitor days (RVDs) for the Globe Ranger District was 1.1 million. An RVD is one 12-hour period of recreational activity by one or more persons. Recreational visitors in the Globe Ranger District increased from approximately 485,000 annual visitors to over 1 million RVDs from 1989 to 1992, which is an average annual increase of 32 percent. Most of the increase occurred in the automobile sightseeing category. Other recreational activities occur outside the immediate project area.

Roosevelt Lake, located approximately 26 miles northwest of Globe, is in the Tonto Basin Ranger District and provides water sport activities year-round to area residents and visitors. Of the more than 1.1 million RVDs in the District in 1992, over 75 percent were tied to activities at Roosevelt Lake. The U.S. Bureau of Reclamation, Plan 6 - Arizona Project, is currently completing a major expansion at Roosevelt Lake. The expansion includes raising Roosevelt Dam, which will influence the use of Roosevelt Lake. Two new large campgrounds—a group campground and a family campground with 206 campsites—are open; four more campgrounds are planned. The Forest Service operates and manages the campgrounds. Other recreation locations in the surrounding area include Pinal Mountain Recreation Area, San Carlos Lake on the San Carlos Indian Reservation, Apache Lake, the Salt River, Sierra Ancha Wilderness, Salt River Canyon Wilderness, and Superstition Wilderness. Urban recreational facilities and programs are discussed in Section 3.7, Socioeconomics.

3.9.2 Environmental Consequences

The proposed action and alternatives could potentially affect the dispersed recreational use and enjoyment of the area. The potential effects are centered around three issues: (1) temporary and permanent loss of dispersed recreational opportunities in the project area, (2) decreased access to adjacent areas, and (3) increased demand for recreational opportunities caused by the loss of land area and population growth associated with the project.

The evaluation criteria used to analyze the recreation impacts for the proposed Carlota Copper Project are listed below:

- Changes in ROS classification (in acres) during and after project operations
- Decrease in recreational activities caused by a decrease in acres, game populations, aesthetic experience, increased demand, or other reasons
- Increase in total recreation demand in RVDs in the project area based on predicted change in population

The project area contains a range of recreational opportunities. The quality of visitors' experiences can be affected by changes to the characteristics of the area and the land. As described in Section 3.9.1, Recreation - Affected Environment, the primary recreation uses within the project area include dispersed recreational activities, such as horseback riding, sightseeing, picnicking, hunting, and hiking.

Recreation impacts are defined in terms of the acreage affected by the proposed action and the alternatives, access limitations, and changes to the quality of the recreational experience. The impact analysis also identifies the areas that would undergo a change in ROS class because of the proposed action and alternatives.

ROS is used to define outdoor recreation settings, activities, and experiences through defined classes. The ROS classes related to the project area are described in Section 3.9.1.1, Recreation - Forest Management Directives. ROS classifications were determined for the proposed action and alternatives to analyze changes in recreation opportunities. The existing ROS classes of the project area are shown in *Table 3-83.*

3.9.2.1 Proposed Action

The proposed action would result in the development of the Carlota Copper Project, which includes an overall project area of approximately 3,050 acres and affected acreage of approximately 1,428 acres. Most of the project area would not be available for recreation activities during mining operations, and portions may not be available for recreation after closure.

The dispersed recreational activities described in Section 3.9.1, Recreation - Affected Environment would be adversely affected by the proposed action in a major portion of the project area. The most significant impact would be from the loss of favorite areas for horseback riding, hunting, four-wheel driving, and sightseeing. This impact would primarily affect local residents from Top-of-the-World and the Globe-Miami area. However, existing use in the area of the proposed project is relatively low. There is more than adequate public land available throughout the surrounding area to provide terrain for these activities. The Globe Ranger District has abundant open space acreage and designated wilderness areas within the general vicinity. Over 59 percent of the area in Gila County is publicly owned, primarily as part of the Tonto National Forest (2,661 square miles). Therefore, the impacts would not be considered significant. However, to address the localized impacts, mitigation is recommended in Section 3.9.4-Monitoring and Mitigation Measures.

The majority of users access the Superstition Wilderness trailheads via Forest Service Roads 287 and 287A. Other users access the Wilderness via Forest Service Trail 203. Another alternate horseback route to Haunted Canyon and the Superstition Wilderness is from the Top-of-the-World along Powers Gulch. Although the horseback use through this access point is relatively low, the proposed project would alter the access, which could indirectly affect recreational use in the Superstition Wilderness. It is unclear how many horseback riders currently use the Top-of-the-World access to Haunted Canyon. Another alternate access route to the Haunted Canyon trail could be developed from Forest Service Route 898 near Top-of-the-World. This route is just west of Powers Gulch. It would cross private property on which the Forest Service currently does not have right-of-way. The route would subsequently reconnect with the existing route to Haunted Canyon outside the project boundary. Access to this trail would be from U.S. Highway 60 (Section 14, T1S, R13E). Please see Section 3.9.4 regarding mitigation relative to recreational access.

A more detailed analysis of wilderness impacts is provided in Section 3.10, Wilderness and Wild and Scenic Rivers. Visual and noise impacts related to mine activities in the Superstition Wilderness are discussed in Sections 3.11, Visual Resources, and 3.12, Noise.

Table 3-83. Change in ROS Class Acreage - Proposed Action

ROS Class	Existing ROS Acres	Area Change (acres)	Project-Related ROS Change (acres)	Percent of Project Area	Percent Change
RNA	2,854	-1,892	962	31.5	-66
U	196	-1,892	2,088	68.5	+965
TOTAL	3,050	0	3,050	100.0	0

No Forest Service campsites, developed recreation sites, or picnic areas would be affected by the proposed action. Forest Service Trail 203 would be impacted by Carlota's proposed well field. The continued use of this road as a mine facility would likely degrade the recreational experience of hikers and horseback riders and would encourage vehicular use.

The projected increase in population from the proposed action is between 161 for the low-impact scenario and 323 for the high-impact scenario (see Section 3.7.2, Socioeconomics - Environmental Consequences), with the majority expected to live in the Globe-Miami area. This population rise would cause an increase in RVDs in the Globe-Miami area and the Pinto Creek area, but it would not put undue pressure on the recreation areas given the dispersed nature of the recreational activities.

The high-impact scenario would represent a 2.7 percent increase in the areawide population, which would not be considered adverse from a recreational standpoint. This population would also increase demand on local community recreational facilities and programs; this issue is discussed in Section 3.7.2.1, Socioeconomics - Public Facilities and Services.

The direct and indirect effects of the proposed action include changes in the ROS classifications of affected areas. Changes from RNA to U would occur because of mining activity, which is considered an urban setting within the ROS standards. *Table 3-83* shows the changes in acres by ROS class and the percent of change in ROS acreage.

As reclamation is completed for project lands, some of the area would remain unusable for recreational purposes (e.g., the open pits), and the area may be less desirable for recreational use. Public access for recreational use would depend on the status of other mining activity in the vicinity of the project area at that time.

3.9.2.2 Alternatives

The following discussion explains the potential impact of each alternative and describes the change in character of the area if the alternatives were implemented. The alternative component locations would generally result in the same type of impacts to the existing recreational use as discussed for the proposed action.

Mine Rock Disposal Alternatives

The recreational impacts associated with the mine rock disposal alternatives, including the additional mine rock disposal sites, additional backfill of the Carlota/Cactus pit, and additional backfill of the Eder South pit, would be the same as the recreational impacts discussed for the disposal and backfill components of the proposed action.

Eder Side-Hill Leach Pad Alternative

The recreational impacts associated with the Eder side-hill leach pad alternative would include a decrease in dispersed recreational activities in the disturbed area near Powers Gulch (approximately 134 acres).

Water Supply Alternative

The impacts associated with the water supply alternative would be the same as the impacts discussed for the water supply components of the proposed action.

Alternative Water Supply Well Field Access Roads

The alternative water supply well field access roads would result in the improvement of slightly different access routes within the Forest. The well field access roads would increase access, particularly by four-wheel drive vehicles, to a segment of Pinto Creek and to Haunted Canyon. Increased access would result in a well-defined and maintained segment of Forest Service Trail 203, but would also result in poor experiences for hikers and horseback riders. Visual impacts, as discussed in Section 3.11, Visual Resources, would potentially affect the recreational experience, but only to a minor degree.

The ROS designation of RNA would not change for these alternatives.

No Action Alternative

Under the no action alternative, Carlota Copper Company would not disturb the approximately 1,428 acres associated with the Carlota Copper Project. Nearly all of the roads within the project area have been identified for closure in the *Tonto National Forest's Resource Access Travel Management Plan.* Roads under Carlota's current *Plan of Operations* would be reclaimed and other roads, many of which are poorly located and contribute to erosion, would be closed in the future. The existing recreational opportunities would be maintained, including horseback access to Haunted Canyon through Powers Gulch and other dispersed recreational activities, such as hunting, hiking, and sightseeing.

3.9.3 Cumulative Impacts

The interrelated actions discussed in Section 1.6, Interrelated Actions, would potentially affect recreational opportunities in the project area. The potential impacts would be associated with constraints placed on recreation access caused by mining and land exchanges, or improved access or opportunity caused by highway improvements, dam modifications, and new recreational facilities. These interrelated actions would change the existing recreational patterns; in some cases, recreational opportunities would improve, in others, they would be more limited after completion of the projects. In addition, the cumulative impacts of changes in the grazing management practice and the potential designation of Pinto Creek as a Wild and Scenic River would represent an indirect effect on recreation, because the future condition of some existing recreational areas would improve from the potential implementation of restrictions affecting future land uses. In these cases, the natural environment would be preserved for low-impact use, which generally would include dispersed recreation.

Recreational opportunities throughout the area will continue to be affected by interrelated actions associated with increased economic activity, resource development, and population growth.

3.9.4 Monitoring and Mitigation Measures

The following mitigation measure is proposed for recreation:

R-1: Develop, in coordination with the Forest Service, an access management plan. The plan would address recreational access during all phases of the operation when it is legally and practicably feasible.

Refer to Section 3.13.4, Transportation-Monitoring and Mitigation Measures, for mitigation of impacts to Forest Service Trail 203.

3.10 Wilderness and Wild and Scenic Rivers

3.10.1 Affected Environment

3.10.1.1. Wilderness

The *Tonto National Forest Plan* (USDA Forest Service 1985) reports a total of 585,990 wilderness acres within the Forest. The Superstition Wilderness has over 160,000 acres, with an estimated 23,819 acres within the Globe Ranger District.

Several wilderness areas occur in the general vicinity of the project area, including the Superstition Wilderness (approximately 3 miles west-north-west of the well field), the Salt River Canyon Wilderness (approximately 12 miles north and east of the project area), and the Salome and Sierra Ancha Wildernesses (25 miles north-northwest and 25 miles north-northeast of the project area, respectively). The Superstition Wilderness is the only area that would potentially be affected by the Carlota Copper Project because of its proximity.

The Superstition Wilderness is characterized by desert, chaparral, and woodland vegetation types with some ponderosa pine and desert grassland. The management concerns stated in the *Tonto National Forest Plan* are to protect the wilderness resource and enhance the visitor experience. The management emphasis for the portion of the Superstition Wilderness in the Globe Ranger District (Management Area 2A) is to manage for wilderness values while providing livestock grazing and recreational opportunities that are compatible with maintaining wilderness values and protecting resources.

Current use in the area consists of dispersed recreation, including hiking, horseback riding, some camping, and some hunting. The primary access to the Wilderness is via Forest Service Roads 287 and 287A and the Miles Ranch Trailhead. The primary access to Haunted Canyon is Forest Service Trail 203 from Forest Service Road 287. Haunted Canyon is a popular horseback riding area for local and regional riders, with additional access from U.S. Highway 60 and mining roads in Powers Gulch.

Mining is no longer allowed in the wilderness, except on valid mining claims.

Recreation visitation in the Globe Ranger District is estimated using the sample observation survey technique. Although the statistical basis is limited, this method still provides a general estimate of recreational use in the Forest. In 1992, the estimated wilderness use in the Globe Ranger District was 21,100 RVDs; one RVD equals one 12-hour period of recreational activity by one or more persons. It is estimated that 75 percent (15,000 RVDs) of this use was in the Salt River Canyon Wilderness; the remaining 25 percent (5,300 RVDs) occurred in the Superstition Wilderness (Killebrew 1993, USDA Forest Service 1992b). Visitor use in the eastern portion of the Superstition Wilderness is believed to be increasing because of the increasing population in the Phoenix metropolitan area. Estimated wilderness RVDs in the Globe Ranger District have increased from 17,400 in 1989 to 21,100 in 1992, an average annual increase of 6.6 percent.

The eastern portion of the Superstition Wilderness, in the Globe Ranger District, is within the Brushiest and Pinto Creek grazing allotments. Both have approved allotment management plans, but the Brushiest allotment is currently ungrazed pending further feasibility analysis.

3.10.1.2 Wild and Scenic Rivers

Pinto Creek in the vicinity of the project area is an intermittent stream with short stretches of perennial flows over bedrock channel. However, approximately 5 miles downstream from the confluence of Pinto Creek and Haunted Canyon, Pinto Creek becomes perennial for approximately the next 8 to 9 miles (Lewis 1977). This segment of the stream was included in a study of rivers and streams potentially eligible for inclusion in the National Wild and Scenic Rivers System. The inventory was conducted by the six Arizona National Forests at the request of the Arizona Congressional delegation.

To be eligible for inclusion in the National Wild and Scenic Rivers System, a stream must be free flowing and must possess one or more outstandingly remarkable values. The values to be considered include scenic, recreational, geologic, fish, wildlife, historic, cultural, riparian, and ecological. If a stream is judged to be eligible, the second test and analysis on classification is carried out: determining the stream to be Wild, Scenic, or Recreational. To determine classification, the stream is analyzed using the impoundment test, the accessibility test, the primitiveness test, the development test, and the water pollution test. The final test for possible designation is suitability; this test has not been completed for Pinto Creek. Based on an informal preliminary analysis, the perennial segment of the stream was considered eligible based on "outstandingly remarkable" scenic, riparian, and ecological values, and was determined by the Forest Service to be potentially eligible for classification as Scenic. The Forest Service has made no proposal for designation of the stream segment, but will consider a proposal at the next revision of the *Tonto National Forest Plan*.

The segment of Pinto Creek that was studied for potential designation is approximately 5 miles downstream from the project area's northern boundary (*Figure 3-35*). The segment being considered is 8.8 miles long, 8.2 miles of which are on Tonto National Forest lands. The Forest Service currently has an instream flow water right permit for most of the eligible segment of the stream. This right ranges from 1.0 to 2.69 cfs depending upon the month, and has a priority date of 1983.

3.10.2 Environmental Consequences

Issues identified for wilderness and wild and scenic rivers included (1) possible effects on the Superstition and Sierra Ancha Wildernesses from changes in air quality, noise and light, visual qualities, social experience, and access; and (2) potential indirect impacts to the segment of Pinto Creek under consideration for Wild or Scenic river designation.

Evaluation criteria used to analyze impacts on these resources are listed below:

- Predicted changes in resources in the Superstition Wilderness compared to the Limits of Acceptable Change as identified in the Superstition Wilderness Plan
- Change in eligibility and classification status of the Pinto Creek segment as a Wild or Scenic river because of adverse changes in associated resources (e.g., water quality, riparian, biological, and scenic values)

3.10.2.1 Proposed Action

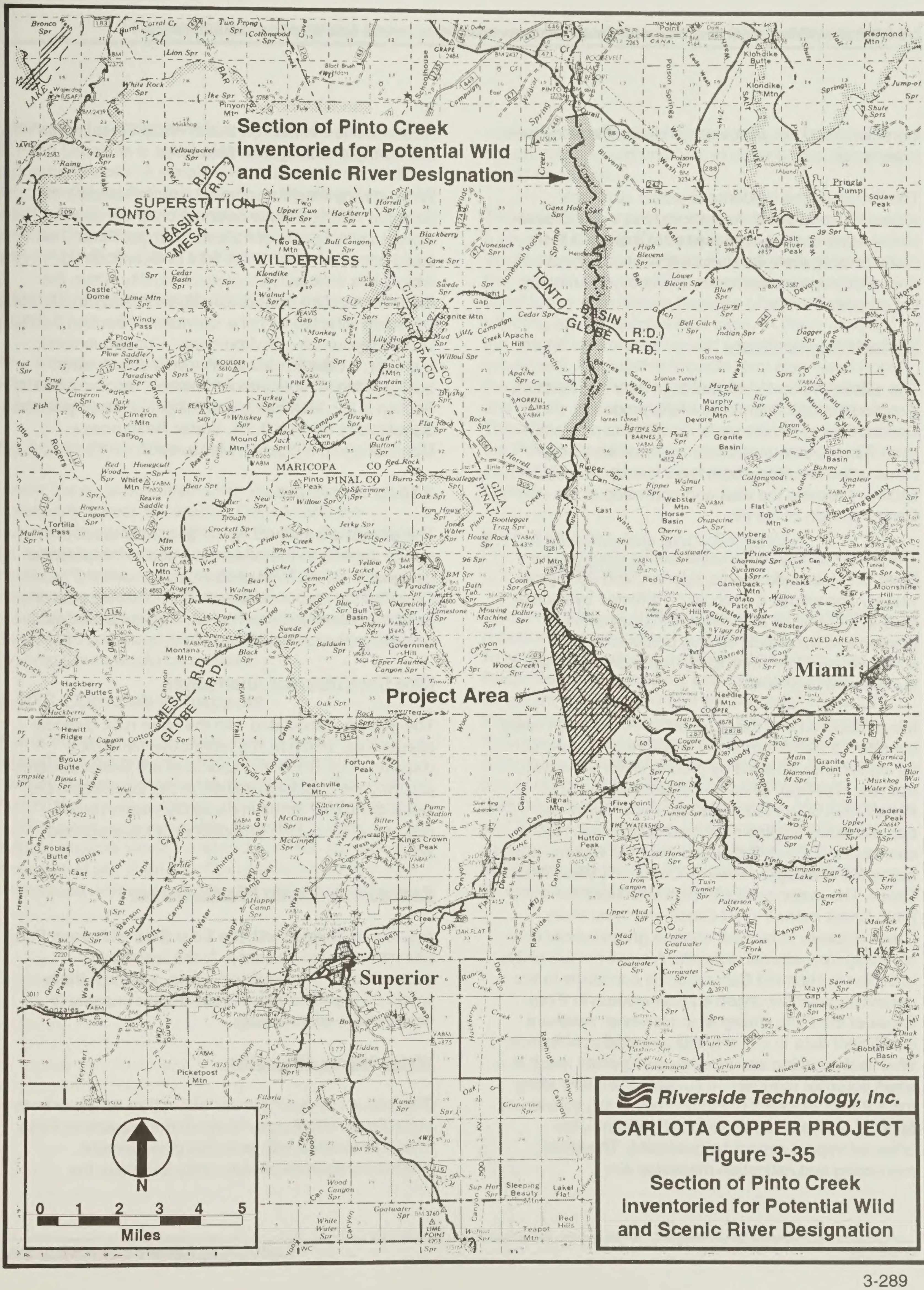
Wilderness

Impacts to a wilderness can rarely be quantified. In the case of the proposed Carlota Copper Project, there are a number of factors that could potentially affect the wilderness experience, even though the project is over 2 miles from the Superstition Wilderness boundary.

The potential impacts of a mining operation on wilderness activities include air quality, visual, noise, and access. Based on information contained in the Visual Resources, Noise, and Air Quality sections (Sections 3.11, 3.12, and 3.1, respectively), it appears that there would be some adverse impacts to the wilderness associated with the proposed project. See the respective sections for a discussion of these impacts.

