# MINE SITE VISIT:

# COLOSSEUM MINE

U.S. Environmental Protection Agency
Office of Solid Waste
401 M Street SW
Washington, DC 20460

# 3.0 SITE VISIT REPORT: COLOSSEUM MINE

## 3.1 INTRODUCTION

### 3.1.1 Background

The Environmental Protection Agency (EPA) is assisting states to improve their mining programs. As part of this ongoing effort, EPA is gathering data related to waste generation and management practices by conducting site visits to mine sites. As one of several site visits, EPA visited Colosseum Mine near Las Vegas, Nevada, May 7, 1992.

Sites to be visited were selected to represent both an array of mining industry sectors and different regional geographies. All site visits have been conducted pursuant to RCRA Sections 3001 and 3007 information collection authorities (see Appendix 3-A). When sites have been on Federal land, EPA has invited representatives of the land management agencies (Forest Service and/or Bureau of Land Management). State agency representatives and EPA regional personnel have also been invited to participate in each site visit.

For each site, EPA has collected waste generation and management information using a three-step approach: (1) contacting the facility by telephone to get initial information, (2) contacting State regulatory agencies by telephone to get further information, and (3) conducting the actual site visit. Information collected prior to the site visit is then reviewed and confirmed during the site visit.

In preparing this report, EPA collected information from a variety of sources, including, Colosseum, Inc. and the Bureau of Land Management (BLM). The following individuals participated in the Colosseum Mine site visit on May 7, 1992:

<u>Colosseum Mine</u>

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Participants in the site visit were provided an opportunity to comment on a draft of this report. Colosseum Inc. submitted comments, which are presented in Appendix 3-A. EPA responses to comments by Colosseum are presented in Appendix 3-B.

### 3.1.2 General Facility Description

Colosseum Inc., a subsidiary of Lac Minerals Ltd., conducted mining and cyanide (carbon-in-pulp) leaching of gold/silver ore in the Clark Mountain Range of southeastern California from 1988 to 1993 (see Figure 3-1

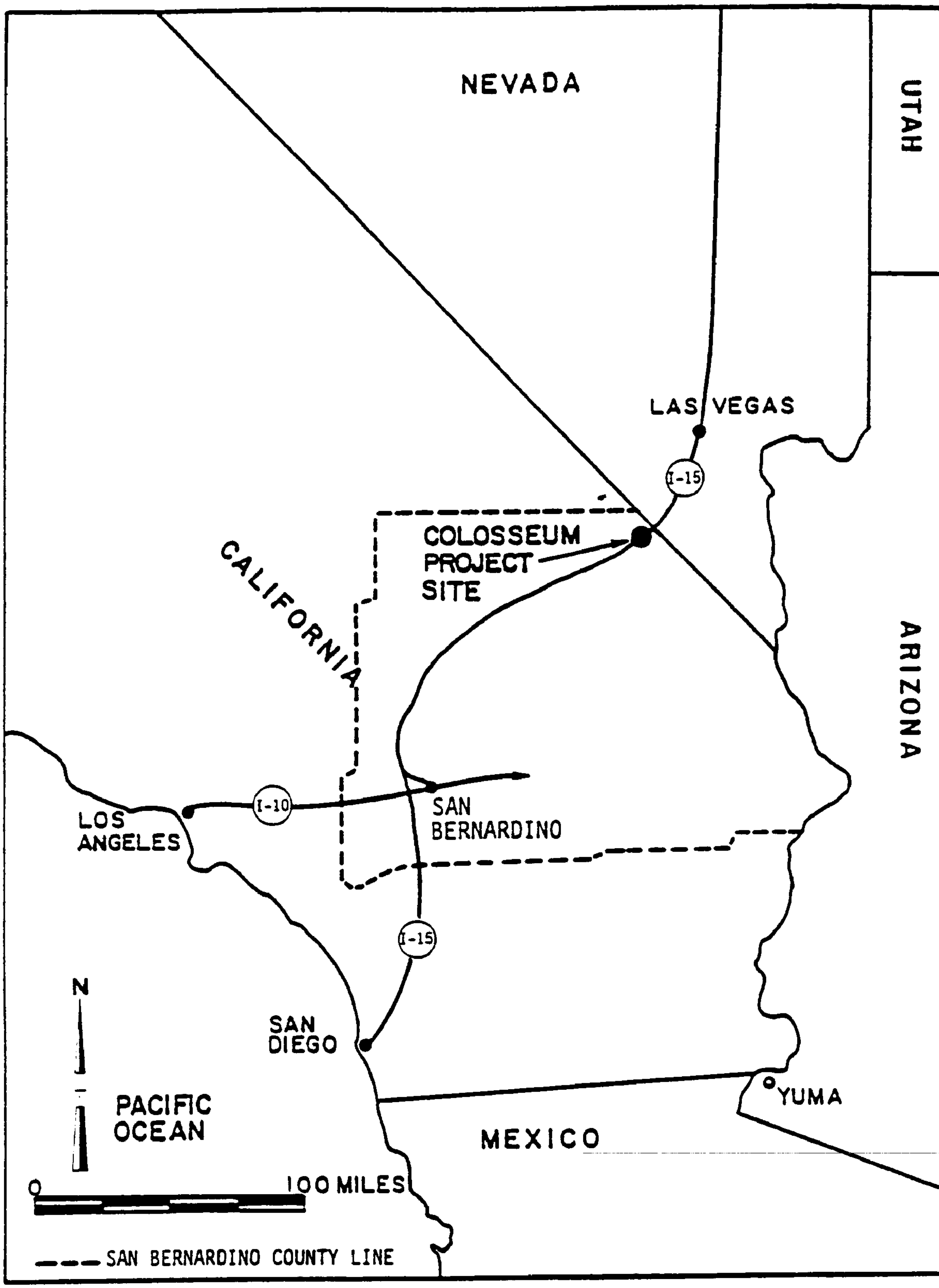


**Figure 3-1. Location of Colosseum Mine**

(Source: Bureau of Land Management, et al., 1985a)

). Mining operations ceased on July 10, 1992. Milling operations continued until May 1993. The mine and mill are located in San Bernardino County, California, approximately 50 miles southwest of Las Vegas, Nevada. The closest developed area to the mine (12 miles) is Whiskey Pete's, Nevada, a roadside development of casinos, gas stations and fast food restaurants on Interstate 15 at the Nevada/California state line.