The wilderness is also situated in proximity to the Pinto Valley Mine, which is adjacent to the proposed Carlota Copper Project. This mine exhibits extensive existing land disturbance, which is visible from the wilderness. The visual impacts from the proposed action, as discussed in Section 3.11, Visual Resources, would not change dramatically from the existing views from the wilderness. Designated Forest Service Trail 203 would remain open, but the segment outside of the wilderness would be used as a road for access to the well field; access to this trail would be limited. Horseback access along Powers Gulch would be cut off after operations begin on the Eder pits. As indicated in Section 3.12, Noise, noise emissions from the proposed project would result in noticeable adverse noise impacts at the eastern edge of the Superstition Wilderness.

Since the east side of the Superstition Wilderness does not receive as much recreational use as the west side, it is not anticipated that the increased population associated with the proposed project would affect the recreational opportunities in the wilderness. There would likely be an increase in use from the project-related population; however, the



CARLOTA COPPER PROJECT
Figure 3-35
Section of Pinto Creek Inventoried for Potential Wild and Scenic River Designation

increase would not adversely influence the wilderness experience.

The Sierra Ancha Wilderness would also likely experience additional recreational use and increased visitor days, but the increase is not expected to be detrimental to the wilderness experience. The Sierra Ancha Wilderness would not be directly affected by the proposed action.

Wild and Scenic Rivers

The existing Pinto Creek drainage runs in a northerly direction through the middle of the proposed Carlota/Cactus pit. Because the ultimate pit would span Pinto Creek, a diversion channel would be constructed to convey both flood waters and sediment around the east and north side of the Cactus portion of the pit.

The outstandingly remarkable values identified for Pinto Creek include scenic, riparian, and ecological values. The values that could be affected by fluctuations in streamflow include potential impacts to riparian and ecological values, particularly the cottonwood-willow community that is prevalent along the 8.8-mile segment.

It is anticipated that the segment of Pinto Creek being considered for Wild or Scenic designation would not be significantly affected by ground water withdrawal from the well field, since the relevant segment of Pinto Creek is located below the Pinto Valley weir approximately 5 miles north and downstream of the confluence of Pinto Creek and Haunted Canyon and below the drainages of Horrel Creek and West Pinto Creek. The major source of perennial baseflow in Pinto Creek below Horrel Creek and West Pinto Creek appears to be near-surface ground water flow surfacing from alluvial deposits. A small portion of the baseflow in Haunted Canyon could contribute to the perennial baseflow observed downstream in Pinto Creek at the Pinto Valley weir. However, there are insufficient data to quantify this potential contribution. Well field pumping and pit dewatering could result in a small potential reduction in surface water flow along the 8.8-mile segment of Pinto Creek being considered for Wild or Scenic designation; at this time, the potential impact cannot be quantified. Therefore, monitoring and mitigation measures are recommended in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

Water quality would also be a factor influencing the potential Wild or Scenic designation of the stream. If current water quality conditions change, Pinto Creek could become ineligible for Wild or Scenic designation. It is anticipated that water quality within the 8.8-mile segment of Pinto Creek would not be adversely affected by mine operations (Section 3.3.2, Water Resources - Environmental Consequences); however, a catastrophic event could affect water quality along this portion of the creek, as discussed in Section 3.3.2. Monitoring and mitigation strategies are discussed in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures.

3.10.2.2 Alternatives

The project alternatives would generally result in similar impacts to the wilderness and to the potential designation of the Wild or Scenic segment of Pinto Creek as the proposed action. The following sections describe potential differences in impacts associated with the project alternatives.

Mine Rock Disposal Alternatives

The impacts associated with the mine rock disposal alternatives, including the alternative mine rock disposal sites, additional backfill of the Carlota/Cactus pits, and the additional backfill of the Eder South pit, would be similar to the impacts discussed for the disposal and backfill components of the proposed action.

Eder Side-Hill Leach Pad Alternative

Impacts associated with the Eder Side-Hill Leach Pad alternative would be similar to the leach pad component of the proposed action, although there would be a greater risk of catastrophic impacts to downstream water quality.

Water Supply Alternative

The use of low-quality water from other mines or from remediation efforts may diminish the impacts to Pinto Creek associated with well field development. Alternative sources of water may decrease the likelihood of reduced baseflow and alluvial underflow in Pinto Creek as a result of ground water withdrawal. If adequate water is supplied from alternate sources, the potential for diminished flows in Haunted Canyon and Pinto Creek would be reduced; therefore, potential impacts to the potential Wild or Scenic segment of Pinto Creek would decrease.

Alternative Water Supply Well Field Access Roads

The impacts associated with Access Road Alternatives A and B would be similar to the access road component of the proposed action.

No Action Alternative

Under the no action alternative, the existing horseback access to Haunted Canyon and the Superstition Wilderness through Powers Gulch would be maintained. Impacts to the wilderness (visual, noise, air quality, and increased use) from mine development and operations would not occur. The potential for diminished streamflows and water quality degradation on the potential Wild or Scenic segment of Pinto Creek would be avoided.

3.10.3 Cumulative Impacts

The interrelated actions discussed in Section 1.6, Interrelated Actions, could potentially affect the wilderness experience in the Superstition Wilderness. Potential direct impacts would be associated with air quality, noise, and visual degradation. Potential indirect impacts would be associated with increased recreational use from an influx of new population. The interrelated actions could change existing wilderness recreational patterns. In some cases, recreational opportunities would improve; in other cases, they would be limited.

The cumulative impact on the potential designation of a segment of Pinto Creek as a Wild or Scenic river would be associated with an indirect recreation effect; that is, the future condition of some existing recreational areas will improve because of restrictions affecting future potential land uses. In these cases, the natural environment would be preserved for low-impact use. Cumulative impacts may also result from the Pinto Valley Mine's impacts to both the quantity and quality of water in the downstream segment. These impacts could result from activities such as at the Pinto Valley Mine ground water pumping and accidental contaminant discharges from project facilities.

3.10.4 Monitoring and Mitigation Measures

Recommended air quality monitoring and mitigation measures are addressed in Section 3.1.4, Air Resources - Monitoring and Mitigation Measures. Recommended monitoring and mitigation measures for potential streamflow and water quality impacts to Pinto Creek are presented in Section 3.3.4, Water Resources - Monitoring and Mitigation Measures. A recommended mitigation measure for the preservation of access to the Superstition Wilderness is presented in Section 3.9.4, Recreation - Monitoring and Mitigation Measures. Recommended mitigation measures for noise impacts to the Superstition Wilderness are identified in Section 3.12.4, Noise - Monitoring and Mitigation Measures.

3.11 Visual Resources

3.11.1 Affected Environment

The project area represents a visually diverse and interesting setting from the perspective of both natural and man-made features. Two well-defined north-south-trending drainages bisect the area. The larger of these is Pinto Creek, which is an intermittent stream throughout much of the project area, with areas of perennial flows downstream. The other major drainage is Powers Gulch, which lies to the west of Pinto Creek and is an intermittent stream throughout the project area. Each of these drainages contains a number of smaller, but often deep and well-defined, side drainages.

Haunted Canyon is perennial downstream of Powers Gulch and contains a riparian area with a dense vegetative canopy. The northern and eastern slopes of this drainage complex are generally heavily vegetated by a mixture of piñon-juniper and chaparral plant species. The relatively high plant diversity that occurs here is evident on close examination, but from a casual or distant perspective these slopes appear to be more uniform than they actually are.

Within the lower portions of the Pinto Creek drainage there is a well-developed and visually interesting riparian zone, which contains an overstory canopy of sycamore, ash, walnut, and other tree species. Many of the south- and west-facing slopes are less vegetated and, in some locations, are dominated by rock outcrops and boulder fields within a desert grassland community. In particular, the southern portion of the project area between the Pinto Creek and Powers Gulch drainages is characterized by very large, rounded granitic boulders and rock formations, with scattered juniper trees and typical chaparral and desert grassland species. In the northern portion of the project area near Grizzly Mountain, several prominent rock formations jut above the surrounding vegetated ridges and serve as visual focal points.

The most extensive and visually evident modification in the vicinity of the project area is the Pinto Valley Mine. This existing copper mine lies just to the east and north of the proposed project site, extending over an area of more than 3 miles from north to south. It includes a central open pit, various mine rock disposal areas and tailings impoundments, and support and processing facilities. This mine is the westernmost of a number of existing copper mines, which extend north and eastward past the communities of Miami and Globe (*Figure 1-2*). An existing steel-lattice 115-kv transmission line runs from east to west across the southern portion of the project area. The line loops in and out of the Pinto Valley Mine near the mine access road. A power line corridor containing the 500 kv transmission lines crosses the northern portion of the project area from east to west. Some four-wheel-drive recreation and mine exploration roads also traverse the area. Top-of-the-World, a small residential community, is located along U.S. Highway 60 southwest of the proposed project.

U.S. Highway 60 traverses to the south of the project area across the upper reaches of the Pinto Creek drainage just to the south of the Powers Gulch headwaters and through the rounded, granitic boulder formations that separate these two drainages at this point. This highway provides elevated views of portions of the project area to the north, particularly to portions of the Pinto Creek drainage and the existing Magma Pinto Valley Mine. Elevated views are also possible from near Top-of-the-World. Within a short walk of several residences within this community, an overview of Powers Gulch and lands to the north can be observed. The Magma Pinto Valley Mine Road provides access to both the Magma Pinto Valley Mine and to Forest Service managed lands beyond the mine to the north and west. Throughout the majority of its length, this road is in the proximity of various features and facilities associated with the existing Magma Pinto Valley Mine. This area is also visible from various back-country viewpoints within the Superstition Wilderness, the boundary of which lies approximately 3 miles to the west.

The Tonto National Forest has inventoried and classified the lands within the project area for visual resources at a planning level of detail. The management objectives that are described in the *Tonto National Forest Plan* (USDA Forest Service 1985) are designed to provide a general indication of landscape values and viewer sensitivity. The majority of lands within the project area has been designated as a Partial Retention visual quality objective. This objective essentially states that changes to the landscape should remain visually subordinate to the characteristic landscape. A portion of the project area in Powers Gulch, which is unseen from the identified sensitive viewpoints, has been classified as a Maximum Modification visual quality objective. This management designation states that with some qualifications, landscape modifications may dominate the characteristic landscape. An approximately 0.5-mile-wide corridor centered on U.S. Highway 60 and the Pinto Valley Mine access road (Forest Service Road 287) has been designated as a Retention visual quality objective. This objective states that landscape modifications should not be visually evident and may only repeat the form, line, color, and texture qualities that are frequently found in the characteristic landscape.

3.11.2 Environmental Consequences

Visual resource issues identified for the proposed Carlota Copper Project include (1) the impacts of open pits, mine rock disposal areas, leach pads, roads, and associated project facilities on the existing visual landscape to sensitive viewpoints, including U.S. Highway 60, the Superstition Wilderness, and Top-of-the-World; and (2) deterioration of the remoteness experience within the Superstition Wilderness and of the rural setting for Top-of-the-World residents because of project night lighting.

Evaluation criteria for the assessment of visual resource impacts include the following:

- Ability to meet the assigned Visual Quality Objectives (VQOs) that have been established for the project area
- Potential increase in night light spill and glare from the project area to the Superstition Wilderness and residents of Top-of-the-World

The ability to meet the assigned VQO levels has been deter-mined through a systematic process composed of the following steps:

- Identification of the nature and extent of physical modifications to the landscape anticipated from the proposed action and alternatives (specifically, how the landscape would be altered)
- Identification of important viewing conditions from the key observation points (KOPs) potentially affected by the project (i.e., distance, duration, screening, etc.)
- Identification of the context of the view from KOPs (character and condition of the surrounding landscape)
- Identification of visual contrast levels for each KOP (the degree of contrast created between the proposed project/alternatives and the surrounding landscape as seen from each KOP)
- Identification of visual contrast levels affected by the alternatives including the proposed action

3.11.2.1 Proposed Action

Based on computer-generated seen-area (visibility) plots, three KOPs were identified as being affected to some degree by views of the proposed Carlota Copper Project. These include relatively short and intermittent segments of U.S. Highway 60 in the vicinity of Pinto Creek, a ridge behind the community of Top-of-the-World, and scattered high points within the Superstition Wilderness. *Figures 3-36a, 3-37a,* and *3-38a* are photographs looking toward the Carlota mine area from these three viewpoints. The U.S. Highway 60 viewpoint photograph was taken from a small pullout approximately 0.75 mile west of the Pinto Creek crossing. The Top-of-the-World viewpoint photograph was taken from a slightly elevated ridge behind the residential area. No project elements would be visible from any of the residences at Top-of-the-World; however, there would be limited visibility from a commercial building. The Superstition Wilderness viewpoint photograph was taken from near Government Hill.

Figures 3-36b and *3-37b* are computer-generated photo simulations from the U.S. Highway 60 and near Top-of-the-World viewpoints that illustrate the height-of-mining stage of development. *Figure 3-38b* is the view from the Superstition Wilderness viewpoint with the computer-generated outline of the main mine features overlaid. *Figure 3-39a* illustrates the proposed project following reclamation from the view-point near Top-of-the-World.

Figure 3-36a. Existing Condition Photograph Looking Northwest from a Road Pullout Approximately Three-Quarters of a Mile West of the Pinto Creek Bridge

Figure 3-36b. Photosimulation of Proposed Carlota Copper Project Looking Northwest from Highway Pullout

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CARLOTA COPPER PROJECT
Figures 3-36 a&b
Views from
U.S. Highway 60 KOP

Figure 3-37a. Existing Condition Photograph Looking North from an Overlook North of the Top-of-the World Residential Area

Figure 3-37b. Photosimulation of Proposed Carlota Copper Project Looking North from an Overlook North of the Top-of-the-World Residential Area

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CARLOTA COPPER PROJECT
Figures 3-37 a&b
Views from the KOP near Top-of-the-World

Figure 3-38a. Existing Condition Photograph Looking Southwest from near Government Hill

Figure 3-38b. Photosimulation of Proposed Carlota Copper Project Looking Southwest from near Government Hill

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CARLOTA COPPER PROJECT
Figures 3-38 a&b
Views from the Superstition Wilderness KOP

Figure 3-39a. Photosimulation of Proposed Post-Mining Reclamation Conditions as Seen from KOP near Top-of-the-World

Figure 3-39b. Photosimulation of Post-Mining Heap-Leach Reclamation Alternative

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CARLOTA COPPER PROJECT
Figures 3-39 a&b
Views of Reclamation Alternatives from the KOP near Top-of-the-World

Table 3-84 illustrates the primary variables involved in determining impacts for the three KOPs. The proposed project would result in a strong degree of modification to the existing landform and vegetation patterns. Proposed structures would represent a lesser (moderate) contrast because of the large scale and complex nature of the existing landscape features. The remaining impact variables are unique to each viewpoint.

The U.S. Highway 60 viewpoint is over a mile from the nearest element of the proposed project. From this KOP, views are generally open to the Carlota/Cactus pit and the Main mine rock area; the Cactus Southwest mine rock area is mostly screened from view, and all other primary mine features are entirely screened from view, as shown in *Figure 3-36b*.

Because of the intermittent and short viewing opportunities, as well as the speed of highway traffic, the

Table 3-84. Visual Resource Impact Summary for the Proposed Action

Impact Variables	KOPs		
	U.S. Highway 60/70	Near Top-of-the-World	Superstition Wilderness
Physical Modification (at mine site):			
Landform	Strong form, line, color, and textural modifications to the landscape		
Vegetation	Strong form and color, moderate line and textural modifications to the landscape		
Structures	Moderate form, line, color, and textural modifications to the landscape		
Assigned VQO from Management Prescription			
Distance	1.1+ miles	0.8+ mile	3.6+ miles
Screening	Generally open views to Carlota/Cactus pit and Main mine rock area; Cactus Southwest mine rock area mostly screened; all other major features entirely screened	Generally open views to Eder pits and mine rock areas; partially screened to Cactus Southwest mine rock area, leach pad, and Main mine rock area; Carlota/Cactus pit entirely screened	All major project features partially screened, but generally open visibility
Duration	Very brief (seconds)	Moderate (minutes-hours)	Moderate (minutes-hours)
Overall Visibility Level	Low	High	Moderate
Context of View	Heavily influenced by existing Magma Pinto Valley Mine	Generally natural; portions of Magma Pinto Valley Mine visible in background	Heavily influenced by existing Magma Pinto Valley Mine in views to the east
Visual Contrast (physical conditions modified by viewing conditions and context)	Moderate (evident but not dominant)	High (dominant)	Low (visible but not evident—would appear as a continuation of existing disturbance)
VQO (visual management prescription)	Partial Retention	Primarily Maximum Modification with some Partial Retention	Partial Retention and Maximum Modification
Short-Term Impacts (during mining)	Moderate	Moderate-High	Low
Long-Term Impacts (post-reclamation	Revegetation efforts would soften the form, line, color, and texture modifications to some degree, but contrast levels would remain high overall, and impacts would remain near short-term levels.		

duration of view would be very brief. The overall level of visibility of the proposed project would therefore be low, as seen from this viewpoint. The context of these views is strongly influenced by the presence of the adjacent Pinto Valley Mine. Overall visual contrast, or the visible degree of landscape modification as influenced by viewing conditions, from this viewpoint would be moderate. This means that the proposed modifications would be evident, but not dominant. With a Partial Retention VQO, short-term visual impacts (during active mining) would be moderate (i.e., at, but not exceeding, the management guidelines).

The viewpoint near Top-of-the-World is approximately 0.8 mile from the nearest project element. Views are generally open to the Eder pits and mine rock area, and partially screened to the Cactus Southwest mine rock area, leach pad, and Main mine rock area. The Carlota/Cactus pit is entirely screened from view (*Figure 3-37b*). The duration of the visual impact would be moderate (i.e., a few minutes to an hour or more); the overall visibility would be high. The landscape in view is generally in a natural-appearing condition, with the exception of a portion of the background that is influenced by the existing Pinto Valley Mine. Visual contrast levels are high (the proposed project would appear as the dominating element in views from this viewpoint). VQO designations on project lands within view are primarily Maximum Modification with some Partial Retention, resulting in short-term impact levels of moderate and high, respectively (at Maximum Modification levels and exceeding Partial Retention levels).

The Superstition Wilderness viewpoint is beyond 3.5 miles from the nearest project features. All major project features are partially screened but generally visible (*Figure 3-38b*). Duration of view would be moderate (i.e., a few minutes to several hours). The overall visibility level would be moderate. The existing Pinto Valley Mine stretches for a long distance across the cone of vision in views to the southeast, strongly influencing the character of the landscape in view. Overall visual contrast is low; the proposed project would appear as an extension of the existing disturbance. The affected lands in view are designated as a combination of Partial Retention and Maximum Modification, which would result in low, short-term visual impacts.

The long-term (postreclamation) impacts from each of these viewpoints would remain essentially the same as those identified above. While revegetation efforts would soften the form, line, color, and texture modifications to some degree, overall contrast levels would not be substantially reduced, primarily because of the scale and extent of modifications proposed and the limitations on the amount of this disturbance that can be effectively reclaimed.

The Carlota Copper Project would cause an increase in night light and glare because of project night lighting for operational, security, and safety needs. Considering the existing night lighting from the adjacent Pinto Valley Mine, the degree of increased night glow would be minor. However, to address potential impacts to Superstition Wilderness users and Top-of-the-World residents, additional mitigation is recommended in Section 3.11.4 - Monitoring and Mitigation Measures.