The mining facilities occupy 284 acres with another 3,316 acres held as private land and unpatented mining claims. Mining was conducted in two open pits, the South Pit and the North Pit. Most of the mining facility lies on unpatented Federal land under the jurisdiction of the Bureau of Land Management (BLM); but two patented claims are located in the South Pit. Land use in the vicinity of the mine includes grazing and recreation. A large BLM grazing lease overlaps the mine/mill/tailings complex. The mine is located within the boundaries of the East Mojave National Scenic Area and the Clark Mountain Area of Critical Environmental Concern. These areas provide for limited multiple use of public lands within their boundaries. In addition, one Wilderness Study Area borders the property held by Colosseum Inc. (Bureau of Land Management, et al., 1985a)

The mine is within the old Clark Mountain Mining District, which produced silver, gold, copper, lead, tungsten and fluorite at various times over the last 120 years. Gold was first produced in the district in the 1930s. In the 1970s, Draco Mines and their partners performed intermittent exploration drilling on the Colosseum property. Amselco leased the property from Draco Mines in 1982 and conducted extensive drilling and feasibility studies between 1982 and 1984. Amselco began the required permit applications in 1983 and a Final Environmental Impact Report and Environmental Impact Statement was approved in July 1985 (see section 3.4.1).

Dallhold Resources, Inc., purchased the Colosseum property in September 1986. Sometime after this purchase, Dallhold Resources, Inc., became part of Bond International Gold, Inc. Mine and mill construction began in 1987 and the mill began operation in January 1988. In November 1989, the Colosseum Mine changed ownership once more when Lac Minerals, Ltd., acquired the mine through their purchase of Bond International Gold, Inc.'s properties. Colosseum, Inc., a subsidiary of Lac Minerals Ltd., operated the Colosseum mine until July 10, 1993. (Attaway, Undated; Bond Gold Colosseum, Inc., 1990; Holden, H.L. 1991)

The mill was active seven days a week, twenty-four hours a day and the open pits were mined Monday through Friday, nine hours a day. On average, the mine employed 110 people, with peak employment of 300 during the construction of the facilities in 1987. The mine employed 94 people in May 1992: 55 employees of Colosseum Inc. and 39 employees of the contract mining company, Industrial Contractors Corporation.

In 1990, total reserves were estimated at 3.9 million tons of ore with an average grade of 0.040 troy ounces of gold per ton. As of July 12, 1990, Colosseum had produced over 170,000 troy ounces of gold. (Bond Gold Colosseum, 1990b).

On July 10, 1992, Colosseum ceased mining after four and one-half years of operation. Milling of stockpiled ore continued until May of 1993. According to Colosseum personnel, there are no plans to continue mining due to a variety of economic reasons. Reclamation has been ongoing. (Colosseum Inc., 1992e)

### 3.1.3 Environmental Setting

The Colosseum Mine lies in the southern end of the Great Basin Physiographic Province in the Clark Mountain Range (see Figure 3-2

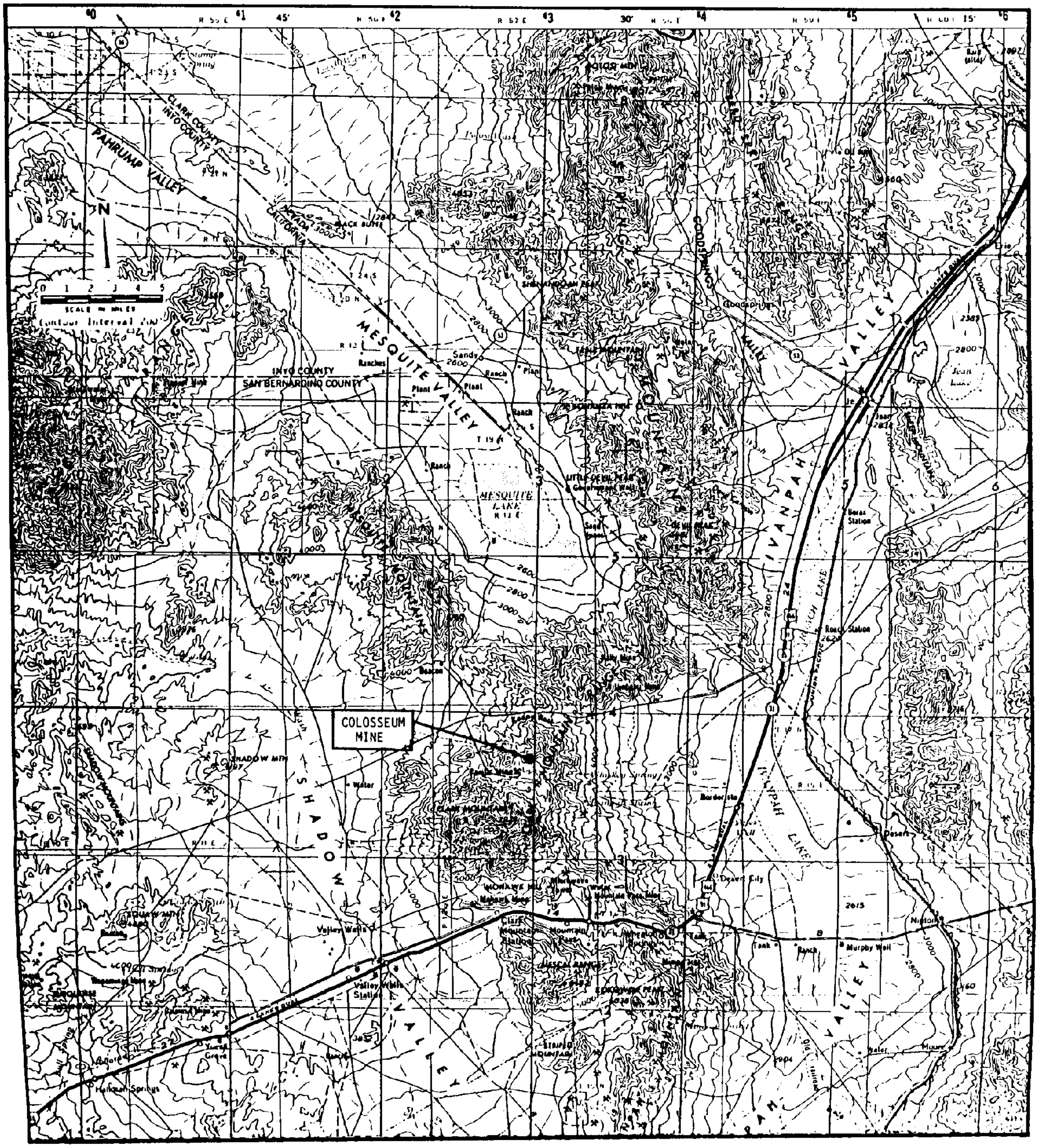


**Figure 3-2. Topographic Setting of the Colosseum Mine**

(Source: Bureau of Land Management, et al., 1985a)

).  The Great Basin Province is characterized by valley and range topography that resulted from block faulting during Tertiary time.  The Clark Mountains reflect this topographic expression, being bounded by Ivanpah Valley on the east, Shadow Valley on the west and Mesquite Valley to the north.

The mine is located between 5,000 and 6,000 feet above sea level on the northeast side of Clark Mountain, the highest peak in the range at 7,929 feet above sea level.  The mine and mill buildings occupy the northern end of a gently sloping plateau-like area, which extends from the north flank of Clark Mountain to the two open pits.  Colosseum Gorge dissects the northern end of this plateau-like area to the east and an unnamed dry wash dissects the area on the west.

The climate is that of a high, mid-latitude desert, characterized by very low precipitation and large diurnal temperature fluctuations.  Annual precipitation (virtually all in the form of rain) at Mountain Pass, approximately six miles south-southeast of the mine site and at a higher elevation, averages between 10 and 12 inches.  Most of the precipitation falls during November and December as frontal winter storms pass over the mountains and in the spring and summer from convectional thunderstorms.  According to Colosseum personnel, since the start of mining, precipitation has averaged less than seven inches per year (as measured by a rain gauge at the mine).  As of May 1992, the mine had received slightly less than six inches of precipitation for the year.

Temperatures in the region experience large ranges due to the efficient heating and cooling of the earth under the generally clear skies.  As of 1980, the mean maximum temperature at Mountain Pass was 85.8 degrees Fahrenheit (°F) and the mean daily minimum temperature was 46.1°F.  Prevailing winds at the mine are from the northwest, with significant southerly flows.  Diurnal wind data indicates a typical up- valley/down-valley pattern of air movement.  During the day, warming air in the valleys rises up the drainages, and through the late night and early morning, cooled air travels back down the drainages.

Habitat for the Desert Tortoise (a Federal endangered species) exists in Ivanpah Valley, along the main access road to the mine.  In addition to the road, the other main disturbance to the Desert Tortoise habitat is a fresh water pipeline that carries water from supply wells in the valley to the mine.  Speed controls, elevated pipelines and regular sweeps of the road have been implemented by Colosseum through their operating permit to protect the Desert Tortoises living in Ivanpah Valley (see section 3.4).

#### 3.1.4 Geology

Igneous and sedimentary rocks of Precambrian and Paleozoic age form the structurally complex Clark Mountain Range.  The mine lies in the Clark Mountains between two major faults: to the west of the mine is the north-northwest trending Clark Mountain thrust fault and to the east is the high-angle Ivanpah normal fault, which extends northwest-southeast through Ivanpah Valley (see Figure 3-3