3.11.2.2 Alternatives

<u>Mine Rock Disposal Alternatives</u>

Alternative Mine Rock Disposal Sites. The alternative sites would not be visible from the viewpoint near Top-of-the-World and would be minimally visible from the U.S. Highway 60 and Superstition Wilderness viewpoints. The reduction in the height of the Main mine rock area is expected to be visually insignificant as seen from any of these viewpoints. This alternative would be very similar to the proposed action.

Additional Backfill of the Carlota/Cactus Pit. The additional mine rock added to the Carlota/Cactus pit would be visible from the U.S. Highway 60 viewpoint, and to a lesser degree from the Superstition Wilderness viewpoint. The primary advantage from a visual resource perspective would be the reduction in the height of the Main mine rock area. This would be most evident in views from the viewpoint near Top-of-the-World, where the middle-ground ridgeline near Grizzly Peak would be eliminated from view under the proposed action. Under this alternative, the top of this middle-ground ridgeline would remain visible above the rock dump, defining the extent of the project. Despite this advantage, substantial portions of the project would remain highly visible, and impact levels would not be measurably reduced. *Figure 3-39b* illustrates the view of a modified reclamation alternative (see the discussion of the heap-leach reclamation alternative below) that includes aspects of the Carlota/Cactus pit backfill alternative, including the height reduction and reclamation of the Main mine rock area as it would appear from the Top-of-the-World viewpoint. This figure also includes reclamation of the heap-leach pad and the Eder pits and mine rock area, which are not part of the Carlota/Cactus pit backfill alternative.

Additional Backfill of the Eder South Pit. Additional backfill of the Eder South pit would be evident only from the viewpoint near Top-of-the-World. The primary benefit would be the removal of the Eder mine rock area. The removal of the mine rock disposal area would not only reduce the visible extent of the disturbed area, but it would also have the benefit of opening up views of the undisturbed background.

Figure 3-39b illustrates the view of a modified reclamation alternative (see the discussion of the heap-leach reclamation alternative below) that includes aspects of the Eder South pit backfill alternative, including the height reduction and reclamation of the Eder mine rock area as it would appear from the Top-of-the-World viewpoint. This figure also includes reclamation of the heap-leach pad and the Main mine rock area, which are not part of the Eder South pit backfill alternative.

<u>Eder Side-Hill Leach Pad Alternative</u>

The alternative leach pad configuration would not be visible from the U.S. Highway 60 viewpoint. It would be visible from the Superstition Wilderness viewpoint; however, at a distance of over 3.5 miles, the change in configuration would be similar to the visual contrast from the proposed action.

The differences in the heap-leach facility under this alternative would result in substantially greater visual contrast as seen from the viewpoint near Top-of-the-World. A portion of the heap-leach facility on the east side of Powers Gulch would be approximately 135 feet lower than the proposed heap-leach facility and would be smaller in area. However, the portion of the alternative heap-leach facility on the west side of Powers Gulch would be approximately 135 feet higher than the proposed Eder mine rock area. Therefore, there would be minor advantages and disadvantages to the relocated heap-leach facility from a visual contrast/scale perspective.

The greater visual contrast of this alternative would come from the relocated Eder mine rock area, which would be within 0.4 mile of the viewpoint near Top-of-the-World. The closest facility under the proposed action would be the Eder South pit at a distance of approximately 0.8 mile. The top elevation of the relocated Eder mine rock area would be 4,480 ft-amsl, which is 140 feet higher that the proposed Eder rock dump and 280 feet higher than the proposed heap-leach facility. The greater height and closer proximity of the Eder mine rock area under this alternative would result in a substantially greater scale of disturbance, both short- and long-term, as seen from this viewpoint. Visual impacts would be high.

<u>Water Supply Alternative</u>

The use of low-quality water from off-site sources would have visual effects similar to the proposed action. The size of the pipelines would be relatively small (8-inch diameter) and would follow the power line route through an area of existing and proposed mining disturbance. The degree of visual contrast would therefore be relatively low; in fact, it would not be visible from any of the three KOPs. Visual resource impacts would be minor from this alternative.

<u>Alternative Water Supply Well Field Access Roads</u>

Access Road Alternative A. This alternative would involve substantially less disturbance than the proposed access road because it would be located along an existing road in the bottom of the drainage rather than requiring new construction on the higher, steep side slopes. This area would not be visible from any of the three KOPs previously identified, but it would be highly visible to back-country recreationists who visit the lower Pinto Creek drainage. Therefore, this alternative would represent a substantial improvement over the proposed access road. Both visual contrast and visual impacts would be measurably reduced.

Access Road Alternative B. Except for a small portion near the confluence of Haunted Canyon and

Powers Gulch, this alternative would be in an area that is not visible from any commonly used viewpoints. The visual impacts would be low because the modifications to the landscape would essentially be unseen.

No Action Alternative

Under the no action alternative, the visual condition of the project area lands would remain nearly in their current condition, allowing for natural ecological change and other unforeseen future minor actions. Because views from U.S. Highway 60 and the Superstition Wilderness into the upper Pinto Creek drainage are already heavily influenced by the existing Pinto Valley Mine, this alternative would have measurable, but not overriding, advantages from a visual perspective. Powers Gulch, on the other hand, is less disturbed and substantially less influenced by the Pinto Valley Mine. This area, while visible from the Superstition Wilderness, is not seen as a distinct part of the overall project area. The primary advantage of the no action alternative, therefore, is the elimination of disturbance within the Powers Gulch area as seen from the viewpoint near Top-of-the-World. In this area, visual impacts would be reduced from moderate-high to none.

Reclamation Alternative

A separate reclamation alternative was evaluated as part of the visual resource analysis to determine if substantial benefits could be realized by implementing specific reclamation measures. The variations described here were analyzed only from a visual perspective.

Figure 3-39b illustrates the visual appearance of additional reclamation of specific components of the proposed action as seen from the viewpoint near Top-of-the-World. Under this reclamation scenario, all pits would be backfilled, resulting in reduced heights to the Main and Eder mine rock areas and the elimination of the Cactus Southwest mine rock area. The tops of the Main and Eder mine rock areas would be reclaimed as well as the top and southwest side of the proposed heap-leach pad. While these measures would noticeably improve the long-term visual contrast as seen from the viewpoint near Top-of-the-World and would improve, to some degree, the visual contrast of the mine and heap-leach areas as seen from the U.S. Highway 60 and Superstition Wilderness viewpoints, the scale of the overall disturbance is such that long-term visual impacts would remain.

3.11.3 Cumulative Impacts

Table 3-85 lists the actions that have been identified for consideration of visual resources. As the first column in this table indicates, a majority of these proposed projects represent either visually minor modifications or are of low contrast within the context of the surrounding landscape. Examples of these two conditions include the transmission line upgrade, which will involve only minor maintenance modifications that are visually insignificant, and the Cyprus Miami Mine, which will not be visually insignificant in its own right but will involve relatively minor modifications in light of the substantial disturbance that already exists in this location.

Table 3-85 also identifies some projects that are located a considerable distance from the proposed Carlota Copper Project. The memory people have about a particular area is in direct proportion to either the significance/familiarity of the place, the distinctiveness (good or bad) of the landscape features there, or the time that has passed since they visited the area. The second column of *Table 3-85* identifies projects that, because of considerations of distance (time) or distinctiveness, have little residual effect on judgment of the overall visual quality of the project area.

The Pinto Valley Mine represents a visually interrelated action. This project is of an actual or potential size/scale to be memorable within the travel time from this mine to the Carlota Copper site. The Pinto Valley Mine expansions are relatively minor in relation to the existing disturbed area. Nevertheless, they are close to the Carlota Copper Project and may have a cumulative interaction. The Gibson mine is a relatively small historic underground mine located on private land; as such, it is of interest to the few people who do see it.

Table 3-85. Summary of Visual Resource Impacts from Interrelated Actions

Proposals	Minor Actions[1]	Distant Actions	Visually Interrelated Actions
Mining Projects			
Old Carlota Mine	X		
Gibson Mine	X		
Copper Cities	X		
Miami Unit	X		
Cyprus Miami Mine			X
Pinto Valley Mine			X
Ray Mine		X	
Superior Underground Mine	X		
Placer Mining	X		
Copper Florence		X	
Energy and Transmission Projects	X		
Water Resource Projects			
Pinto Creek (w/s River)	X		
Coolidge Dam Project	X	X	
Roosevelt Dam Project		X	
Transportation Projects			
Highway 60/70 Improvements	X		
Highway 88 Improvements		X	
Private Land Development Projects (Commercial and Residential Development in the Globe-Miami Area)			X

[1]Visually minor actions, or actions that represent a relatively minor addition to an already altered landscape

Of more significance in determining the cumulative effect of this project on the visual character and quality of the region are the extensive, large-scale past and existing mining operations that exist within a few miles of the proposed project. With little exception, this activity visually dominates the landscape to the east from the existing Pinto Valley Mine, immediately adjacent to the proposed Carlota Copper Project, through the Miami-Globe area. Within this context, the proposed Carlota Copper Project represents only a relatively minor addition. Its greatest adverse impact from a cumulative visual perspective is that it expands the extent of large-scale mining activity by one drainage to the west.

3.11.4 Monitoring and Mitigation Measures

Through the course of this analysis various reclamation scenarios were simulated to assess their effectiveness. The reduction in the mine rock areas through backfilling the pits would have a noticeable positive influence. However, even these actions, as costly and intensive as they are, would not mitigate the overall adverse visual impacts associated with the proposed project. This is primarily because they would affect a relatively small portion of the overall disturbed area.

During active mining, little can be done to reduce the strong form and color contrasts without unduly interfering with mine operations. Measures to curtail dust are discussed in Section 3.1, Air Resources. Other possible options for reducing visual impacts during active mining include the following:

<u>VR-1</u>: Colors for buildings and field facilities would be selected to blend with the surroundings and to reduce reflectivity to the greatest degree possible.

Specifications would be submitted to the Forest Service for review.

VR-2: Permanent night-lighting would be shielded and directed downward to avoid night spill and glare. Mobile lighting would be positioned to minimize glare off of the property, consistent with safety considerations.

VR-3: Revegetation would be implemented where feasible to reduce the long-term (postmining) form and color contrasts that would be created by mining. Of greatest priority for revegetation are roads and the southern and western portions of mine rock areas and the heap-leach pad, which are most visible from the viewpoint near Top-of-the-World.

VR-4: Top portions of the Eder pits would be treated, particularly the south-facing slopes, to reduce the visual impacts of the open pit slopes if there is a large light or color contrast with the surrounding area. This would be accomplished using chemical darkening agents, rounding or warping benches, and/or rubblizing slopes. Final mitigation design would be approved prior to the Eder phase of mining.

3.12 Noise

3.12.1 Affected Environment

The principal issue associated with the noise analysis is the potential increase in sound levels above the levels that currently exist in the project vicinity, sometimes referred to as the ambient or background level (see *Table 3-86* for noise definitions). While increased sound levels are not inherently objectionable, sound becomes noise when it is unwanted or disagreeable. Noise presents a problem when it interferes with the performance or enjoyment of other activities.

Estimating the likelihood that the proposed Carlota Copper Project would cause adverse increases in noise levels requires that the character of the existing noise environment be established as a baseline for the analysis. Important features of the existing noise environment include the locations and types of noise-sensitive receptors, terrain features that would affect noise propagation from project-related activities, sources of existing noise near the project site, and existing ambient noise levels in the vicinity.

Certain human activities are commonly more susceptible than others to noise interference. Such activities or land uses, termed sensitive receptors, include residential areas, schools, hospitals, libraries, and certain outdoor gathering places, such as parks, particularly when they are primarily used for passive types of recreation. Two areas have been identified as potential noise-sensitive receptors in the vicinity of the proposed Carlota Copper Project: the Superstition Wilderness and the Top-of-the-World community.

The Superstition Wilderness contains 159,780 acres, stretching approximately 24 miles east to west and 16 miles north to south. The southeastern edge of the wilderness is approximately 2.5 miles west of the western site boundary of the project. The nearest proposed project facility, the Main mine rock disposal area, is approximately 2,500 feet farther inside the site boundary. Top-of-the-World is a small, unincorporated residential community containing approximately 200 homes and 500 to 600 people. The nearest residence is approximately 600 to 800 feet from the project site boundary and 4,200 feet south-southeast from the nearest proposed project facility, the Eder South pit.

Terrain can affect noise either as a barrier or as a reflector of sound energy. Terrain acts as a barrier when an earth mound breaks the line of sight between a noise source and a receptor. The degree of effect on noise propagation depends on several factors, but projective calculations typically focus on the height and continuity of the barrier. Generally, the higher the barrier projects into the line of site, the greater the noise reduction; a relatively long, continuous barrier is noticeably more effective than a broken barrier. The reflector effect typically occurs where a noise source is located between a raised topographic feature and a receptor. A reflector effect is generally more pronounced where the topographic incline is steep, hard surfaced, and smooth, such as a building or a flat-faced rock cliff.

Topography in the vicinity of the proposed Carlota Copper Project is extremely complex, dissecting the area into several named drainages with numerous minor tributaries. The primary ridge dividing the north-flowing Pinto Creek basin from the south-flowing Devil's Canyon basin crosses the study area in a generally east-west direction. The ridge runs northwesterly from Five Point Mountain, 1 mile south of the project site, crossing U.S. Highway 60 at the Gila/Pinal County line just east of Top-of-the-World. North of the highway, the ridge turns westerly, closely tracking the southern boundary of the project site. It continues to the west for several miles before twisting northwesterly into the Superstition Wilderness. The low point of the ridge is approximately 4,615 ft-amsl, where it is crossed by the highway. Northwest of the highway, the ridge varies from just over 4,600 ft-amsl to more than 5,400 ft-amsl. Several secondary ridges branch off the primary ridge. The proposed project site includes parts of the Powers Gulch and Pinto Creek drainages, straddling one of these secondary ridges. Another ridge forms part of the western boundary of the site.

The elevation of the project site varies from below 3,450 ft-amsl in the Powers Gulch and Pinto Creek drainage bottoms along the northern site boundary to over 5,000 ft-amsl in places along the southwesterly site boundary. Top-of-the-World is at approximately 4,600 ft-amsl. The southeastern boundary of the

Table 3-86. Noise Terminology and Symbols

Symbol	Term	Definition
dBA	A-weighting	The most commonly used frequency-weighting measure; simulates human sound perception and correlates well with human perception of the annoying aspects of noise.
	Ambient Noise	Total, all-encompassing noise associated with a given environment and time.
	Background Noise	Noise from all sources other than a particular sound of interest (e.g., other than mining noise if mining noise was being measured.
dB	Decibel	Unit of measure of sound pressure and sound power levels; expresses relative difference in power between two signals equal to 10 times the logarithm (base 10) of the ratio of the two levels. Because of the logarithmic scale, the noise level doubles with each increase of 10dB.
LEVELS		
CNEL	Community Noise Equivalent Level	L_{eq} for a 24-hour, midnight-to-midnight period with 5 dBA added to the sound levels from 7 p.m. to 10 p.m. and 10 dBA added to the sound levels between 10 p.m. and 7 a.m.
L_d	Day Average Sound Level	L_{eq} for the daytime period from 7 a.m. to 10 p.m.
L_{dn}	Day-Night Average Sound Level	L_{eq} for a 24-hour, midnight-to-midnight period with 10 dBA added to the sound levels from 10 p.m. to 7 a.m.
L_{eq}	Equivalent Continuous Sound Level	Level of steady state sound that, in a specific time period, has an equal amount of sound energy as the time-varying sound. The time period varies depending on the application; it is commonly a 24-hour day unless otherwise specified
L_{max}	Maximum Sound Level	The greatest sound level measured on a sound level meter during a designated time interval or event using fast time averaging on the meter.
L_n	Night Average Sound Level	L_{eq} for the nighttime period from midnight to 7 a.m. and from 10 p.m. to midnight.
L_{pk}	Peak Sound Level	Maximum instantaneous sound level during a specified time interval or event.
L_1	Percentile Level 1	Sound level exceeded 1 percent of the time during a given period. In other words, the sound level would be at or below the L_1 level for 59 minutes and 24 seconds per hour measured.
L_{10}	Percentile Level 10	Sound level exceeded 10 percent of the time during a given period; often represents a short-term noise associated with passing vehicles or airplanes flying over.
L_{50}	Percentile Level 50	Sound level exceeded 50 percent of the time during a given period; the median sound level.
L_{90}	Percentile Level 90	Sound level exceeded 90 percent of the time during a given period; sometimes used as an approximation for background noise.
	Noise	Unwanted sound; one that interferes with one's hearing of something; a sound that lacks agreeable musical quality or is noticeably unpleasant.

Superstition Wilderness ranges in elevation from 3,800 ft-amsl in Haunted Canyon to nearly 5,100 ft-amsl on several promontories.

Elevations in the interior of the Wilderness range from below 2,000 to 6,266 ft-amsl at Mound Mountain.

Existing noise sources near the proposed project are important because they influence existing noise levels and, consequently, may affect the likelihood that project-related noise would be audible at sensitive receptors. Noise sources in the vicinity of the proposed project include highway traffic on U.S. Highway 60, ongoing operations at the Pinto Valley Mine, frequent overflights by military jet-fighter aircraft, and natural noise sources, such as wind, birds, and insects.

A series of noise measurements was taken in the vicinity of the proposed Carlota Copper Project to provide a sense of existing noise levels. Measurement results illustrated in *Table 3-87*, and weather conditions illustrated in *Table 3-88* indicate that

Table 3-87. Ambient Noise Survey Data

Monitoring Location[1]	Date	Time[2]	Duration (minutes)	Sound Pressure Levels (dBA)				Notes
				L_{10}	L_{50}	L_{90}	L_{90}	
Superstition Wilderness								
Location A	12/16/92	15:00	20	31.5	27.5	26.0	29.1	Streamflow noise
Location B	12/16/92	12:38	2	28.0	18.5	18.5	26.3	Slight, sporadic breeze
	12/16/92	12:50	2	28.5	21.5	19.5	24.5	Slight, sporadic breeze
	12/16/92	13:12	2	22.0	18.5	18.5	20.4	Faint mine hum
	12/16/92	13:24	2	28.5	20.5	19.0	25.9	
	12/16/92	13:36	5	53.0	42.0	23.5	47.8	Two jet fighters[4]
	12/16/92	13:48	10	27.0	21.0	18.5	25.9	
	12/16/92	14:00	NA	[3]	[3]	[3]	18.2	Faint mine hum
	12/16/92	14:10	NA	[3]	[3]	[3]	26.2	Slight breeze
	12/16/92	14:20	NA	[3]	[3]	[3]	22.1	
Top-of-the-World								
Location C	12/16/92	17:15	20	51.5	47.0	42.5	49.6	Traffic, dogs, airplane
	12/16/92	22:45	15	43.0	36.0	20.5	39.1	Light traffic, dogs
Location D	12/16/92	18:35	20	45.5	37.5	27.0	45.5	Traffic, dogs
Location E	12/15/92	19:06	10	42.0	35.5	26.0	36.0	Light traffic, dogs
	12/15/92	23:55	15	36.5	28.0	22.5	32.2	Light traffic

[1] See *Figure 3-40.*
[2] Approximate time.
[3] Octave band measurements taken to characterize the sound frequencies represented in the ambient noise. A different measurement technique was used than for the other measurements in this table, so useable information on L_{10}, L_{50}, or L_{90} was not generated.
[4] L_{pk} = 73.1 dBA.