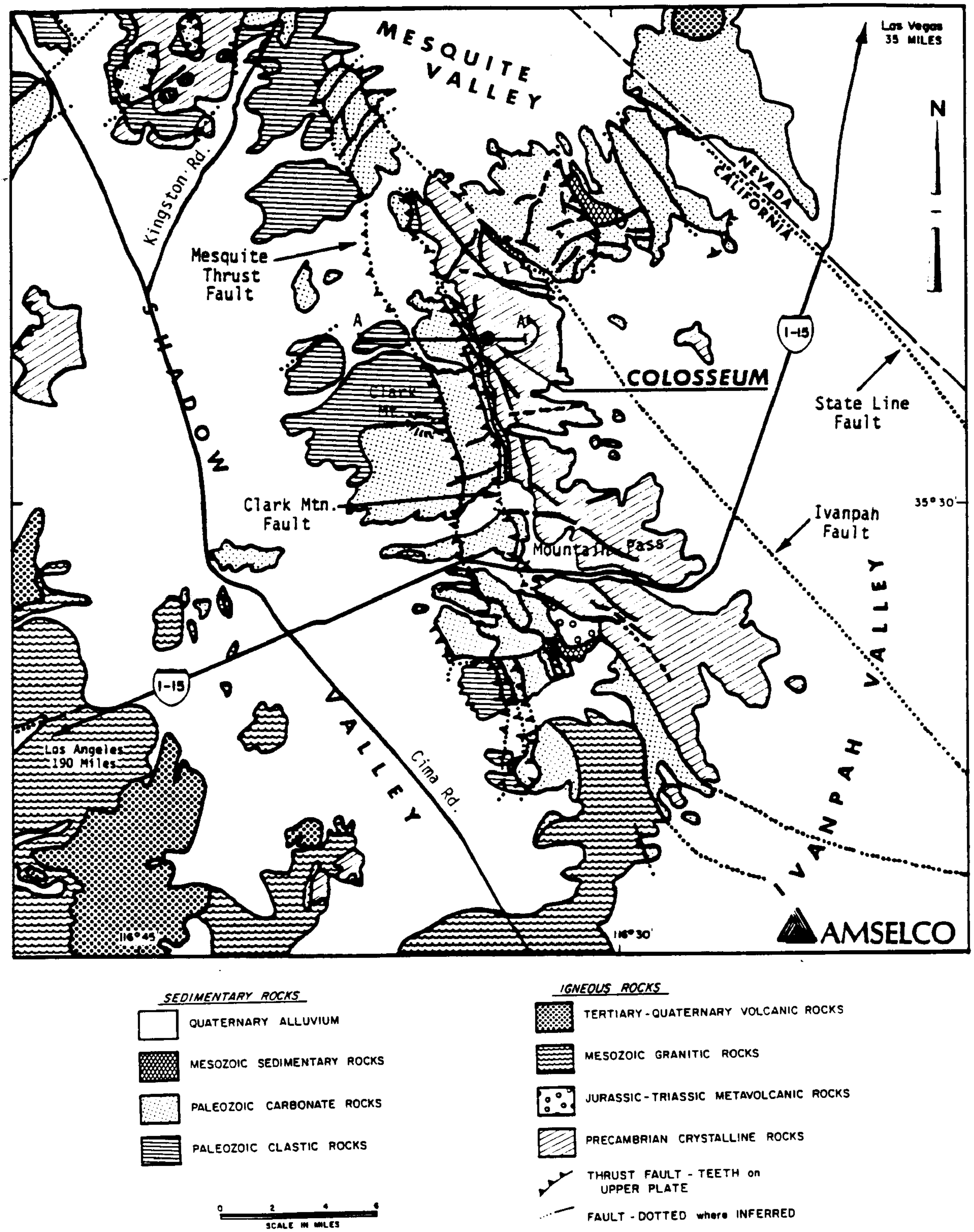


**Figure 3-3. Colosseum Site Geology**

(Source: Bureau of Land Management, et al., 1985a)

The Clark Mountain thrust fault creates an unconformity between Precambrian granitic gneiss to the east of the fault and Cambrian sedimentary rocks to the west of the fault. (Bureau of Land Management, et al., 1985a)

The ore body mined by Colosseum consists of two small mineralized felsite breccia pipes (north and south) intruded into the Precambrian granite gneisses. The breccia pipes are estimated to be 100 million years old (mid to late Cretaceous). Each breccia pipe is approximately 500 feet x 300 feet wide and extends to over 1500 feet deep.

A felsite breccia dike connects the two pipes. The emplacement and mineralization of the pipes is thought to have occurred through the intrusion of rhyolite bodies followed by multiple explosive hydrothermal fluid movements. (Bond Gold Colosseum, Inc, 1990; McClure, 1988)

Most of the mine facilities are located on soils weathered from Precambrian crystalline rocks. The contact between the Precambrian crystalline rocks and the Cambrian sedimentary rocks is just west of the mine buildings, near the tailings impoundment. Thin and discontinuous alluvial deposits are found in drainages around the facility area.

Two wells (MW1 and MW3, see section 3.3.2) drilled downgradient of the tailings impoundment intersect Cambrian sedimentary rocks after drilling through alluvial materials (Sergent, et al., Undated). One well intersects the Cambrian rocks at three feet below the ground surface and the other at 90 feet below ground surface. This 87 foot offset may suggest that a high angle fault extends between the two closely spaced wells. According to Colosseum, the difference in Cambrian contact elevation may simply be the result of stream erosion.

The gold mineralization in the breccia pipes is submicroscopic and occurs with silver in close association with pyrite (the ratio of gold to silver is 1:1). Gold occurs in contact with pyrite, in pyrite fractures, along pyrite grain edges, and encased in pyrite crystals. A low percentage (around 15 percent) of silver is found with the gold as electrum, a natural alloy; the rest is believed to be present in silver minerals (McClure, 1988). Other metals found in the ore include lead, zinc, copper, arsenic, and mercury. According to Colosseum personnel, very little mercury is found in the ore. The two pipes have been mined in two separate open pits: the North Pit with an average grade of 0.04 troy ounce of gold per ton and the South Pit with an average grade of .067 troy ounce of gold per ton.

Recent history indicates that the Colosseum Mine is located in an area of relatively minor seismic activity. From 1932 through 1977, no earthquakes of Richter Magnitude 4 or greater were recorded within a 50 mile radius of the mine. However, for the design of the tailings impoundment, seismic studies were conducted to determine the Maximum Credible Earthquake (MCE). The MCE was determined to occur along the Ivanpah Fault (see Figure 3-3) at Richter Magnitude 6.0. (Bureau of Land Management, et al., 1985a)

### 3.1.5 Surface Water

No perennial streams exist in the vicinity of the Clark Mountains. During the site visit, the EPA team observed no water in the ephemeral channels at the site. Information on when and how much water is conveyed in these drainages was not obtained. Springs in the Colosseum Gorge support intermittent streams and watering holes southeast of the mine along the Old Gorge road. According to Colosseum, all of the haul roads, pits, and mill area drain to the tailings impoundment. Other mine areas, including the waste rock piles drain directly to Shadow Valley.

### 3.1.6 Ground Water

According to the EIS, hydrogeologic studies (author unknown) at the mine site suggest that ground water resources are limited, existing primarily in fractured bedrock (Precambrian gneiss). However, regional ground-water systems exist in the valleys surrounding the Clark Mountain Range: Ivanpah, Shadow and Mesquite Valleys. These ground-water systems are at least ten miles from the mine and are at elevations approximately 2,000 to 3,000 feet below the mine. Recharge to these systems occurs through direct precipitation and runoff from the surrounding mountains (including the Clark Mountains). (Bureau of Land Management, 1985a)

Ground water exists in fractured Precambrian gneiss at the mine site. According to Colosseum, five (of nine) site monitoring wells contain water. Green's well, an old livestock watering well now beneath the tailings impoundment, also contained water. All of these wells were completed in bedrock. Depth to water in these wells (total depth of wells was not available) ranges between 14 and 67 feet below ground surface. Green's well and mine shafts (see Section 3.3.2 for further discussions), located in the middle of the tailings impoundment, were estimated as over 350 feet deep and as containing ground water at a depth of 55 feet below ground surface (Bureau of Land Management, 1985a).

The gneisses are of low permeability: field tests indicate hydraulic conductivity ranges from $3 \times 10^{-7}$ to $9 \times 10^{-6}$ centimeters per second. Transmissivity calculated from results of aquifer tests ranged from 24 to 52 gallons per day per foot. According to the EIS, these very low values indicate groundwater exists in the fractured bedrock, but that existing water flows at very low velocity and is subject to very little recharge from surface runoff (exact data on recharge were not provided in the EIS). Baseline geologic and hydrogeologic studies completed prior to the approval of the mine state that these aquifer properties limit the vertical or lateral hydraulic connection that may exist between the site ground-water resources and the regional ground water systems existing in the valleys (Bureau of Land Management, 1985a). These baseline studies were not obtained for review and analysis in this report.

Two wells, MW1 and MW3, drilled into the sedimentary Cambrian units downgradient of the current tailings impoundment, were found to be dry. It is unclear if the Cambrian units may contain water in other areas surrounding the facility. According to Colosseum personnel, further information on these wells is not available.

It is unclear if water resources exist in small pockets of alluvium at the site. With the exception of monitoring well MW2, a dry well installed downgradient of the tailings impoundment, no information was obtained on wells that may have been completed in the limited alluvial deposits (see section 3.3.2).

Several springs, both perennial and intermittent, exist in the Colosseum Gorge, just east of the site. Water quality of these springs is good; TDS concentration is approximately 550 mg/l. The springs yield only small amounts of water, ranging from 0.1 - 5.0 gpm; however, as discussed above, they provide sufficient water tosupport intermittent streams and watering holes in the Colosseum Gorge. (Bureau of Land Management, et al., 1985a) Figure 3-4, a topographic map of limited extent, shows the location of several ground-water wells

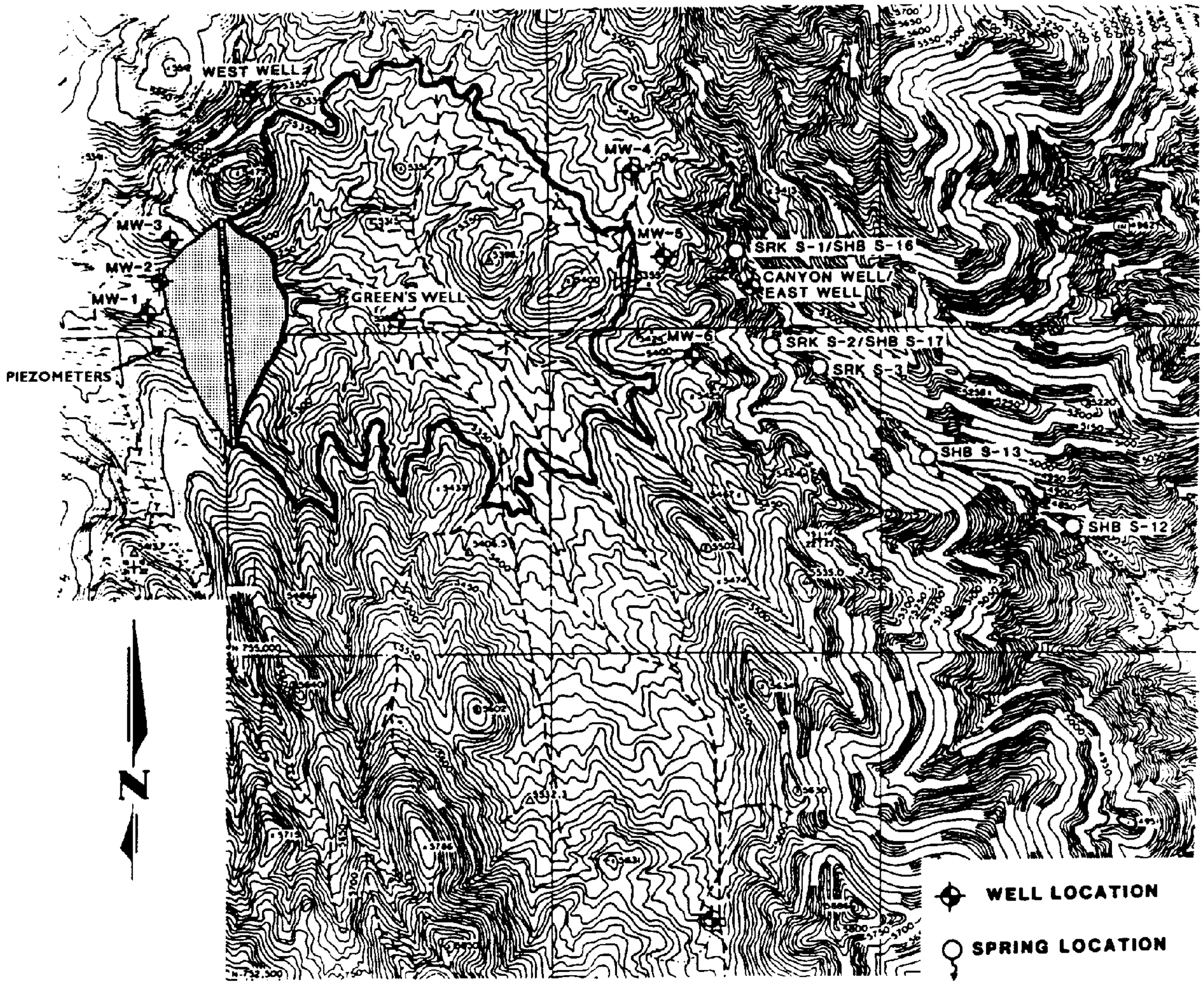


**Figure 3-4. Locations of Wells and Springs Near the Tailings Impoundment and in Colosseum Gorge**

(Source: Steffen Robertson and Kirsten, 1987)

**Table 3-2. Concentrations of Selected Constituents from Quarterly Samples of Ground Water Extracted From the Ivanpah Valley Aquifer**

| Analyte | 1988* Min. - Max. | 1989 Min. - Max. | 1990 Min. - Max. | 1991** Min.- Max. |
|---|---|---|---|---|
| Conductivity, mmhos/cm | 697 - 709 | 678 - 709 | 666 - 741 | 653 - 769 |
| pH, s.u. | 8.0 - 8.10 | 8.08 - 8.19 | 7.80 - 8.13 | 8.16- 8.48 |
| WAD CN, ppm | <0.005 - <0.02 | <0.02 | <0.02 | <0.02 |
| Total CN, ppm | <0.005 - <0.02 | <0.02 | <0.02 | <0.02 |
| TDS, ppm | 313 - 350 | 325 - 340 | 330 - 360 | 350 - 360 |
| Sulfate, ppm | 37 - 47 | 45 - 46 | 35 - 45 | 43 - 47 |
| Sodium, ppm | 47 - 57 | 48 - 59 | 55 - 63 | 59 - 63 |
| Copper, ppm | <0.01 - <0.02 | <0.02 | <0.02 | <0.02 |
| Iron, ppm | 0.05 - <0.02 | 0.05 - <0.01 | <0.01 | <0.01 - <0.04 |
| Zinc, ppm | 0.18 - 0.37 | 0.05 - 0.17 | 0.03 - 0.1 | 0.02 - 0.9 |
| Lead, ppm | NS | <0.002 | <0.002 | <0.002 |

KEY:
* 1988 data is for only two sampling events (two quarters).
** 1989 data is for only three sampling events (three quarters).
NS - No sample

Source: Colosseum, Inc., 1992.

and springs.