Table 3-88. Weather Conditions During Noise Survey

Date	Time[1]	Temperature (°F)	Wind Speed (mph) and Direction		Relative Humidity (%)
12/15/92	14:50	44	0-5	SW	25
	17:15	36	0-3	SW	29
	18:35	34	0	---	25
	19:06	34	0	---	19
	22:45	30	0	---	46
12/16/92	12:38	54	0-2	SE	25

[1] Mountain Standard Time

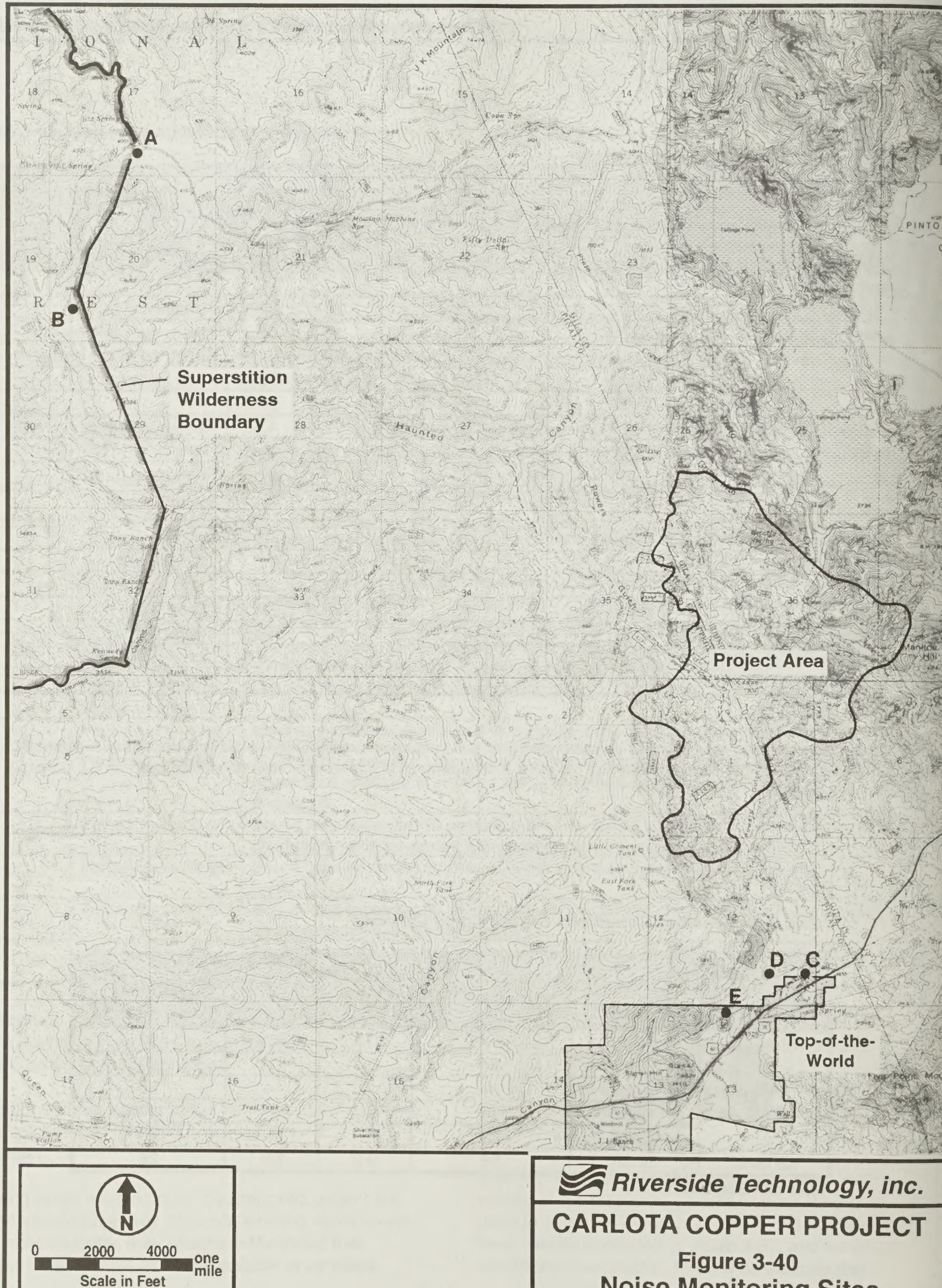

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Figure 3-40
Noise Monitoring Sites

existing noise levels in the area range from very quiet in the back country when the wind is calm to moderate near the Top-of-the-World community with some highway traffic present.

The noise measurements were taken at two locations in the Superstition Wilderness and at three locations in and near Top-of-the-World (see *Figure 3-40*). Wilderness monitoring locations were (A) near the trailhead of Forest Service Trail 203 and (B) on the ridge forming the eastern boundary of the Superstition Wilderness northeast of Government Hill. Top-of-the-World monitoring locations were (C) approximately 300 feet north of U.S. Highway 60 on the northern edge of Top-of-the-World, (D) approximately 0.5 mile north of Top-of-the-World on Forest Service Road 898, and (E) approximately 800 feet north of Top-of-the-World on the same road.

The average equivalent continuous sound level (L_{eq}) at the edge of the Superstition Wilderness without the aircraft noise or the stream noise was 24.6 dBA; L_{90} was 19.0 dBA. These readings are below most wilderness noise measurements cited in literature sources (EPA 1971a, NPS 1990). The low levels are likely attributable to the lack of wind at the time of the monitoring; wind is an important determinant of back country noise, as noted by Bommer and Bruce (1992), among others. The daytime L_{eq} measured at Top-of-the-World was 49.6 dBA. This level is approximately equivalent to typical measurements reported by the EPA (1971a) for suburban and small town neighborhoods.

Subjective observations from the field monitoring effort indicate existing noise levels in the Superstition Wilderness varied greatly with weather conditions, especially with wind speeds (*Table 3-88*). The measurements recorded at site B were taken with almost no air movement and no discernible animal or insect noise. Under those circumstances, operations at the Pinto Valley Mine were perceived as a very low-level hum. Even the slightest breeze through grasses, shrubs, and trees raised sound pressure levels by 3 to 6 dBA, completely obliterating any perception of the Pinto Valley Mine noise. Measurements taken at site A, approximately 50 yards from the stream, were dominated by water noise such that only high-level external sources, like aircraft overflights or strong breezes, would be perceptible above the background levels.

Noise at the Top-of-the-World site was dominated by traffic noise from U.S. Highway 60. This was not surprising since traffic noise is almost invariably the dominant noise source affecting existing ambient noise levels near a major highway or street. It held true even with light traffic in the early evening and late at night, suggesting that other sources contributed very little to the overall background noise.

Traffic flow data from the ADOT and methodology documented in *Noise Assessment Guidelines* (U.S. Department of Housing and Urban Development 1984) were used to check the field measurement data for representativeness. Similarly, for existing noise levels in the Superstition Wilderness, measured noise levels were compared with EPA (1971a) data based on land use and density and with other file data and literature sources. Again, the comparison was made to check the short-term measurement data for representativeness of the ambient condition. Based on these comparisons, the noise measurements are considered representative of ambient conditions in similar environments.

3.12.2 Environmental Consequences

The noise issues associated with the proposed Carlota Copper Project include adverse noise impacts to (1) residents of Top-of-the-World and (2) recreational users of Forest Service lands, specifically the Superstition Wilderness.

Noise impacts are commonly judged according to two general criteria: the extent to which a project would exceed federal, state, or local noise regulations, and the estimated degree of disturbance to people or wildlife. For the Carlota Copper Project site, there are no specific governing noise regulations. Consequently, the degree of disturbance becomes the key factor in evaluating noise effects. In this case, the sensitivity considerations are focused on residents of Top-of-the-World and on the Superstition Wilderness. Specific evaluation criteria are (1) the degree of project-related increase in average sound levels (L_{eq}) in the Superstition Wilderness relative to an L_{90} reference level and (2) project-related changes in noise levels at Top-of-the-World relative to the U.S. Department of Housing and Urban Development acceptable noise standard of 65 dBA (L_{dn}) in residential areas. These criteria comprise a quantifiable method to evaluate the concept of human disturbance, which is known to vary with a number of interrelated factors, including the change in noise level; the presence of other, non-project-related noise sources in the vicinity; people's attitudes toward the project; the number of people exposed; and the type of human activity affected (e.g., sleep or quiet conversation as compared to physical work or active recreation).

In preparing the analysis, guidance was taken from *Guidelines for Preparing Environmental Impact Statements on Noise* (CHABA 1977). Noise impacts were projected using NOISECALC, a sound propagation model developed for analyzing large-scale industrial-type development projects. NOISECALC provides for evaluation of atmospheric attenuation, barrier attenuation, source directionality, and path-specific or non-path-specific excess attenuation at the analyst's discretion. NOISECALC employs noise analysis methodology adopted by American National Standards Institute (ANSI).

3.12.2.1 Proposed Action

Major sources of noise from the Carlota Copper Project would include crushing ore, drilling rock, blasting, loading trucks hauling rock and ore, and handling and distributing crushed ore. The types and numbers of equipment planned for use are listed in *Table 3-89*.

Total noise emissions were estimated for the anticipated activities based on the equipment roster in *Table 3-89* using noise emission factors obtained from EPA data (EPA 1971b), from file data, and from field measurements of other mining projects with similar characteristics. Because the distances from project activities to sensitive receptors would be large relative to the distances between operating equipment involved, noise sources were grouped for analysis purposes into four noise emission centroids, or major composite noise sources, representing the major activity areas (See *Figure 3-41)*. The four centroids are (A) the Carlota/Cactus pit, Main mine rock area, and primary and secondary crushers; (B) the Eder South pit and mine rock area; (C) the Eder North pit and mine rock area; and (D) the leach pad. Two high-activity time periods were analyzed: Years 8 and 14. Year 8 represents maximum activity in the Carlota/Cactus pit with the largest number of trucks running and the highest activity level on the Main mine rock disposal area. Year 14 represents the maximum activity level in the Eder pits area.

The projected noise levels were estimated with all equipment operating simultaneously and no barriers intervening in the line of sight between the equipment and the listener. These are considered to be very conservative conditions because, in the actual operating conditions of a mine, equipment use varies in time and location. As development of a mine proceeds, pit activities recede progressively deeper into the earth such that the pit wall becomes a higher and higher barrier, blocking transmission of an increasing percentage of the noise generated. Similarly, as rock dumps increase in size they become progressively larger above ground barriers to noise transmission. Also, mine trucks and other vehicles move about through the varying terrain of a mine site, sometimes moving behind natural or man-made barriers, sometimes stopping and idling or shutting off their engines, and sometimes moving down grade with engines throttled back. Stationary equipment, such as crushers and conveyors, may operate steadily throughout a day, but they may also be shut down for fairly long periods of time. The noise emissions thus vary dramatically as mine activities ebb and flow. It is not feasible or even possible to model all of the variations. Consequently, a high level of activity was modeled under the assumption that resultant project-related noise levels would rarely, if ever, exceed the estimated levels.

It should also be noted that the sensitive receptor locations identified for the Superstition Wilderness are on the very easterly edge of the area on topographic high ground. Designated trails nearest these receptor points receive relatively light use, estimated at less than 1 percent of trail use in the Wilderness (USDA Forest Service 1986). The farther into the interior of the Wilderness one would go, the lower the project-related noise levels would be. Also, noise levels in valleys below the ridge tops would be lower than those presented because the ridges act as barriers to noise, providing increasingly greater noise sheltering the farther one is below the ridge top.

Table 3-89. Carlota Copper Project Equipment Roster

Typical Sound Levels (dBA) for Mine and Plant Equipment				
Equipment Type	No. Units Operating	Operating Schedule (7 days/week)	dBA	Distance from Receptor (feet)
Blasthole Drill (type 75,000-lb pulldown)	2	3 shifts/day	75	50
Hydraulic Shovel (typ 13-16 cu yd)	3	3 shifts/day	85	50
Road Grader	2	3 shifts/day, 50% utilization	82	50
Track Dozer	2	3 shifts/day, 50% utilization	82	50
Rubber-Tire Dozer	1	3 shifts/day, 75% utilization	81	50
Leach Pad Dozer	1	2 shifts/day, 50% utilization	82	50
Front-End Loader (backup and stockpile) (typ 13.5 cu yd)	1	1 shift/day avg	85	50
Haul Truck (typ 90-120 ton)[1]	16	3 shifts/day	77-80	50
Haul Truck on Leach Pad (typ 90 ton)	2	2 shifts/day	70-75	50
Water Truck (typ 50 ton)	2	2 shifts/day	70-75	50
Crushers, Chutes, Feeders, Screens, etc.		3 shifts/day	90-105	50
Primary Blasting	—	1 blast/day	70-120	1,000

[1] If 150-ton haul trucks would be used, the additional noise would be negligible as truck noise levels in the analysis are well below emission levels for crushers, dozers, etc., which are the dominating noise sources.

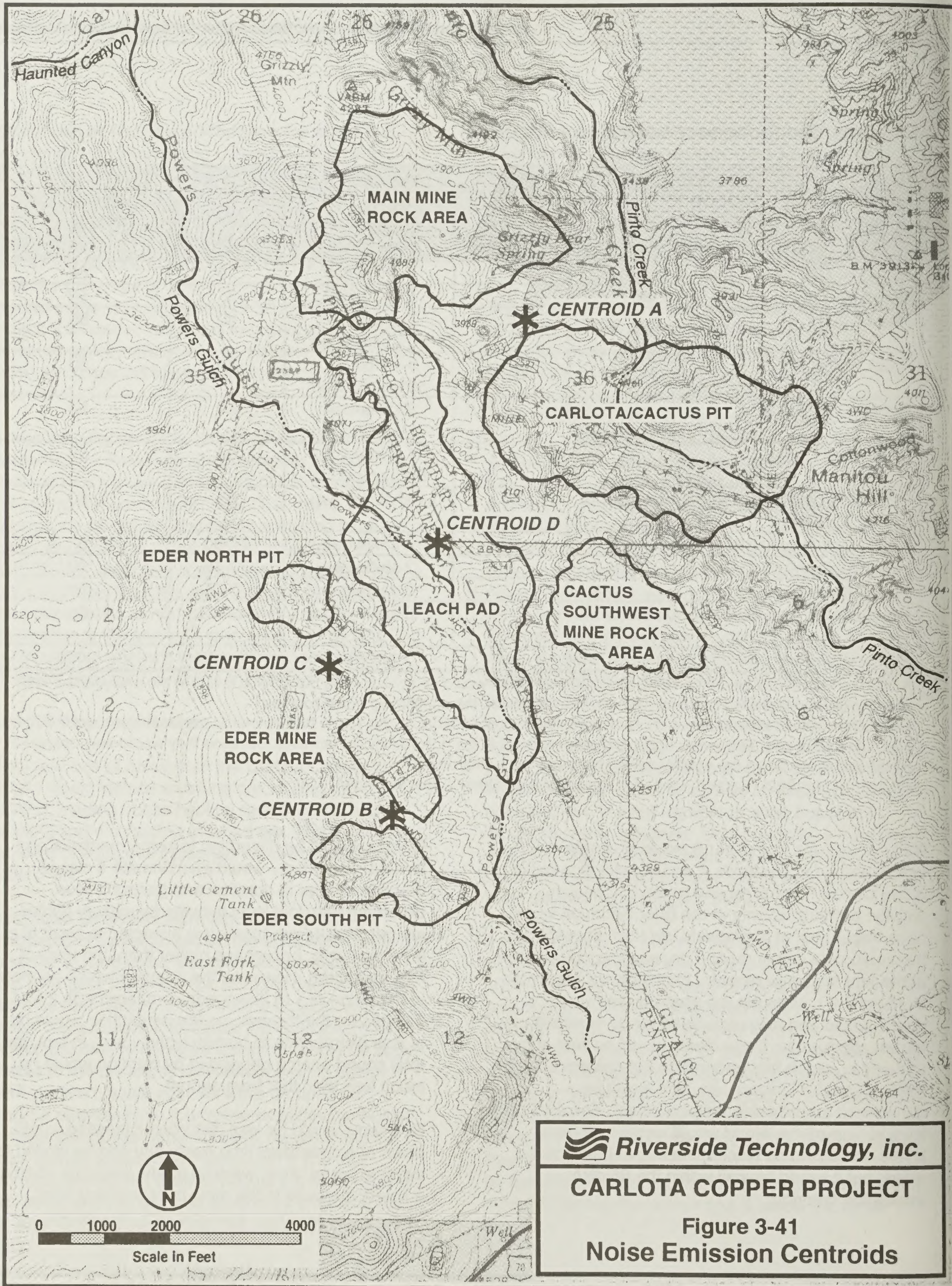
Note: There would also be two diesel powered, back-up generators on the site, a 350-hp unit at the leach pad, and a 600-hp unit at the plant site. They were not specifically included in the noise analysis, however, because they would only operate in upset conditions when the notably noisier crushers were shut down.

Source: BLM (1992) (Section 4.9.1 - Equipment Manufacturer's Specifications)

Noise emissions from Year 8 would emanate mainly from activities at centroids A and D, reflecting mining at the Carlota/Cactus pit and related processing activity; pre-strip activity at the Eder South pit would have begun, but at a relatively low level according to the equipment assignment. The resulting noise levels at the four sensitive receptor locations are presented in *Table 3-90*. Although the analysis was very conservative and fully accounted for pit noise with no barrier attenuation, these levels would be well above ambient L_{90} at the high ground on the eastern edge of the Superstition Wilderness. This would be considered a noticeable adverse effect. The 49.5 dBA level at Top-of-the-World would exceed ambient levels and would be discernible above background noise, but it would be well within the 65 dBA evaluation criterion.

Blasting would be disturbing to some residents and visitors. The effects would approximate a clap of thunder, shorter in duration and generally less disturbing than low-level flyovers by military fighter aircraft. Noise from blasting is expected to peak at a level similar to, or perhaps higher than, the level of military aircraft. However, the duration would be more in the range of 1 to 2 seconds compared with 2 to 4 minutes for the flyovers, so the perception would be of less disturbance to human activity and, in fact, the total sound energy generated by blasting would be much less than that from aircraft.

Residents would be less disturbed if blasting would occur at a consistent time every day and be limited to daytime hours. Also, warning sirens would be used as a safety measure in the mine prior to every blast.



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CARLOTA COPPER PROJECT

Figure 3-41
Noise Emission Centroids

Table 3-90. Project-Generated Noise Levels at Sensitive Receptors - Year 8

Receptor	Significance Threshold[1]	Noise Level (dBA)	
		Estimated L_{eq}	L_{dn}
Superstition Wilderness Valley	26 dBA[2]	43.2	49.6
Superstition Wilderness Ridge	19 dBA[3]	43.4	49.8
Tony Ranch Ridge	19 dBA[3]	45.2	51.6
Top-of-the-World	65 dBA[4]	49.5	55.9

[1]See Section 3.12.2, Noise - Environmental Consequences, above.
[2]Threshold based on L_{90} reference level measured at location A (see *Table 3-87* and *Figure 3-40*).
[3]Threshold based on L_{90} reference level measured at location B (see *Table 3-87* and *Figure 3-40*).
[4]Source: HUD 1984

The same sirens, occurring at a consistent time each day, would notify nearby residents of an impending blast and would thus further reduce the startle factor of blasting noise. If properly managed, the effects are so brief that they would not be considered a major adverse impact. Mitigation measures presented in Section 3.12.4 would constrain the noise effects of blasting to a reasonable level at residences in Top-of-the-World. (See Section 3.12-4, Noise, Monitoring and Mitigation Measures, for specific mitigation requirements.)

Blasting noise and some equipment noise would decrease somewhat over time because, as the depth of the pit increases, the pit walls would function as a noise barrier.

Noise emissions from the project would vary over time. The variation could occur in the course of a single day, and would certainly occur over weeks and months in the life of the project as activities shift from place to place on the site and as various types of equipment are turned on or off to support the current activities. The noise impact levels noted in *Tables 3-90* and *3-91* are considered to be very conservative. Variations in the noise levels would be of a lower magnitude in any reasonably foreseeable set of circumstances during operation of the proposed project.