As discussed above, there are aquifers in the valley surrounding the site. The Ivanpah Valley Aquifer ranges from 20 to 220 feet below the surface of the valley. The total aquifer storage capacity has been estimated by the California Department of Water Resources at 3,090,00 acre-feet, with an annual recharge of approximately 800 acre-feet. According to the EIS, when the mine was originally proposed, the Ivanpah Valley Aquifer was experiencing diminishing ground water levels, or "overdrafts", as a result of annual ground-water extractions exceeding the annual recharge. Colosseum maintains two wells in the Ivanpah Valley for water supply. These wells provide 800 gallons per minute, 16 hours a day (i.e., approximately 860 acre-feet per year). Consequently, ground water extraction for Colosseum's operations may result in further ground water overdrafts in the Ivanpah Valley Aquifer. Water quality of ground water in the aquifer is highly variable, ranging from good to poor, and has been used in industrial, irrigation, domestic, and livestock operations. Colosseum samples and analyzes the ground water extracted from their Ivanpah Valley Aquifer water supply wells on a quarterly basis. Samples are collected at building taps. Table 3-1 presents a summary of this water quality data.

The Shadow Valley Aquifer ranges in depth from 40-300 feet below ground surface. Total storage capacity was estimated by the California Department of Water Resources as 2,130,000 acre-feet. Ground water quality in the Shallow Valley aquifer is highly variable, with TDS values ranging from 500 - 2,400 mg/l and poor quality water exiting from the local valley springs. During operations, Colosseum extracted no water from the Shadow Valley Aquifer.

Depth to the Mesquite Valley Aquifer ranges from 20 to 200 feet. The California Department of Water Resources estimated the aquifer storage capacity at 580,000 acre-feet. The water quality is locally unsuitable for domestic and irrigation uses. During operations, Colosseum extracted no water from the Mesquite Valley Aquifer.

## 3.2 FACILITY OPERATIONS

This section describes the extraction and beneficiation operations as they appeared during the time of EPA's site visit at the Colosseum Mine in May of 1992. Since that time both the mine and mill have ceased operation. During operation, the flow of materials began with the removal of waste rock and ore from two open pits. The ore was either transported to the mill or stored in the low grade stockpile. At the mill, the ore was crushed, ground and leached in a Carbon-In-Pulp (CIP) cyanide circuit for the removal of precious metals. After stripping the precious metals from the carbon, electrowinning, electrorefining and smelting (in a small furnace), a doré of 70 percent gold and 30 percent silver was produced. A general site map illustrates the location of facilities described below (see Figure 3-5

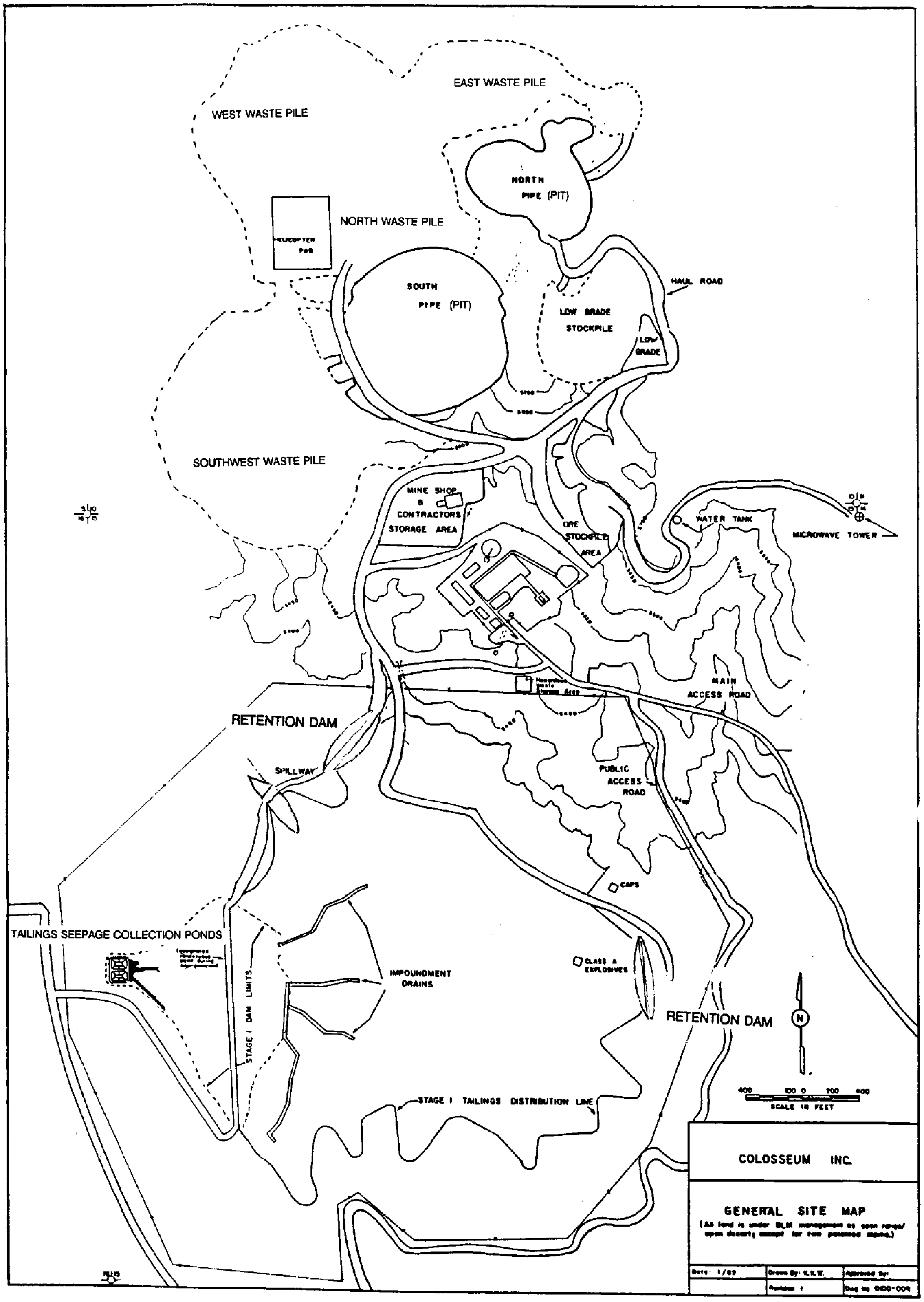


**Figure 3-5. General Site Map of the Colosseum Mine**

(Source: Colosseum, Inc., 1989a)

### 3.2.1 Mining

Mining began at Colosseum in late 1987 and the mill began operating in January 1988. In May 1992, mining at the Colosseum Mine removed 15,000 tons of rock per day, five days a week. This rate was down from the 29,000 tons of rock removed per day, six days a week in 1990. The State permitted the mine to excavate up to 31,000 tons per day. (Attaway, Undated)

The two breccia pipes (ore bodies) were mined through two open pit excavations: the North and South pits. Colosseum used a contract mining company, Industrial Contractors Corporation, to drill, blast, excavate and transport the waste rock and ore from the pits. Blastholes with a 6.5 inch-diameter were drilled on a 15-foot by 15-foot square pattern using a downhole hammer. ANFO (ammonium nitrate mixed with fuel oil) was used as the blasting agent. Four blasts were conducted each week, with no more than one per day. A 13-cubic yard front-end loader excavated the broken rock and placed it into 85-ton haulage trucks for transport to either the waste rock piles, the low-grade stockpile (the waste rock /low-grade cutoff was not obtained), or the primary crusher. Fifty-ton haulage trucks were used in the South Pit due to the restricted access of the narrowed pit configuration at the bottom of the pit (see section 3.3.3).

According to Colosseum, the project to date stripping ratio in both pits was 3.97:1 (waste to ore). In the South Pit, Colosseum maintained a 2:1 (waste to ore) stripping ratio. Colosseum reported a 6:1 stripping ratio on some 20 benches in the South Pit (it is unclear how this ratio relates to the overall South Pit ratio of 2:1). The stripping ratio in the North Pit was 1:1 (waste:ore). The interslope angle of the South Pit is 53 degrees. The interslope angle of the North Pit is 45 degrees. Twenty-foot benches were maintained in both pits. Safety benches were left every 60 feet in the South Pit and every 40 feet in the North Pit.

At the time of EPA's visit, the bottom of the South Pit was at an elevation of 5280 feet, approximately 760 feet deep. Colosseum personnel estimated that continued mining in the South Pit will result in a finished elevation of 5240 feet for the bottom of the South Pit. The mine superintendent estimated the greatest distance across the South Pit to be 1600 feet. The EPA team observed water in the bottom of the pit. According to Colosseum personnel, water is pumped to the tailings impoundment from a sump in the bottom of the pit (no estimate was provided on the amount of water encountered or the level at which water was first encountered). Ore removed from the South Pit yielded approximately 80 ounces of gold per day (when higher grade ore was mined, yields were up to approximately 200 ounces of gold per day). Mining in this pit was scheduled to end in June 1992.

The North Pit bottom was at an elevation of 5,740 feet with a depth of 300 feet at the time of EPA's visit. Prior to 1991, the North Pit was used mostly as a "relief area," mined when the South Pit was being drilled and blasted. In 1991, heavy mining began in the North Pit. According to Colosseum personnel, ore removed from the North Pit yielded 40 to 60 ounces of gold per day. During the site visit, Colosseum personnel estimated that mining would cease in the North Pit at the end of August 1992. On August 4, 1992, Colosseum notified EPA that mining had terminated in both pits on July 10, 1992.

### 3.2.2 Beneficiation

The beneficiation plant is designed for an ore throughput of 3,400 tons per day, or 1.2 million tons per year. As of May 1992, the circuit was beneficiating 3,000 tons of ore per day. Milling operations ceased on May 31, 1993. Figure 3-6 presents a map of the mill. Figure 3-7