Activity in Year 14 would be almost entirely shifted to the Eder South and North pits, centroids B and C, still including the leach pad, centroid D. Noise level effects of Year 14 activities at the four sensitive receptor locations are presented in *Table 3-91*. As they were for Year 8, noise levels at Year 14 are projected to exceed the stringent evaluation criterion at the edge of the Superstition Wilderness, but not the less stringent standard in Top-of-the-World.

To add perspective to the noise effects presented in Tables 3-90 and 3-91, the conservative estimated L_{eq} levels at the edge of the Superstition Wilderness, ranging from 43 dBA to 45 dBA in Year 8 and 45 dBA to 47 dBA in Year 14, are in the range variously described as "quiet suburban residential" to "normal suburban residential" (EPA 1971b) or as "quiet residential" (Beranek 1971). The Year 8 estimated level in Top-of-the-World falls between "quiet residential" and "average residential" while the Year 14 level coincides with "average residential" (Beranek 1971).

3.12.2.2 Alternatives

<u>Mine Rock Disposal Alternatives</u>

Alternative Mine Rock Disposal Sites. The alternative mine rock disposal sites would reduce the adverse noise effects by moving a portion of the mine rock disposal activity farther from the Superstition Wilderness into a location with better screening from Top-of-the-World. The noise advantages would be modest, however, because high activity mining, crushing, ore transport, and leach pad areas would not be moved from their proposed locations.

Additional Backfill of the Carlota/Cactus Pit. This alternative would generate more overall noise over the life of the project because of the additional

Table 3-91. Project-Generated Noise Levels at Sensitive Receptors - Year 14

Receptor	Significance Threshold[1]	Noise Level (dBA)	
		Estimated L_{eq}	L_{dn}
Superstition Wilderness Valley	26 dBA[2]	44.8	51.2
Superstition Wilderness Ridge	19 dBA[3]	45.1	51.5
Tony Ranch Ridge	19 dBA[3]	47.3	53.7
Top-of-the-World	65 dBA[4]	55.0	61.4

[1]See Section 3.12.2, Noise - Environmental Consequences, above.
[2]Threshold based on L_{90} reference level measured at location A (see *Table 3-87* and *Figure 3-40*).
[3]Threshold based on L_{90} reference level measured at location B (see *Table 3-87* and *Figure 3-40*).
[4]Source: HUD 1984

material handled and transported. It would be unlikely to greatly raise the maximum noise levels currently projected because a portion of the hauling and grading activity would take place within the mine, where the pit would effectively screen some of the noise from reaching sensitive receptors.

Additional Backfill of the Eder South Pit. The Eder South pit backfill alternative would have similar effects on noise as those described above; however, the noise would occur much closer to Top-of-the-World. Higher noise levels at the Eder South pit would increase the noise effects at Top-of-the-World, although the threshold would not be exceeded.

<u>Eder Side-Hill Leach Pad Alternative</u>

From a noise perspective, the Eder side-hill leach pad alternative would be impossible to distinguish from the proposed project leach pad location. The general locations are very similar, and the activity levels would be similar such that at a distance of more than a mile at the nearest receptor, no noise difference would be apparent.

<u>Water Supply Alternative</u>

The use of the low-quality water from off-site sources would have minimal effects on noise levels in the project vicinity. Noise emissions would result from constructing this alternative, but the magnitude would be small and short-term in duration, ending with construction.

<u>Alternative Water Supply Well Field Access Roads</u>

The construction and use of the two alternative well field access roads would result in minor effects on noise levels in the project vicinity. The noise levels associated with these alternatives would be considered relatively small and would be similar to the access road component of the proposed action.

<u>No Action Alternative</u>

The no action alternative would effectively continue noise levels as they currently exist.

3.12.3 Cumulative Impacts

Past and present actions that may interact with the proposed Carlota Copper Project from a noise standpoint are already included by virtue of the field measurement and evaluation of existing ambient noise in the project vicinity. Most of the mining projects cited fall into this category, although only a few within close proximity are likely to generate noise that can be heard in the noiseshed of the project site. It appears, from the information available, that major adverse cumulative noise effects are unlikely.

Grazing management changes would have no substantive, cumulative effects on noise in the project vicinity.

The proposed transmission line upgrade would have no substantive cumulative effects on noise near the proposed Carlota Copper Project, nor would any of the water resources projects. The Pinto Creek Wild/Scenic River designation, should it occur, would produce minimal, if any, additional noise. The dam projects are far too distant to be interactive. Proposed highway improvements near the project site would produce construction noise levels that could impact Top-of-the-World; however, the effects would be transient, limited to the short duration of the highway construction, and likely limited to daylight hours.

Although the designated military training route over the project area was deleted in the Department of Defense's Flight Information Publication AP-1B following the closure of Williams Air Force Base, another route is immediately to the north of the project area, and low-level military flyovers are likely to occur in the future.

Potential additional development at Top-of-the-World would be the only private land development near enough to generate interactive noise effects. Construction may generate some objectionable noise; however, the typically short time span of the activity would not be likely to produce major adverse effects.

3.12.4 Monitoring and Mitigation Measures

Mitigation potential for major adverse mining noise effects is somewhat limited by the nature of ore body locations and the scale of operations involved. Nevertheless, certain measures listed below can be implemented to minimize adverse effects.

N-1: All equipment would use state-of-the-art mufflers and would be maintained in good operating condition at all times.

N-2: A blasting schedule would be implemented that would avoid nighttime hours and would establish a consistent time of blasting.

N-3: The Forest Service would review final stationary facility (e.g., crushers and screens) design for noise considerations (for example, mitigation of noise impacts to the Superstition Wilderness and Top-of-the-World would be considered as part of facility sitings, or berm construction would be required if predicted levels of noise generation could not be met).

N-4: Occasional monitoring would be conducted to verify the model and determine operational noise. This monitoring would consist of monitoring for 1 day annually (selected randomly) until a reasonable level of model verification was obtained for the Superstition Wilderness and at Top-of-the-World.

N-5: Carlota would submit changes in equipment types or size to the Forest Service together with the manufacturer's noise specifications. The Forest Service would determine whether additional modeling or mitigation would be required to address noise impacts.

3.13 Transportation

3.13.1 Affected Environment

3.13.1.1 Highways and Roads

The proposed project area is served by a somewhat sparse network of roadways, typical of much of rural Arizona. Interstate 10 (I-10) is the primary east-west traffic artery across southern Arizona, connecting the region with Las Cruces, New Mexico, and El Paso, Texas, to the east and the Los Angeles basin to the west. I-10 passes approximately 65 road miles west of the project site at its nearest point and runs through both Phoenix, 65 miles west of the site, and Tucson, 80 miles to the south. I-8 originates near Casa Grande, halfway between Phoenix and Tucson, connecting I-10 west with San Diego. Major north-south routes are I-17 north from Phoenix and I-19 south from Tucson.

U.S. Highway 60 forms the southeast boundary of the project site and provides the primary access route connecting the site with Phoenix to the west and the Miami-Globe area to the east. U.S. Highway 60 continues northeast from Globe providing access to northern New Mexico. U.S. Highway 70 runs south-east from Globe providing access to southern New Mexico. Arizona State Routes 88 and 77 provide access to the northwest and south, respectively, from the Miami-Globe area. County and Forest Service roads serve as collector roads for the major state and federal routes.

Access to the project site is proposed to come from the existing Forest Service Road 287, a paved road running north from U.S. Highway 60 to the Pinto Valley Mine operation. The road is maintained by BHP Copper Company. An existing dirt road would be improved to provide access from the Forest Service road to Carlota Copper Project facilities.

U.S. and state highways in the project vicinity are typically paved, all weather, two-way rural highways with 11- to 12-foot-wide travel lanes in generally good condition. U.S. Highway 60 in the immediate project vicinity has a third lane. At the intersection with the Pinto Valley Mine Road, the third lane is reserved for left turns. Farther west, where U.S. Highway 60 abuts the project site, the third lane is a passing lane.

Shoulders on U.S. Highway 60 are typically paved for 2 feet beyond the delineated lanes and graded but unpaved for 3 to 6 feet beyond the pavement; however, this width varies with terrain. Immediately west of the Pinto Valley Mine Road, shoulders are only 2 feet wide, stopped on the south side by a rock face and on the north side by a guard rail protecting a drop-off. The north shoulder is approximately 3 feet wide adjacent to the project site, stopped again by a rock outcrop.

Forest Service and county roads are more varied in quality and condition than state and federal highways. They range from very rough jeep tracks to well maintained, graded roads with full two-lane cross sections to paved, striped highways. Back country roads follow terrain rather than survey lines and are virtually all indigenous dirt and rock with no imported surface material applied.

The Pinto Valley Mine Road, designated Road 287 on Forest Service maps, is paved from U.S. Highway 60 to the Pinto Valley Mine entrance gate, with the pavement generally wider than 24 feet. Pinto Valley Mine Road widens near its intersection with U.S. Highway 60, spreading from approximately 35 feet at the cattle guard to well over 100 feet at the edge of U.S. Highway 60 pavement. This widened road neck accommodates a relatively high-speed, right-turn movement from westbound U.S. Highway 60 northbound on the road. It also has two lanes southbound to separate left-turning traffic from right-turning traffic. Another road, Forest Service 349, extends south from the U.S. Highway 60 intersection, but it receives very little traffic.

Forest Service Road 287 continues northwesterly from the mine gate, through and among Pinto Valley Mine facilities, to Pinto Creek. This segment of the road is dirt and gravel surfaced in generally good to excellent condition, although in a few places it can become slick with clay mud in wet weather. West of Pinto Creek, Forest Service Road 287 continues northerly. Forest Service Road 287A branches off to the west for 4 to 5 miles, ending at Miles Ranch on the boundary of the Superstition Wilderness. Forest Service Road 287A provides access to the Superstition Wilderness via several trailheads. The road is in generally fair to good condition, although it is surfaced entirely with native materials.

Traffic count data for project area highways indicate diverse patterns of change in traffic flows. This suggests the variations result from localized conditions rather than any identifiable, area-wide trend. Counts for U.S. Highway 60 in the project vicinity indicate only moderate variation in recent years. Traffic volumes increased 6 percent from 5,100 vehicles per day in 1989 to 5,400 in 1990, but then declined 11 percent to 4,800 in 1991. In addition, the volume of traffic on Highway 60 has probably decreased somewhat with the shut-down of this Superior Mine in 1996. Although this pattern was not unique to U.S. Highway 60, there was no discernible pattern that was typical of traffic variations on highways in the project area.

Current traffic volumes are at or below capacity on all major highways in the project area (*Table 3-92*). U.S. Highway 60 is operating at a C level of service (LOS) in the vicinity of the project site, indicating traffic flows are stable with some restrictions on drivers' choice of speed, lane changing, and passing. This is an acceptable LOS, often used as an appropriate design criterion. U.S. Highway 70, east of Globe, and State Highway 88, north of Miami, are operating at LOS E, indicating traffic volumes on those roadway segments are reaching capacity in peak periods.

Streets in the communities of Miami and Globe generally have sufficient capacity to accommodate current traffic with no major trouble spots. Traffic volumes are highest during shift changes at area mines, but traffic continues to flow at acceptable levels (Stratton 1993).

3.13.1.2 Commercial Transportation

Local public transportation is generally not available in the Miami-Globe area. Interstate bus service is provided by Greyhound Bus Lines eastbound and westbound through Globe. The Globe-San Carlos Regional Airport, located east of town, is a general aviation field with a lighted 4,750-foot runway. The nearest scheduled commercial air service is 70 miles away in Phoenix. Both Superior and Globe-San Carlos have limited service and fixed base operators; charter service is available. The Arizona Eastern Railroad provides freight rail service to the area.

Table 3-92. 1991 Major Highway Traffic Volumes in the Carlota Copper Project Area

Highway Segment	AADT[1]	Peak Hour[2]	V/C Ratio[3]	LOS[4]
U.S. Highway 60				
AZ 177 to Bluebird	4,800	576	0.30	C
Northeast of U.S. Highway 70 Junction	3,200	384	0.20	C
U.S. Highway 70				
East of U.S. Highway 60 Junction	3,500	1,140	0.66	E
West of AZ 77 Junction	5,000	600	0.32	C
East of AZ 77 Junction	3,500	420	0.22	C
AZ 77				
South of U.S. Highway 60 Junction	1,000	120	0.06	A
AZ 88				
North of U.S. Highway 60 Junction	8,500	1,020	0.54	E
AZ 177				
South of U.S. Highway 60 Junction	2,600	312	0.16	B

[1]AADT - Annual Average Daily Traffic
[2]Estimated at 12 percent of AADT
[3]V/C - Volume/Capacity Ratio
[4]LOS (Transportation Research Board 1985)

3.13.2 Environmental Consequences

Transportation issues associated with the Carlota Copper Project include (A) impacts to traffic flow and safety on U.S. Highway 60 and (B) impacts on existing roads and trails within the project area. Transportation effects were evaluated relative to four criteria: (A-1) increase in Average Daily Traffic (ADT) count on access routes; (A-2) compliance with applicable LOS criteria, (A-3) protection of safety conditions for the traveling public, and (B-1) number of miles of roads and trails on the Resource Access Travel Management Plan (USDA Forest Service 1990a) removed from public access.

In the Carlota Copper Project context, the relevant LOS standard is the ADOT criterion of LOS C for peak periods. At LOS C, traffic flows are in the stable range, but most drivers are becoming restricted in their freedom to select speed, change lanes, or pass. Intersection capacity is often a potentially key limiting factor in traffic analysis. This is certainly the case for the project site, as U.S. Highway 60 is the only major artery funneling traffic to the site from all origins, and there would be only one intersection access point connecting the proposed project to the highway. The LOS approach was also used to evaluate intersection operations, though it is commonly applied separately to individual traffic movements through the intersection, rather than to total intersection capacity and LOS, because service levels of different movements in a single intersection can vary dramatically from one another.

Safety is a less well defined concept as a significance criterion. Many different factors affect highway safety, including sight distances, road conditions, roadway geometry, and even weather conditions. Particular factors of interest are those that might be modified by developing a mining project, such as the mix of different types of vehicles in the traffic stream, the availability of gaps in the dominant traffic flow to accommodate traffic entering the highway from a side road, and the introduction of unusually large numbers of oversized vehicles.

The Resource Access Travel Management Plan is the result of a Forest Service process developed to identify desired future roadway and trail access conditions. The plan establishes target objectives to aid in decision-making for maintenance activity programming and for project and management activity review. As an evaluation criterion, the plan is useful for defining the priority roads and trails that may be affected by the proposed project or alternatives.

3.13.2.1 Proposed Action

Two major categories of traffic would be generated by the proposed action; worker commuting traffic (mainly automobiles and pickup trucks) and material deliveries (mainly heavy trucks and tractor-trailer rigs). Commuting traffic is estimated at approximately 50 vehicles inbound to the site and 50 outbound at major shift change hours. The basis for this estimate is 301 workers operating 3 shifts per day, 7 days per week. Four approximately equal sized crews were assumed necessary to cover the resulting 21 shifts per week. Commuting traffic was further assumed to average 1.5 persons per vehicle. For purposes of the analysis, shift changes were assumed to occur concurrently with morning and afternoon peak traffic flow hours.

Delivery truck traffic was estimated at 18 heavy delivery trucks and 5 light delivery trucks per day, making one inbound and one outbound trip each (Carlota 1993a). As a worst case estimate, 15 percent of the deliveries (7 trips) was assumed to occur during the peak hours.

Employing the scenario described above, approximately 107 vehicles would be added to the traffic flow on U.S. Highway 60 during the peak hours. Traffic east of the site was estimated at 80 percent (86 vehicles), with the remaining 20 percent (21 vehicles) assigned to the west. Traffic flows would remain at LOS C for both legs of the major arterial with full development of the proposed Carlota Copper Project, despite the growth in traffic.

The principal access point for the proposed project would be the Pinto Valley Mine Road, also known as Forest Service Road 287. The intersection of this road with U.S. Highway 60 was recently improved by ADOT to provide longer sight distances, wider shoulders, and a better alignment for the south approach. The intersection was evaluated for LOS using procedures set out in the *Highway Capacity Manual* (Transportation Research Board 1985). The left-turn movement from Pinto Valley Mine Road southbound onto U.S. Highway 60 was found to be operating at a LOS C; all other movements through the intersection were operating at a LOS A. Adding the estimated traffic from the proposed Carlota Copper Project would not change the LOS ratings of any of the movements through the intersection.

Initially, an alternative access point was considered that would be located approximately 2.5 miles west of the Pinto Valley Mine Road intersection. However, this alternative was eliminated from further consideration because its intersection with U.S. Highway 60 currently has severe sight restriction caused by curves near outcroppings. The site would require substantial improvements to address safety concerns.

Transportation safety concerns related to the proposed project have been largely eliminated by recent reconstruction of the Pinto Valley Mine Road intersection. The reconstruction was warranted by a series of accidents in the vicinity in recent years and by identified sight distance and stopping distance adversities that made access to U.S. Highway 60 difficult. The new intersection layout effectively removed the safety impediments. Development of the proposed project would have no effect on the physical characteristics of the intersection or the highway. The increase in traffic would be modest, remaining well within the roadway capacity, as noted above. The mix of heavy vehicles in the traffic stream would not substantially change. As such, any increase in the risk of traffic accidents would be minor and proportional to the overall increase in traffic. Potential impacts associated with the transport of hazardous materials are addressed in Section 3.14, Hazardous Materials.

Based on the analysis described, development of the proposed project would not cause major adverse changes to highway traffic and safety conditions in the site vicinity.

Commercial transportation operations would not be adversely affected by developing the proposed project. To some degree, commercial operations may benefit from the increased population base and increased business activity generated by the project. No indication was found of capacity limitations for the commercial transportation resources.

Portions of several existing Forest Service roads are contained within the project area. According to the Resource Access Travel Management Plan, all roads but one, Forest Service Road 898, are planned for closure. Development of the project would comply with the Resource Access Travel Management Plan for closing those roads. It would perhaps speed up the actual closure in some cases, although some roads have already been blocked by earth barriers and are not accessible to vehicles at this time.

Forest Service Road 898 is a loop road approximately 5.5 miles long. It intersects U.S. Highway 60 on the west edge of Top-of-the-World, heads northerly along the west side of Powers Gulch for approximately 2.5 miles, and returns along the back (west) side of the ridge to U.S. Highway 60 approximately 1 mile west of the starting point and at the west base of Signal Mountain. Development of the proposed project would truncate approximately 2.2 miles of Forest Service Road 898 beginning approximately 0.8 mile in from U.S. Highway 60 on the easterly leg of the loop. The proposed project would conflict with the Resource Access Travel Management Plan in this respect. From a practical standpoint, however, portions of Forest Service Road 898 are washed out and may be impassable. At best, access is limited to four-wheel-drive vehicles. The Forest Service has no immediate plans to upgrade the road. Consequently, the potential conflict with the Resource Access Travel Management is more theoretical than actual in this case.

Forest Service Road 287, Pinto Valley Mine Road, is also planned to remain open to public access, according to the Resource Access Travel Management Plan. Although the proposed project boundary abuts Forest Service Road 287, development of the project would not adversely affect the road or public use of the road, so there would be no conflict with this aspect of the Resource Access Travel Management Plan.

The Resource Access Travel Management Plan also addresses trail access in the Tonto National Forest. In the project vicinity, Forest System Trail 203 through Haunted Canyon is planned to remain open to the public to provide access to the Superstition Wilderness via Tony Ranch. The proposed project would affect this trail by authorizing the use of a section of the trail (previously a road) to be maintained as an access road to well sites. There is currently access to the trail from the south through the project site. This access is proposed for closure in the Resource Access Travel Management Plan; however, regardless of the outcome of the Carlota Copper Project, future access would come only from the north via Forest Service Road 287. The proposed project would thus not conflict with the Resource Access Travel Management Plan relative to trails. There is a portion of Forest System Trail 203 that is coterminous with a well field road, which may be closed to vehicle traffic not required to maintain the well field; however, trail access would be protected so no adverse effect is anticipated from this interaction. There may be some conflicts between using the road for well field access and using the trail for recreation.

3.13.2.2 Alternatives

The on-site project alternatives, including the mine rock disposal sites, the Eder side-hill leach pad alternative, and the water supply alternative would have virtually no effect on transportation off the site.

The selection of the water supply well field access route along Pinto Creek (Alternative A) would preclude access to the area during periods of high flow and would affect a longer segment of Forest Service Trail 203. The other access route (Alternative B) would be similar to the proposed action.

The no action alternative would essentially result in a continuation of existing traffic conditions.

3.13.3 Cumulative Impacts

Past and present activities in the project vicinity are reflected in the affected environment discussion presented previously. Among the mining projects included in the list of interrelated actions (Section 1.6, Interrelated Actions), only a few in close proximity to the Carlota Copper Project are likely to actually generate traffic interactions that would be considered problematic. BHP Copper's Florence Project is near enough that there would be a potential for interactive traffic effects, primarily at Top-of-the-World. The probability level and degree of interaction is difficult to quantify without additional information on the exact location, the scale of the project, mining methods and equipment proposed, and the development schedule anticipated. It appears, from the information available, that adverse cumulative traffic effects are unlikely.

Grazing management changes would have no substantive, cumulative effect on traffic in the project vicinity.

The proposed transmission line upgrade would have minimal effects, if any, on traffic near the proposed project. Construction near or on the U.S. Highway 60 right-of-way would cause minor traffic flow constraints, but the effects would be short-term and temporary and would not be expected to be significant.

The Pinto Creek wild and scenic river designation, should it occur, would produce minimal, if any, additional traffic that would most likely not be focused on the peak hour traffic periods most sensitive from a traffic perspective.

The dam and water-based recreation projects are too distant to result in cumulative impacts.

Proposed highway improvements near the project site would produce construction-related traffic constraints that could adversely interact with project traffic, but the effects would be transient, short-term, and would likely be managed by ADOT to minimize adverse traffic effects.

Potential additional development at Top-of-the-World would be the only private land development near enough to generate cumulative traffic effects. Construction may generate some heavy truck traffic, though the typically short time span of the activity would not be likely to produce major adverse effects. Longer-term population growth in the area would contribute proportionally to traffic growth, which would interact with project-related traffic. In the event of concurrent development of other large-scale mining projects in the area, there may be a future need to address cumulative transportation effects by such means as modifying shift schedules or by carefully managing deliveries of equipment and supplies.

3.13.4 Monitoring and Mitigation Measures

With no major adverse LOS or safety impacts identified, specific traffic mitigation measures are not considered necessary. Nonetheless, there are opportunities to reduce traffic associated with the Carlota Copper Project, such as encouraging carpooling among workers.

T-1: Carlota would fund relocation of Forest Service Road 898 or maintenance of the westerly leg of the road to the extent that public access to the northern end of the Eder ridge is preserved. A final plan would be developed and completed before Carlota's operation restricts access to the easterly leg of the road.

T-2: Carlota would close or obliterate (as determined by the Forest Service) and revegetate those roads identified on Resource Access Travel Management Plan that are located within the project area for which access would be cut off by project operations. Additional measures for closing these roads are provided in Section 3.4.4, Soils-Monitoring and Mitigation Measures. This measure would also satisfy some of the requirements for mitigating impacts to upland habitat.

T-3: Carlota would participate with the Forest Service in developing a plan to manage the section of Forest Service Trail 203 that would be impacted by operations. The plan would ensure access by both Carlota, for well site operation and maintenance, and the trail users. Carlota would fund maintenance of the section of the trail that may include, but not be limited to, drainage, erosion control, turnarounds, gating, signing, and revegetation. Upon closure of operations, Carlota would reclaim that section of the trail to trail standards present before the project's initiation.

T-4: Carlota would acquire a Road Use Permit from the Forest Service to use and maintain the paved portion of Forest Service Road 287 (Pinto Valley Mine Road). This portion of the road would continue to be used by the general public, other Forest System Land users, and private land owners in the area.

3.14 Hazardous Materials

3.14.1 Affected Environment

Small quantities of hazardous materials may exist on the project site as a result of historic mining and exploration activities along Pinto Creek and Powers Gulch. An abandoned rail tanker car located in the northwestern portion of the proposed Carlota/Cactus pit may have been used historically to store sulfuric acid; however, the tanker and the surrounding soil beneath and in the vicinity of the tanker have not been sampled for hazardous substances. Two wooden troughs with scrap iron are also located in the western portion of the proposed pit. These troughs are believed to have been used to extract copper from copper sulfate solution.

Since ore processing activities were conducted in the past in this area, hazardous substances may be present. Several other potential sites that may contain hazardous materials are described in the cultural resource survey (SWCA 1993a). Most of these sites are associated with existing mine workings shown in *Figure 3-5*. Several sites are described in the cultural resources report as containing slag deposits presumably left from past ore processing activities. However, according to Carlota personnel, this material is not slag, but actually naturally leached and oxidized rock (known as vein gossan) composed primarily of iron oxide minerals. The affected environment that could potentially be affected by an accidental release of hazardous materials during transportation to and from the mine site and during storage and use on the project site includes air, water, soil, and biological resources.

3.14.2 Environmental Consequences

3.14.2.1 Project-Related Hazardous Materials

The Carlota Copper Project would require the transportation, handling, storage, use, and disposal of materials classified as hazardous. These hazardous materials include (1) diesel fuel, gasoline, oils, greases, antifreeze, and solvents used for equipment operation and maintenance; (2) kerosene, sulfuric acid, oxime reagent, and cobalt sulfate used in the copper extraction process; (3) ammonium nitrate and high explosives used for blasting in the open pits; and (4) sludge and other by-products generated during the copper extraction process (*Table 3-93*). Some substances are listed generically (i.e., oils, greases, lubricants, solvents, and high explosives), since the exact chemical composition would depend on the brand and type selected. However, the transportation, handling, storage, use, and disposal would be the same, regardless of the brand and type.

Table 3-93. Hazardous Substances Approximate Daily Usage, Delivery Frequency, and On-Site Storage

Substance	Typical Daily Usage	Nominal Delivery Size	Approx. Delivery Frequency	Planned On-Site Storage
Diesel Fuel	7,500 gal	7,500 gal	1/day	30,000 gal
Gasoline	100 gal	3,000 gal	1/month	5,000 gal
Oil, Grease, Anti-freeze, Lubricants	410 lbs	As needed	1/week	5,000 lbs
Solvents	15 gal	As needed	1/month	300 gal
Kerosene	930 gal	7,500 gal	1/week	18,000 gal
Sulfuric Acid	403 tons	27 tons (3,500 gal)[1]	17/day	1,540 tons
Oxime Reagent	700 lbs	As needed	1/month	10,000 lbs
Cobalt Sulfate	145 lbs	As needed	1/month	1,500 lbs
Ammonium Nitrate	12 tons	24 tons	3/week	126 tons
High Explosives	170 lbs	As needed	2/month	5,000 lbs

[1]One gallon of sulfuric acid weighs 15.3 lbs.

Brief descriptions, including the use and storage of the substances listed in *Table 3-94* as well as other hazardous materials that may exist during the operation of the project, are provided in the following sections.

Diesel Fuel and Gasoline

These petroleum products would be used as fuel sources for the daily operation of the mining equipment. Fuels would be stored in covered above-ground tanks designed for that purpose. The storage areas would be HDPE-lined or paved and surrounded by dikes to contain rainfall and spills. The volume of the containments would be at least as large as the largest tank plus 10 percent. A sump would be provided for collecting minor spills. Signs warning against smoking and open flames would be posted on or near the tanks.

Fuels would be dispensed to mobile equipment and vehicles using DOT-approved equipment. A portion of the normal preventive maintenance program would be devoted to detecting and eliminating fuel leaks.

Oils, Greases, Lubricants, Anti-Freeze, and Solvents

Oils, greases, lubricants, and antifreeze would be used for lubricating and cooling mobile and stationary equipment. Solvents would be used for cleaning and thinning. These materials would be stored in above-ground tanks located in the maintenance shop. The storage area would have a concrete slab foundation, with a concrete curb (approximately 4 inches high) along its perimeter. Appropriate warning signs would be posted. Used oil would be placed in a holding tank and shipped off the site for recycling or disposal.

Solvents would be contained and continuously recycled in the parts-cleaning basins. As the solvents become loaded with grease, dirt, or contaminants, they would be periodically replaced. Spent solvent would be collected in a storage drum for disposal or would be removed from the site by a solvent recycling contractor.

Mobile equipment would be fueled and lubricated in active operating areas using separate mobile fueling and lubrication units in order to minimize downtime and maximize operational efficiencies. These mobile units could contain diesel fuel, hydraulic oil, motor oil, antifreeze, and grease. Drybreak couplings and pressure-sensitive automatic shutoff valves would ensure that transfer would occur without spillage.

Kerosene

Kerosene, which would be used as a diluent for the oxime reagent in the SX process, would be circulated in a closed-loop system within the SX section. The kerosene would be pumped from the kerosene tank to the SX mixer-settlers. After the initial loading of the process tanks, additional kerosene would be required to make up primarily for evaporation losses.

Kerosene would be delivered by road tankers and then unloaded into a vertical cylindrical storage tank in the bermed area beside the sulfuric acid tank.

Table 3-94. Estimated Number of Spills Resulting from Truck Accidents (Rural Two-Lane)

Truck Shipment Type	Total Truck Deliveries	Rural Road Haul Distance	Accident Rate per Million Miles Traveled[1]	Calculated Number of Accidents	Probability of Release Given an Accident[1] (%)	Calculated Number of Spills
Sulfuric Acid	124,100	75	2.19	20.38	18.8	3.83
Diesel	7,300	75	2.19	1.20	18.8	0.22

[1]Accident rates are based on the average number of truck accidents occurring per million road miles traveled by road types. Spill probabilities are based on statistics from accident reports that indicate the percentage of truck accidents involving liquid tankers that resulted in spills.
Source: Hardwood and Russell 1990, and Rhyne 1994

Diluent would be pumped as required for make-up (for 1.5 hours per week) into the loaded organic decant tank. The tank would be provided with a flame arrestor. The storage tanks, process piping, and SX equipment would be located within a secondary containment structure with sumps and pumps. Spills would be collected and sent to the process area or a tank, as appropriate.

Sulfuric Acid

Sulfuric acid would be used to leach the copper from the ore on the leach pad and as an electrolyte in the EW tank house. The sulfuric acid would interact with the kerosene and oxime reagent in the SX mixer-settlers. Both the leaching and electrolyte solutions would be circulated in closed-loop systems. The acid in the leaching solution would be consumed in the leaching process, although small amounts of acid mist would be lost to the atmosphere from the EW cells.

Acid solution may be sprayed or sprinkled onto the ore in a pretreatment process before the ore is placed on the leach pad. The ore would then be leached to recover the copper. The leach solution that would percolate through the ore would be collected on an impermeable liner and would flow through lined channels to a double-lined collection pond. It would be pumped from the pond to the SX/EW plant, where the copper would be extracted. The barren solution, or raffinate, would flow to a double-lined pond, where it would be refortified with acid and pumped back to the leach pad to leach the ore.

Road tankers would deliver sulfuric acid (93 percent) to the plant. The tanker pump or compressed air would be used to unload the acid into a 201,500-gallon above-ground tank near the process plant. This tank would be located in a bermed area containing limestone for neutralizing spills. The containment area would be capable of containing the volume of the largest tank plus 10 percent. A horizontal-centrifugal pump within the berm would deliver acid to the pretreatment area and the raffinate spiking at the static mixer. A smaller dosing pump would deliver acid to the electrolyte recirculation tank to make up for acid lost in the electrolyte bleed. The containment area would be equipped with a sump to transfer spilled acid to the process pond or to a tank. Appropriate warning signs would be posted.

Piping for the acid solution would be made of HDPE or stainless steel. These materials were selected because of their resistance to acid and their high resistance to physical damage.

Oxime Reagent

Salicylaldoxime reagent would be the active reagent in the SX process. It would be mixed with kerosene and circulated within the SX section in a closed-loop system. Small amounts of reagent would be lost primarily to evaporation. The reagent would be delivered in a partly diluted state either in bulk or in 55-gallon drums by flatbed truck. The reagent would be stored either in a tank or in drums on a paved patio adjacent to the SX plant.

Cobalt Sulfate

Small amounts of cobalt sulfate would be mixed with the electrolyte to control anode corrosion. The reagent would be delivered in bags and made up into a 1 percent solution with hot water in the reagent preparation tank. This solution would be dosed by a positive displacement pump into the circulating electrolyte to make up for losses in the electrolyte bleed. The cobalt sulfate would be consumed in the process.

Ammonium Nitrate/High Explosives

These explosives would be used for blasting in the open pit. Boosters and detonating cord would be transported to the blast site by pickup truck and loaded into the holes. A mixture of ammonium-nitrate and fuel oil (ANFO) would be used as the primary blasting agent for Carlota's mining operations. All of the explosive would normally be consumed in the blast. A blasting contractor would be employed during operations.

The location of the ANFO storage has not yet been determined. Because the two components are relatively easily handled and are non-explosive prior to mixing, they would be stored separately and mixed only in quantities necessary for near-term blasting operations. The ammonium nitrate storage facility would consist of an ammonium nitrate bulk storage bin and storage trailers and magazines used to store initiators, boosters, blasting caps, and other blasting supplies. Bulk ammonium nitrate would be discharged to a specially designed ANFO mixing and loading truck that would belong to the blasting contractor. The ANFO truck, which would have a self-contained 230-gallon fuel-oil tank, would travel to the blasting area and mix the ammonium nitrate and fuel oil as it is loaded into pre-drilled blastholes.

Leach and Electrolyte Solutions

These solutions would be contained within the process vessels of the SX/EW plant.

Miscellaneous

Guartec, a natural gum derivative, would be used as a deposit-smoothing aid in the tank house. It would be incorporated in the cathode deposit and would require make-up in addition to that required to compensate for the electrolyte bleed.

Electric Power

All electrical equipment on the property would be non-polychlorinated byphenyl (non-PCB). Non-PCB oil-filled electrical equipment and transformers would be inspected regularly for evidence of damage or deterioration that could result in failure of the transformer casing or equipment housing.

Hazardous Waste

Small quantities of hazardous waste, such as chlorinated solvents, laboratory chemicals, or other materials, may be generated. Carlota would most likely be classified as a small quantity generator of hazardous waste, and an EPA identification number would be acquired.

3.14.2.2 Impact Analysis

Important issues related to the presence of hazardous materials at the proposed project site are the potential impacts to the environment in the event of an accidental release of hazardous materials during transportation to the project area and use or storage of these materials at the site. The criterion for evaluating the impacts of hazardous materials is the risk of a potential spill to sensitive receptors along transport routes or exposure pathways.

If some of the previously listed chemicals were to enter the environment in an uncontrolled manner, there could be associated direct or indirect harmful effects. The environmental effects of a release would depend on the substance, quantity, timing, and location of the release. The event could potentially range from a minor diesel fuel spill on the project site where cleanup equipment would be readily available, to a severe spill during transportation involving a large volume of sulfuric acid that could be released into a stream or populated area. Some of the chemicals could have immediate destructive effects on soils and vegetation, and there could also be immediate degradation of aquatic resources and water quality if spills were to enter streams. Spills of hazardous materials could seep into the ground and contaminate the ground water system. In addition, infiltration into the subsurface could occur from beneath the leach pads or process ponds, resulting in degradation of the ground water. Depending on the proximity of people to such spills or the use of degraded water for human consumption, such accidental spills could affect human health. In addition, some of the chemicals have the potential to create fires or explosions if mishandled or if an unforeseen incident occurs.

Transportation

Trucks would be used to transport a variety of hazardous and non-hazardous materials and wastes to and from the project site. Based on the quantity of materials and number of deliveries, the materials of greatest concern would be sulfuric acid and fuel (gasoline and diesel).

The largest daily delivery to the project site would be sulfuric acid, with an average of 17 tanker truckloads per day (3,500 gallons/tanker). Sulfuric acid would be supplied by the BHP Copper's San Manual Mine located approximately 75 miles south of the project site near San Manual, Arizona. The most likely transportation route for the sulfuric acid would be north from the San Manual Mine on State Highway 77 to State Highway 70, west on State Highway 70 to U.S. Highway 60, and then west on U.S. Highway 60 to the project access road. The route crosses the communities of Mammoth, Dudleyville, Hayden, and

Miami-Globe, and the San Pedro, Aravaipa, and Gila Rivers. Other hazardous materials would be transported from a variety of local suppliers (i.e., from other nearby mining companies) in the Phoenix area (approximately 65 miles to the west) or other locations. The main transportation route for these hazardous materials into and out of the site would be along U.S. Highway 60.

It is assumed that liquid fuels would be transported from the Phoenix area. Carlota expects a delivery frequency to average 1 shipment per day for diesel fuel and 17 shipments per day for sulfuric acid over the life of the project (3,500 gal/truck for sulfuric acid and 7,500 gal/truck for diesel fuel). This would result in a total of 124,100 shipments of sulfuric acid (17 shipments/day x 365 days/year x 20 years) and 7,300 shipments of diesel fuel (1 shipment/day x 365 days/year x 20 years).

The risk of a release involving deliveries of these two substances was based on accident statistics for liquid tankers carrying hazardous materials (Harwood and Russell 1990). According to these statistics, the average rate for truck accidents for two-lane rural loads is 2.19 per million miles traveled. The statistics also indicate that, on the average, 18.8 percent of accidents involving liquid tankers carrying hazardous materials resulted in a spill or release. The probability of a spill resulting from a truck carrying sulfuric acid or diesel is presented in *Table 3-94.* The probability analysis indicates that approximately four accidents involving a sulfuric acid release may occur over the life of the project (3.83 releases). The probability of an accident involving a diesel spill is less than one (0.22) release over the life of the mine. Carlota would most likely obtain fuels from a distributor located closer than Phoenix, resulting in an even lower probability of an accidental release. One spill resulting from a truck accident for either of these substances would be considered a significant impact.

All hazardous substances would be transported by commercial carriers or vendors in accordance with the requirements of Title 49 CFR and Title 28 Arizona Revised Statutes. Title 49 CFR requires that all shipments of hazardous substances be properly identified and placarded. Shipping papers must be accessible and must include information describing the substance, immediate health hazards, fire and explosion risks, immediate precautions, fire-fighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers. Carriers would be licensed and inspected as required by the ADOT. Tanker trucks would be inspected and would have a Certificate of Compliance issued by the Arizona Motor Vehicle Division. These permits, licenses, and certificates are the responsibility of the carrier.

In the event of a release off the project site, the transportation company would be responsible for response and cleanup. Each transportation company would develop a Spill Prevention, Control, and Countermeasures (SPCC) Plan to address the materials being transported. Local and regional law enforcement and fire protection agencies also may be involved initially to secure the spill site and protect public safety. Carlota has developed a contingency plan for transportation accidents occurring on or near the project site (Carlota 1993a), which includes notifying the local emergency response personnel (law enforcement, fire fighters, and/or medical personnel, as appropriate) and providing advice, personnel, and equipment as appropriate to minimize the impact of the accident. In addition, the Chemical Manufacturer's Association maintains the Chemical Transportation Emergency Center (CHEMTEC), which has a 24-hour hotline to provide information, advice, and assistance in identifying and mitigating chemical emergency scenes.

Title 49 CFR requires that the carrier notify local emergency response personnel, the National Response Center (for discharge of reportable quantities of hazardous substances to navigable waters), and DOT in the event of an accident involving hazardous substances. Carlota personnel trained in hazardous materials handling would assist in response actions, whenever possible.

Storage and Use

The operation of the project would require the use and storage of materials classified as hazardous. These materials would be used in various applications, such as mining (ANFO and high explosives), copper extraction (sulfuric acid and process reagents), and equipment operation (fuels, antifreeze, and lubricants). The general use, storage locations, and quantities for these materials are summarized in *Tables 3-93* and *3-95.*

Table 3-95. Use and Storage Areas for Hazardous Materials

Substance	Operational Use	Storage Area
Diesel Fuel and Gasoline	Equipment Operation	Mine Maintenance Shop
Oil, Grease, Lubricants, and Antifreeze	Equipment Operation and Maintenance	Mine Maintenance Shop
Solvents	Parts Cleaning and Thinning Agent	Warehouse
Sulfuric Acid	Ore Leaching and the SX/EW Process	SX/EW Plant
Kerosene	SX/EW Process	SX/EW Plant
Oxime Reagent	SX/EW Process	SX/EW Plant
Cobalt Sulfate	SX/EW Process	SX/EW Plant
ANFO and High Explosives	Mining (blasting)	Undetermined

Over the life of the project, the probability of minor spills of materials such as fuels or lubricants is relatively high. These releases could occur during such operations as haul truck refueling or as a result of a hydraulic oil line rupture on a piece of excavating equipment. Spills of this nature would most likely be localized, contained, and removed. Carlota would have the necessary spill containment and cleanup equipment available at the site, and personnel would be able to respond quickly.

The design of the SX/EW plant, along with the other ore processing facilities on the site, would minimize the potential for an upset that would result in a major spill. The SX/EW plant site would be designed to prevent discharge to the vadose zone (the unsaturated layer above the water table) or to waters of the U.S. Tanks would have secondary containment sufficient to hold the volume of the largest tank and additional freeboard. Tanks and vessels would be positioned on an asphalt or concrete surface or on a surface protected by a synthetic liner. Surface water runoff and any spills from the SX/EW plant site would drain into the double-lined raffinate and plant/PLS ponds adjacent to the plant. The raffinate and plant/PLS ponds are designed to contain the largest estimated combined volume of stormwater (resulting from the 72-hour 1/2 PMP) and antecedent operational storage with 3 feet of remaining freeboard (Knight Piésold 1996i). The raffinate pond would be located directly upgradient from the lined leach pad, and solution that overtops the pond embankment would flow down a spillway into the leach pad.

Materials stored at the mine/maintenance facilities would be contained in above-ground tanks located in the maintenance shop. The storage area would have a concrete slab foundation and would be enclosed by a concrete curb approximately 4 inches high. Appropriate warning signs would be posted. Parts, supplies, and small quantities of chemical products would be stored in the warehouse, adjacent to the maintenance shop. Small quantities of chemical products, such as industrial cleaning agents, spray solvents, and water treatment chemicals, would be stored in a special hazardous materials storage area; incompatible materials would be segregated.

The hazardous waste storage area would consist of a chemical storage building in a secured area. The floor of the building would be grating over a sump, which could be gravity drained. The building would be equipped with an emergency alarm, lighting, and fire suppression equipment. Leaks or spills from drums or waste receptacles would be limited to the contents of one container; material would be caught in the floor sump. Transmission fluid, shop solvents, and bulk bins for grease would be stored in the lubricant storage area at the warehouse. This area would also be constructed with a concrete slab floor.

Samples would be collected and analyzed in the on-site laboratory located near the SX/EW plant. The laboratory facility would consist of a storage and preparation area and the analysis laboratory. Routine analysis procedures would involve analysis of leaching and process solutions. Chemicals would be stored in original vendor containers in a locked cabinet when not in use. A chemical spill cleanup kit would be stored in the laboratory. All handling, storage, shipment, and related documentation of laboratory wastes would be completed in accordance with applicable regulations under the designation of "Small Quantity Generator" (40 CFR Part 261.5).

Solution ponds associated with the heap-leach operation would have double-synthetic liners and leak collection and recovery systems. Pipelines would transfer PLS from PLS ponds on the west side of the leach pad to the SX/EW plant adjacent to the east side of the leach pad. Pipelines would originate at each of the two PLS ponds and extend to a junction located about midway between the ponds. The pipeline would be placed on top of the HDPE synthetic liner of the leach pad. From the junction of the two pipelines, a single pipeline would extend from the top of the leach pad liner or the top of the leach pad to the SX/EW plant. The pipelines would be approximately 24 inches in diameter and constructed of HDPE, stainless steel 316L, or carbon steel lined with HDPE; piping joints would be constructed as required by design pressures. In the event of a leak or spill from the pipeline, the fluid would be contained by the liner underlying the leach pad and would drain to the PLS ponds or would be contained by the asphalt or synthetic liner underlying the SX/EW plant and drain to the raffinate or plant PLS/SX ponds.

All hazardous substances would be handled in accordance with applicable Mine Safety and Health Administration (MSHA) or OSHA regulations (Titles 30 and 29 CFR). The hazardous substances to be used at the mine (fuels, oils, lubricants, kerosene, packaged chemicals, and ammonium nitrate) would be handled as recommended on the manufacturer's Material Safety Data Sheets (MSDS). High explosives and sulfuric acid would be handled only by specially trained personnel with appropriate protective and handling equipment. With the above-listed design features and operational practices in place, the probability of a major release occurring at the site would be low.

In the event of a major or minor spill, Carlota has prepared an SCHMM Plan (Carlota 1993b) that addresses (1) potential contaminant sources and planned protective measures, (2) inspections and record keeping, and (3) incident coordination and emergency response. All spills would be cleaned up or neutralized and reported, if required, to the National Response Commission, State Emergency Response Commission, and/or Local Emergency Planning Commission.

Disposal

Since some of the hazardous materials used in the general operation of the facility would not be totally consumed in the process, they would become waste materials. These materials would include used oils from mobile and stationary equipment and used solvents from cleaning and thinning processes. These substances would be temporarily stored on the site and routinely shipped off the site by a licensed oil/solvent recycling contractor for recycling or disposal.

Other materials produced as by-products of the copper extraction process that are considered hazardous wastes include the following:

- An organic and solid mixture typically known as "Crud" from the crud tank in the SX/EW plant
- Cell sludge from the SX/EW plant
- Slime at the bottom of the raffinate and plant PLS/SX ponds
- Small quantities of hazardous wastes, such as laboratory wastes or chlorinated solvents

The solid portion of the crud that accumulates in the SX/EW plant would be routinely separated from the liquid phase and disposed of on the leach pile. The liquid portion would be recycled back into the process. Cell sludge, which has a high lead content, would be collected and transported off the site for recycling by the vendor selected to supply the anodes for the EW process; this vendor would also remove and recycle the electrodes and the associated metal residue. At closure, slimes or residual material that would occur at the bottom of the raffinate and plant PLS/SX ponds would be excavated and placed on the leach pad (Carlota 1995a).

Laboratory wastes would be stored on the site for a maximum of 180 days, and then they would be shipped to a licensed hazardous waste disposal facility. Laboratory waste containers would be properly labeled, and all required paperwork, such as hazardous waste manifests, would be completed prior to shipping.

These materials would be produced as by-products of the operation, and only the cell sludge and laboratory wastes would have to be transported off the site for recycling or disposal. Because of the small volumes and infrequent handling of these wastes, the potential for a spill that would greatly impact the environment would be low. If a release were to occur, containment and cleanup procedures outlined in the SCHMM plan would be followed.

3.14.2.3 Alternatives

The environmental impacts associated with the transportation, handling, storage, use, and disposal of hazardous materials for the project alternatives would be similar to the relevant component(s) of the proposed action.

3.14.3 Cumulative Impacts

Large-scale mining operations occur throughout the Globe-Miami area, all of which require shipments of process chemicals, reagents, and various supplies to operate the facilities. Some of the shipments contain materials classified as hazardous. The Carlota Copper Project would add approximately 18 truck-loads per day of hazardous materials to the roads in the vicinity of the project. The greatest increase would be the 17 truckloads of sulfuric acid that would travel State Highway 77 between San Manual and the project site. As discussed in Section 3.13, Transportation, State Highway 77 operates at LOS A. With this low level of use, it is unlikely that the increased truck traffic would significantly increase the probability of an accident and a release of a hazardous material. The probability of an accident with a release would increase along U.S. Highway 60 (near the project site), where the LOS is at a level C.

The cumulative effects of the use and storage of hazardous materials on the project site would be minimized by implementing spill prevention and containment design features, along with the SCHMM plan.

3.14.4 Monitoring and Mitigation Measures

HM-1: Currently, Carlota's SCHMM Plan is preliminary and is written to cover issues in general terms. The plan would be updated as engineering design plans for the project are finalized. BMPs for handling hazardous materials would be included in the final SCHMM Plan. The SCHMM Plan would be subject to Forest Service and other appropriate regulatory agency approval. The plan would be reviewed on an annual basis and amended as necessary.

HM-2: Any potential existing hazardous materials located on the site (such as the abandoned railroad tanker car) during construction would be tested to determine the contents or makeup. Appropriate cleanup and disposal actions would be taken if the substances were found to be hazardous.

HM-3: The sulfuric acid would be offloaded from the tanker trucks to the storage tank using a gravity flow system to minimize the risk of a spill during this procedure.

HM-4: The SCHMM plan necessitates 24-hour access to the project site to ensure incident coordination and emergency response are implemented in the event of a spill of hazardous materials. Since the main access road to the site crosses Pinto Creek, the crossing must be designed to accommodate the 100-year, 24-hour storm event. The final SCHMM plan must include a commitment to other means of entry if events greater than the 100-year, 24-hour storm or other unforeseen circumstances make the main road inaccessible.

HM-5: At closure, any slimes and residual materials remaining in ponds containing process solutions (excluding the PLS ponds within the leach pad) would be tested to evaluate the toxicity and leaching characteristics of the material. If these materials are toxic or have the potential to leach constituents that could adversely affect surface or ground water quality, the material would be disposed of in accordance with the ADEQ Aquifer Protection Permit and applicable state and federal regulations.

3.15 Summary of Monitoring and Mitigation Measures

Table 3-96 summarizes the monitoring and mitigation measures identified in Sections 3.1 through 3.14.

These measures apply to the proposed action and the alternatives unless otherwise indicated.

Table 3-96. Summary of Monitoring and Mitigation Measures

Resource	Impacts	Monitoring and Mitigation
General	All identified environmental impacts	Contribute funding to the Forest Service, through a collection agreement, through project construction. The funding would be used to expedite approvals, monitor project construction, and implement operational monitoring programs.
Air Resources	Air quality degradation from H_2SO_4 emissions	AQ-1: Design tank house ventilation system to facilitate deposition of H_2SO_4 emissions as close to tank house as possible.
	Potential for perceptible plume impacts in the Superstition Wilderness	AQ-2: Establish a three-tier monitoring program. The first tier would determine the existence of perceptible plume impacts in the Superstition Wilderness due to emissions from the Carlota Copper Project. If impacts are detected, the second tier of the program will be implemented to further characterize and more accurately attribute these impacts to emissions from the Carlota Copper Project. If necessary, the third tier involves using the results of the monitoring program to identify and implement additional mitigation measures to rectify any visibility impacts.
Geology and Minerals	• Ground subsidence associated with shafts and adits	GM-1: (1) Remove wood, garbage, and other debris or loose material from the openings prior to backfilling. (2) Use large rocks ($\geq$ 1 ft diameter) as backfill. (3) Use an acid-resistant concrete mixture to fill openings in the leach pad footprint.
		GM-2: Plug all existing drill holes with acid-resistant grout prior to heap-leach pad construction; follow Arizona regulations for well abandonment.
	• Potential slope stability problems in the Carlota/Cactus and Eder pits	GM-3: (1) Identify potentially adverse geologic conditions in the pit walls by geologic mapping. (2) Define potential failure planes using rock-coring. (3) Implement slope dewatering. (4) Detect initial signs of slope instability. (5) Develop contingency plans. (6) If necessary, modify final setback distance of any potentially affected facility. (7) Place fencing around pits beyond limits of potential mass failures.
	• Potential for induced slope instability and increased erosion during construction of water supply access road	GM-4: (1) Get approval from Forest Service for design and alignment of the road based on a geotechnical investigation of existing slope conditions.

Table 3-96. Summary of Monitoring and Mitigation Measures (continued)

Resources	Impacts	Monitoring and Mitigation
	• Potential slope stability problems for the Powers Gulch diversion, Powers Gulch diversion embankment alternative, Eder side-hill leach pad, and low-quality water pipeline alternative	GM-5: Develop site-specific mitigation measures, if necessary, after conducting a thorough geotechnical investigation and analysis of slope conditions. All remaining material from the Eder mine rock disposal area would be removed and placed on the heap-leach pad or other designated area.
	• Potential for small avalanche-type failures on the Main mine rock disposal area	GM-6: Demonstrate, using slope stability analysis, that the final rock pile design will be stable under both static and pseudo-static conditions.
Water Resources	• Potential effects to surface water and ground water resources	WR-1: Revise ground and surface water monitoring plan (GWRC 1996a) to include additional monitoring points and revise monitoring frequency of existing monitoring points. The plan would be submitted to and approved by the Forest Service prior to initiation of project construction.
	• Potential effects on streamflows and alluvial ground water in Haunted Canyon and Pinto Creek from well field pumpage	WR-2: Conduct additional aquifer and well field testing during the mine construction phase but prior to well field production for operating the mine. The full-scale testing would be designed to simulate withdrawal rates expected during the life of the project and would concurrently monitor the effects on surface and ground water resources.
		WR-3: Implement wellfield mitigation program to offset potential flow reductions in Haunted Canyon and Pinto Creek and to maintain aquatic and riparian resources at pre-project levels. Streamflow would be augmented with ground water pumped from the well field, or with water from other suitable source(s) approved by the Forest Service and other appropriate agencies.
		WR-4: Implement measures as necessary to ensure that the water discharged to supplement streamflows (as required in WR-3) meets applicable Arizona water quality standards.
	• Potential effects of pit dewatering on Pinto Creek flows	WR-5: If necessary, implement mitigation to off-set impacts to Pinto Creek from pit dewatering. Mitigation could potentially include a cutoff wall on the downstream end of the Pinto Creek diversion and/or improvements to other nearby stream reaches, wetlands, or riparian corridors.
	• Potential effects of pit dewatering on springs	WR-6: Establish a ground water monitoring program to measure water level changes in natural springs and seeps. Mitigate affected springs and seeps by: (1) Supplementing or replacing flows, (2) Improving collection or yield at existing springs, (3) Developing or improving nearby springs, and (4) Using a replacement water source.
	• Potential effects to water supply wells from mine dewatering and well field development	WR-7: Implement a comprehensive ground water monitoring program (GWRC 1996a) to measure the extent and rate of ground water drawdown. Carlota has indicated its intent to assist affected parties by deepening existing wells, drilling new wells, or providing a replacement water supply of equivalent yield and general quality during any period of effect.

Table 3-96. Summary of Monitoring and Mitigation Measures (continued)

Resources	Impacts	Monitoring and Mitigation
	• Potential reduction in stream flows from well field pumpage	WR-8: Implement water conservation measures to reduce the quantity of ground water required. Carlota would prepare a water conservation plan for approval by the Forest Service.
	• Potential effects to surface and ground water quality from an accidental release of leachate solution	WR-9: Install and maintain (1) automated monitoring in Powers Gulch to provide for early detection of a release, (2) flow shutoffs and secondary containment for piping between components, and (3) an emergency pump system capable of removing solution to an emergency containment facility. Mitigate adversely affected surface or ground water quality by identifying the potential contaminant source, correcting the source of release (where possible), and remediating contamination, if necessary. Target borrow material for leach pad subgrade with loaded permeability potential of $1x10^{-6}$ cm/sec in most critical areas.
	• Potential effects from runoff or seepage from the waste rock facilities	WR-10: Implement a waste rock sampling plan and, if necessary, develop and implement a materials handling plan to prevent impacts to surface and ground water as specified in the ADEQ Aquifer Protection Permit.
	• Potential erosion and sedimentation effects associated with facility construction, operation, and closure	WR-11: Develop and implement erosion and sediment controls and a Stormwater Protection Plan in coordination with the Forest Service.
		WR-12: Design and maintain process solution containment components to accommodate the peak flows and volumes resulting from the 1/2 PMF without any discharge of process solutions. Design the Powers Gulch and East diversion channels to safely accommodate the 6-hour 1/2 PMF.
		WR-13: At closure, redesign the Pinto Creek, Powers Gulch, and East diversions to safely convey the full PMF storm event. Conduct periodic inspections of the diversions postclosure to ensure diversion design is adequate for maintenance-free operation.
	• Potential impacts to water resources from the heap-leach pad operation and postclosure	WR-14: Construct an upstream access port for the central spine drain beneath the main portion of the heap-leach pad to provide an upstream opening that could be used for clean out, flushing, or inspection, if necessary.
		WR-15: Investigate and test closure methodology and provide annual reports of findings to the Forest Service. Prepare final heap leach closure design for approval by the Forest Service and other regulating agencies.
		WR-16: The main and north embankments would have a seal zone keyed into bedrock. The need for alluvial monitoring wells upgradient of the embankments would be evaluated based on site conditions and depth of alluvium below the spine drains.
		Note: Additional mitigation measures for the alternatives are identified in Section 3.3.4.4.

Table 3-96. Summary of Monitoring and Mitigation Measures (continued)

Resources	Impacts	Monitoring and Mitigation
Soils and Reclamation	• Potential loss of soil resources or reduction of soil productivity, and potential damage to surface resources of the National Forest system lands	SR-1: (1) Salvage suitable soils and extend equipment operations up to 40 percent grades. (2) Identify alternative borrow materials for leach pad construction. (3) Minimize excavation and transport losses of salvageable soil materials.
		SR-2: (1) Develop and maintain an approved topsoil management plan. (2) Locate topsoil stockpiles in protected areas. (3) Inspect stockpiles to determine stability and success of reseeding and mechanical erosion controls.
		SR-3: (1) Review reclamation priorities with Forest Service to determine use of excess topsoil. (2) Improve microbial conditions using bacterial and fungal inoculants or other seedbed amendments.
		SR-4: Prevent excessive topsoil erosion by: (1) Evaluating BMPs such as placing slope breaks along leach pad slopes, using mulches on all areas to be revegetated, and constructing embankments at the toes of the Main mine rock disposal area (2) Monitoring and maintaining these features (3) Implementing BMPs for surface drainage, roads, and erosion and sedimentation controls
		SR-5: Evaluate reclamation after 3 years to determine if success criteria are met.
		SR-6: Implement as much concurrent reclamation and stabilization as possible.
		SR-7 Remove and dispose of all building and facility foundations according to appropriate regulations.
		SR-8 Define the bonding requirements for reclamation.
		SR-9: Define the closure and reclamation schedule.
		SR-10: Define the proposed revegetation testing program (schedule and location) during project operation.
		SR-11: Incorporate the types and application rates for seedbed amendments (including microbial inoculants) into the revegetation testing program.
		SR-12: Define the reseeding methods and locations.
		SR-13: Define the final seed mixes and planting specifications for reclamation.
		SR-14: Determine additional monitoring and maintenance for the reclamation program. Maintain firefighting capabilities until reclamation is deemed successful.
		SR-15: Close roads to normal vehicular traffic; restore drainages; and approximate original contour, stabilize, and revegetate.
		SR-16: Reclaim the impoundment area created by the alternative Powers Gulch diversion embankment by using suitable waste rock and creating a drainageway for surface flows; revegetate backfill areas.

Table 3-96. Summary of Monitoring and Mitigation Measures (continued)

Resources	Impacts	Monitoring and Mitigation
Terrestrial Biology	• Direct loss or disturbance to occupied and potential Arizona hedgehog cactus habitat	TB-1: Subject to the U.S. Fish and Wildlife Service Biological Opinion, identified measures are listed below: (1) Review facility sites and alignments for relocation to avoid cacti. (2) Protect plants in occupied areas using fencing and stakes. (3) Establish revegetation test plots to determine best methodology for reestablishing vegetative cover; where avoidance is not feasible, transplant cactus into test plots to determine optimum re-establishment habitat. (4) Permanently withdraw from mineral entry a selected parcel (186 acres) that support populations of Arizona hedgehog cactus. (5) Acquire a grazing permit for an area that includes Arizona hedgehog cactus populations and preclude grazing activity during mine operation and reclamation. (6) Develop a conservation plan, in coordination with the Tonto National Forest, for protecting the Arizona hedgehog cactus over the long term.
	• Indirect water quality impacts to bald eagles on Roosevelt Lake	TB-2: Implement water quality monitoring and mitigation measures (Section 3.3.4) to mitigate or alleviate potential water quality impacts to Roosevelt Lake.
	• Direct and indirect disturbance to riparian vegetation and wetlands	TB-3: (1) As described in the CWA Section 404 permit, improve/enhance riparian habitat in an amount and quality greater than that disturbed by the project. (2) Acquire grazing permits and implement non-use during the life of the project. (3) Construct fencing around off-site riparian areas to protect them from grazing.
	• Indirect impacts to riparian habitats in Haunted Canyon	TB-4: Implement hydrologic and riparian habitat monitoring and initiate water augmentation, as necessary.
	• Disturbance to bat roosts	TB-5: Identify and provide for protection of alternative bat roost sites, as necessary.
	• Impacts to potential lesser long-nosed bat foraging habitat	TB-6: Transplant agaves from disturbance areas to appropriate undisturbed habitats in project area.
	• Loss of upland vegetation and habitats	TB-7: (1) Construct fencing of mining areas. (2) Implement road closures. (3) Purchase grazing permit(s), and implement non-use. (4) Maintain existing off-site water developments.
Aquatic Biology	• Sedimentation impacts on aquatic and fish spawning habitat	AB-1: Coordinate construction activities with the Forest Service to ensure that proper mitigation measures are implemented; schedule activities to minimize impacts during spawning periods.
	• Loss of wetland habitat	AB-2: As required by the CWA Section 404 permit, restore wetland habitat in an amount and quality greater than that disturbed by the project.
	• Loss of waters of the U.S.	AB-3: As required by the CWA Section 404 permit, restore waters of the U.S. in an amount and quality equal to or greater than that disturbed by the project.

Table 3-96. Summary of Monitoring and Mitigation Measures (continued)

Resources	Impacts	Monitoring and Mitigation
Cultural Resources	• Direct impacts to 56 cultural sites (35 are NRHP-eligible), and indirect impacts to 12 sites (8 are NRHP-eligible)	CR-1: Retrieve data at 35 directly impacted, NRHP-eligible sites and conduct appropriate mitigation. Monitor 8 indirectly impacted, NRHP-eligible sites regularly (by an archaeologist), and fence sites, if necessary. This mitigation applies to the TCPs associated with impacted NRHP-eligible archaeological sites. For non-eligible sites, the Forest Service may consult with concerned Tribes to identify possible ways to alleviate potential impacts.
Socioeconomics	• In-migration of workers	SE-1: Provide recruitment and training opportunities for the Native American workforce at the San Carlos Indian Reservation and other local workers.
	• Housing shortage for both construction and operations workforce	SE-2: Provide a schedule of project development to local government planning agencies.
	• Decrease in water availability for Top-of-the-World residents	See measures WR-1 and WR-7 under Water Resources.
Land Use	• Disturbance and loss of grazing allotments that would require an amendment to the *Tonto National Forest Plan*	LU-1: Relocate allotment boundary fences and implement range structural improvements according to a plan developed by Carlota, the permittees, and the Forest Service.
		LU-2: Construct fences to exclude livestock from active mining and processing areas.
	• Loss of permit(s) for fuel wood salvage that would require an amendment to the *Tonto National Forest Plan*	LU-3: Develop a plan with the Forest Service to salvage fuel wood from disturbed areas.
	• Lowering of livestock numbers for grazing permits	LU-4: Work with Bellevue and Bohme grazing permittees to develop plan to minimize their economic losses.
Recreation	• Reduction in dispersed recreation activities in project area; including elimination of access for horseback riding in Powers Gulch	R-1: Develop a recreational access management plan with the Forest Service.
Wilderness and Wild and Scenic Rivers	• Potential flow and water quality impacts on the Pinto Creek segment being considered for Scenic designation	See measures WR-1, 3, 4, 5, 6, 7, 8, 10, and 13 under Water Resources.
	• Limited access to the Superstition Wilderness	See measure R-1 under Recreation.
	• Increased noise levels in the Superstition Wilderness	See measures N-1 through N-5 under Noise.
Visual Resources	• Visual impacts to sensitive viewpoints such as U.S. Highway 60, the Superstition Wilderness, and Top-of-the-World residents	VR-1: Select colors for buildings and project facilities that blend with the surroundings and reduce reflectivity.
		VR-2: Shield and direct night-lighting downward to avoid night spill and glare.
		VR-3: Revegetate (where feasible) to reduce the long-term (postmining) form and color contrasts. Priority locations would include roads, mine rock areas, and the heap-leach pad.

Table 3-96. Summary of Monitoring and Mitigation Measures (Continued)

Resources	Impacts	Monitoring and Mitigation
		VR-4: Treat the top portions of the Eder pits using chemical darkening agents, rounding or warping benches, and/or rubblizing slopes to prevent color contrast with surrounding area.
Noise	• Noise impacts to sensitive receptors such as the Super stition Wilderness, Top-of-the-World, and Tony Ranch Ridge	N-1: Use state-of-the-art mufflers and maintain equipment in good operating condition.
		N-2: Avoid nighttime blasting.
		N-3: Submit final facility design to the Forest Service for review of noise considerations.
		N-4: Conduct monitoring to verify model and determine operational noise.
		N-5: Submit changes in equipment type or size to the Forest Service; additional modeling or mitigation may be required to accommodate the change.
Transportation	• Restricted access to Eder Ridge	T-1: Fund relocation of Forest Service Road 898 and/or maintenance of the westerly portion so that public access to Eder Ridge is preserved.
	• Planned closure of portions of several existing Forest Service roads	T-2: Close and revegetate those roads identified in the RATM that would be cut off by project operations.
	• Restricted access to Forest Service Trail 203	T-3: Develop a plan with the Forest Service to manage the section of Forest Service Trail 203 affected by project operations. Maintenance activities may include drainage, erosion control, turnarounds, gating, signing, and revegetation.
	• Vehicle wear on Forest Service Road 287 (Pinto Valley Mine Road)	T-4: Implement a Road Use Permit between Carlota and the Forest Service to use and maintain the paved portion of Forest Service Road 287.
Hazardous Materials	• Potential impacts to environ-mental resources in the event of an accidental release of hazard-ous materials during transporta-tion and use or storage at the site	HM-1: Update Carlota's SCHMM Plan after engineering design plans for the project are finalized.
		HM-2: Test existing hazardous materials that are located on the site during construction to determine their contents and cleanup/disposal actions.
		HM-3: Offload sulfuric acid from tanker trucks to storage tank using gravity flow system.
		HM-4: Revise the SCHRMM plan and modify Pinto Creek main access road crossing design to allow access for emergency response during flooding events.
		HM-5: Test slimes and residual materials remaining in the lined ponds containing process solutions (excluding the PLS ponds within the leach pad) and, if necessary, dispose of the material in accordance with the ADEQ Aquifer Protection Permit and applicable state and federal regulations.

3.16 Unavoidable Adverse Impacts

Unavoidable adverse impacts are impacts that remain following the implementation of mitigation measures, or impacts for which there are no applicable mitigation measures. Implementation of the proposed environmental protection measures and the mitigation measures identified in Chapter 3, Affected Environment and Environmental Consequences, would eliminate most of the adverse impacts associated with the proposed action and the alternatives. The unavoidable adverse impacts that would remain following mitigation are summarized below for each resource. If specific alternatives would result in different unavoidable adverse impacts, the impacts associated with the alternatives are listed for the affected resources.

The potential impacts associated with a leak or spill of hazardous materials, including a release of material from the heap-leach pad, are identified for the appropriate resources; however, the nature and severity of the impact would depend upon numerous factors, such as the location and volume of the spill or leak in relation to the sensitive resources, time of year, sensitivity of the resource, and characteristics of the pathway (e.g., surface water flow, gradient, etc.).

No unavoidable adverse impacts are anticipated for socioeconomics, recreation, or transportation.

3.16.1 Air Resources

- Potential to cause perceptible plume impacts in the Superstition Wilderness.

3.16.2 Geology and Minerals

- Disturbance to approximately 1,428 acres of surficial geologic materials.
- Generation of approximately 100 million tons of spent ore to be left in the closed and reclaimed heap-leach pad.
- Permanent storage of approximately 160 million tons of mine rock in surface disposal areas. (This amount would be reduced by approximately 17 million tons for the agency preferred alternative.)

3.16.3 Water Resources

- Permanent loss of approximately 39 acres of alluvial floodplain.
- Removal and consumption of ground water from well field extraction and mine dewatering.
- Loss of approximately 2.4 miles of natural stream channel.
- Permanent removal of 0.5 square mile of contributing watershed area.
- Possible release of hazardous substances resulting in ground water or surface water impacts.
- The success of stream and spring mitigation is unknown; if mitigation does not succeed, unavoidable adverse impacts would occur.

3.16.4 Soils and Reclamation

- Long-term loss of approximately 490 acres of soils from postmining land uses (and an additional 34 acres of soils for the Eder side-hill leach pad alternative).
- Potential reduced soil production associated with a spill or leak of hazardous materials.

3.16.5 Biological Resources

3.16.5.1 Terrestrial Biology

- Of the vegetation types in the project area (interior chaparral, rubbleland chaparral, dry-slope desert brush, and juniper/grassland), approximately 490 acres would be removed and would not be reclaimed (and an additional loss of approximately 34 acres for the Eder side-hill leach pad alternative).
- Loss of wildlife habitat in vegetation types listed above.

- Loss of approximately 10 to 20 percent of transplanted Arizona hedgehog cacti that may be unsuccessfully transplanted for the proposed action (and additional backfill of the Eder South pit alternative or the Eder side-hill leach pad alternative).
- Loss of occupied habitat for the Arizona hedgehog cactus: 23.9 acres for the proposed action (6.9 acres for the additional backfill of the Eder South pit alternative; 20 acres for the Eder side-hill leach pad alternative. Agency preferred alternative would partially restore potential habitat in reclaimed area of Eder South pit).
- Loss of potential habitat for the Arizona hedgehog cactus of 237.6 acres for the proposed action; however, unoccupied habitat is not protected under the Endangered Species Act.
- Possible effects of a spill or leak on vegetation and wildlife habitat, including the Arizona hedgehog cactus.
- Possible toxic effects of a spill or leak on populations of Arizona toad and lowland leopard frog in Haunted Canyon and Pinto Creek. Adverse effects on amphibian populations would affect food sources for common black-hawk.

3.16.5.2 Aquatic Biology

- Possible toxic effects of a spill or leak on aquatic biota, including the desert sucker and longfin dace in Haunted Canyon and Pinto Creek.
- Loss of habitat in a 7,300-foot section of Powers Gulch caused by flow reductions from the construction and operation of the diversion and inlet control structure.

3.16.6 Cultural Resources

- Direct impacts to 56 cultural resource sites; indirect impacts to 12 cultural resource sites.
- Impacts to TCPs cannot be avoided and are not mitigable, but may be alleviated through further consultation with the affected Tribes prior to project implementation.

3.16.7 Land Use

- Temporary loss of approximately 1,500 acres of grazing area.
- Loss of approximately 490 acres of unreclaimed land to postmining land uses.

3.16.8 Wilderness and Wild and Scenic Rivers

- Potential effects on ecological values because of a release from the leach pad.

3.16.9 Visual Resources

- Moderate visual impacts from U.S. Highway 60 and moderate-to-high impacts from the Top-of-the-World community.
- High visual impacts from the Top-of-the-World community (Eder side-hill leach pad alternative).

3.16.10 Noise

- Noise impacts to recreationists at the eastern edge of the Superstition Wilderness.

3.16.11 Hazardous Materials

- Potential spills or leaks of hazardous materials may affect environmental resources. The magnitude of the impact would depend on numerous factors, as discussed above.

3.17 Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Short term is defined as the life of the Carlota Copper Project through closure and reclamation. Long term is defined as the future after reclamation is completed.

Many of the impacts associated with the Carlota Copper Project would be short term and would no longer be adverse after reclamation. However, decreases in the long-term soil and vegetation productivity on 490 acres at the pits, mine rock disposal areas, and portions of the leach pad areas are expected. These impacts would be partially offset by reclaiming previously disturbed areas. The relationship of the short-term use of the environment and long-term productivity are identified for each resource in *Table 3-97*.

Table 3-97. Irreversible, Irretrievable, Short-Term, and Long-Term Commitment of Resources - Proposed Action

Resource	Irreversible Impacts	Irretrievable Impacts	Relationship of Short-Term Use of the Environment and Long-Term Productivity
Air Quality	No	No	The potential for perceptible plume impacts in the Superstition Wilderness would exist throughout the life of the project. The potential for these impacts to occur would vary depending upon meteorological conditions and mining activity rates.
Geology and Minerals	Yes	Yes	Approximately 900 million pounds of copper would be removed from the mineral resource.
Water Resources	No	No	Ground water would be consumed from well field extraction and mine dewatering. Well field extraction and mine dewatering would lower the ground water table and could result in the loss of some stream and spring flows; proposed monitoring and mitigation measures are anticipated to minimize these impacts. The ground water levels and resources dependent on these ground water conditions would eventually recover and approach premining conditions.
	Yes	Yes	The lake formed in the Carlota/Cactus pit after closure would continue to be a source of ground water loss through evaporation on the order of 480 acre-feet per year (after the pit lake water level reaches equilibrium); however, this loss is small compared to the overall water balance for the ground water basin.
	Yes	Yes	Permanent watershed loss of 0.5 mi^2.
Soils and Reclamation	Yes	Yes	Soil erosion is expected to be short-term because of the use of reclamation measures. There would be a long-term reduction in soil productivity on approximately 490 acres that would not be reclaimed.
Terrestrial Biology	Yes	Yes	There would be a long-term reduction in vegetation productivity on approximately 490 acres of land that would not be reclaimed. Other impacts would be short-term because of reclamation and mitigation measures.
	No	No	Loss of habitat would be a short-term impact during the life of the project.

Table 3-97. Irreversible, Irretrievable, Short-Term, and Long-Term Commitment of Resources - Proposed Action (continued)

Resource	Irreversible Impacts	Irretrievable Impacts	Relationship of Short-Term Use of the Environment and Long-Term Productivity
Aquatic Biology	No	No	Loss of habitat from the diversion channels would be short-term, since recolonization in new channels would be expected. Loss of habitat from dewatering would be short-term because mitigation measures would return flows to affected stream segments. Potential effects of spills or leaks would likely be short-term, with effects minimized by protection measures and recovery of affected populations.
Waters of the U.S., Including Wetlands	No	Yes	There would be an irretrievable loss of waters of the U.S., including wetlands, under all alternatives. Development of the Carlota/Cactus Pit and the Pinto Creek diversion would result in the irretrievable loss of 0.34 acre of jurisdictional wetlands and 7.28 acres of waters of the U.S. in the Pinto Creek drainage. Construction of the heap-leach pad and the Powers Gulch diversion would result in the irretrievable loss of 2.18 acres of waters of the U.S. for all alternatives except the Eder Side-hill Leach Pad Alternative. Carlota's proposed mitigation plan, in compliance with Carlota's CWA Section 404 permit, would replace lost wetlands at a ratio of 3 to 1 in the Pinto Creek drainage and reconstruct waters of the U.S. in the diversion channels at a ratio of 1 to 1.
Threatened and Endangered Species	No	Yes	Loss of habitat and potential effects of dewatering and spill or leaks would be short-term, as listed for aquatic and wildlife resources. Loss of Arizona hedgehog cactus individuals (unsuccessful transplants) and habitat would potentially be long-term. However, recovery of habitat and individuals would be expected after 20 to 30 years.
Cultural Resources	Yes	Yes	Disturbance of cultural sites would result in permanent loss of those sites and their context, with partial mitigation by data recovery.
Socioeconomics	No	No	There would be short-term impacts to the local infrastructure. There would be increased productivity during the life of the project including production of copper reserves, creation of 177 construction jobs, 282 to 301 operations jobs, and revenue support for Gila and Pinal Counties, as well as the State of Arizona.
Land Use	No	Yes	There would be a short-term loss of public land for livestock grazing and temporary elimination of horseback riding access to the Haunted Canyon trail via Powers Gulch. Reclamation and mitigation would restore grazing productivity and the horseback access, respectively. There would be a long-term loss of postmining land use on areas within the pits and the leach pad. The project would irretrievably devote National Forest System lands to mining uses for the 23-year life of the project. Following completion of mining, about 490 acres of land would not return to premining uses.
Recreation	No	No	Short-term impacts on horseback access, as identified for Land Use would occur. There would be short-term impacts on dispersed recreation, such as hunting.
Wilderness and Wild and Scenic Rivers	No	No	Potential releases from the leach pad would affect the ecological value of the Pinto Creek Scenic river designation on a short-term basis. Decreases in long-term productivity of natural resources would not be expected because of recovery and mitigation measures.

Table 3-97. Irreversible, Irretrievable, Short-Term, and Long-Term Commitment of Resources - Proposed Action (continued)

Resource	Irreversible Impacts	Irretrievable Impacts	Relationship of Short-Term Use of the Environment and Long-Term Productivity
Visual	No	Yes	Moderate to high visual impacts would occur during the life of the project from the Top-of-the-World community. Impacts would be reduced through reclamation and mitigation measures.
Noise	No	No	Short-term noise impacts during construction and operation on the Superstition Wilderness would occur. Impacts would cease after project reclamation is completed.
Transportation	No	No	Short-term traffic impacts during construction and operation would occur.
Hazardous Materials	No	No	A spill or leak of hazardous materials would potentially affect sensitive environmental resources on a short-term basis. However, protection measures, mitigation, and expected recovery of natural resources would result in no long-term reduction in productivity.

3.18 Irreversible and Irretrievable Commitment of Resources

The construction and operation of the Carlota Copper Project could result in the irreversible or irretrievable commitment of certain resources. Irreversible is defined as the loss of future options for using nonrenewable resources, such as minerals or cultural resources, or factors such as soil productivity, which would be renewable only over a very long period. Irretrievable is a term that represents the loss of production, harvest, or use of natural resources. In some instances, irretrievable actions can be reversed if the use changes after the completion of the project. The irreversible and irretrievable impacts of the proposed action are summarized in *Table 3-97* in Section 3.17. In general, the alternatives would result in a similar irreversible and irretrievable loss of resources.