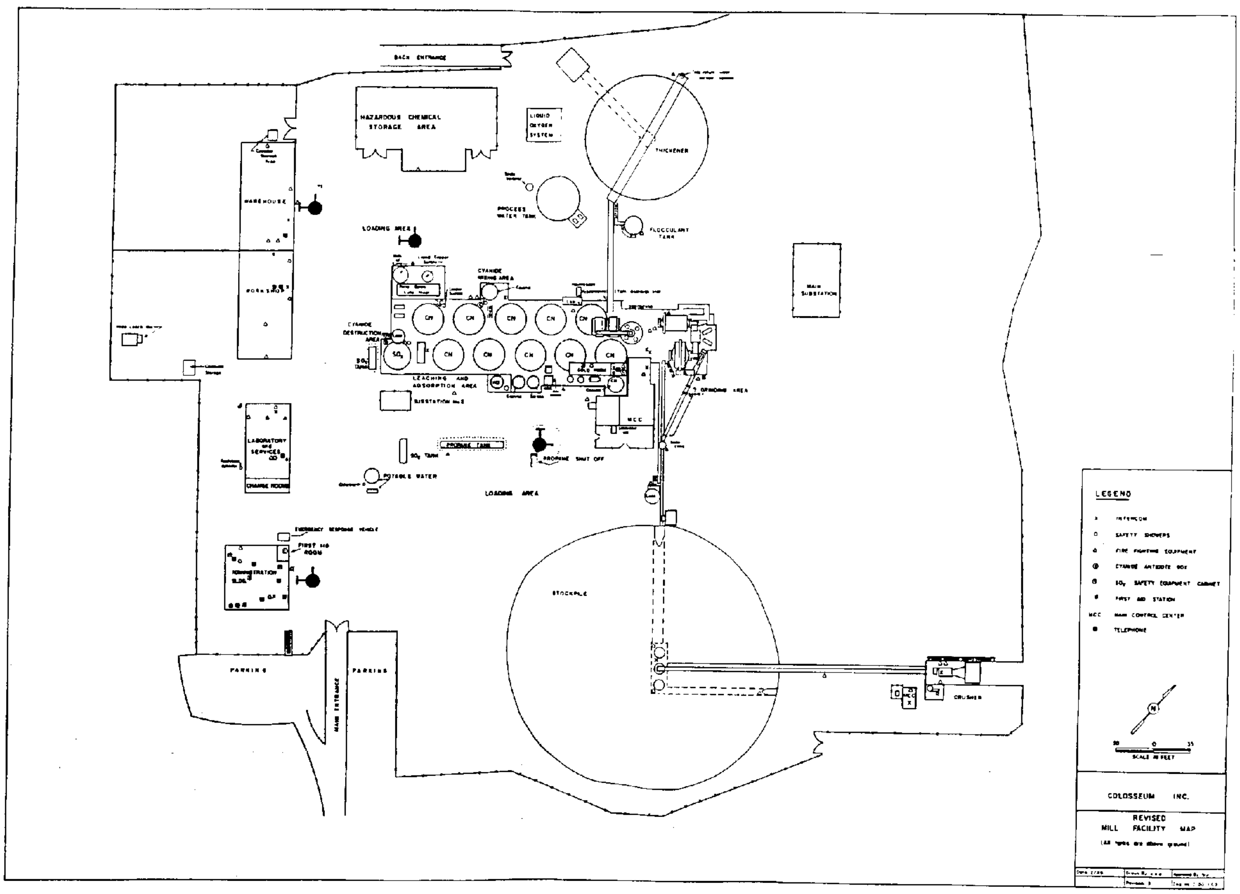


**Figure 3-7. Colosseum Mill Facility Map**

(Source: Colosseum, Inc., 1989b)

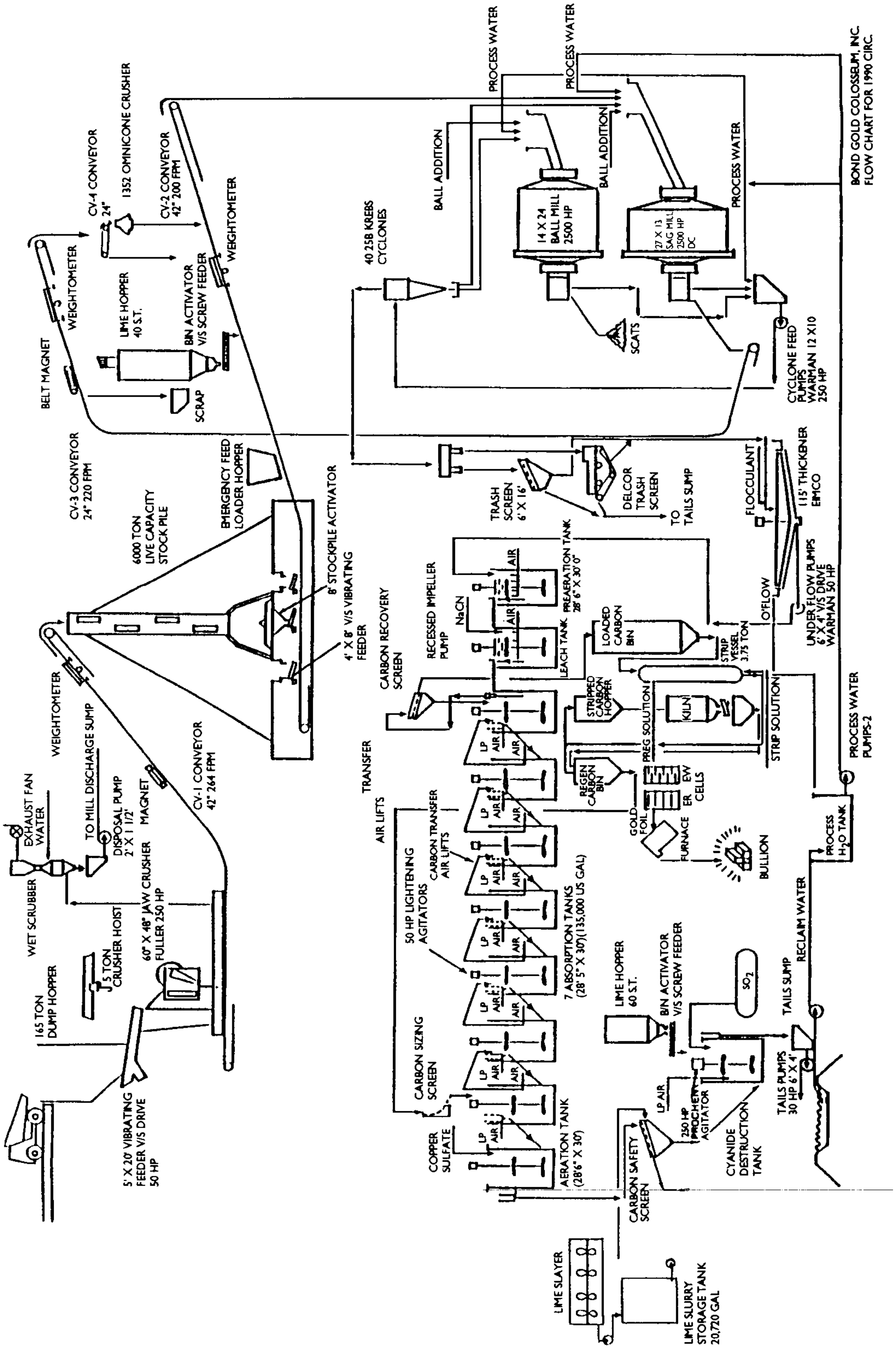


**Figure 3-7. Colosseum Mill Flow Chart**

(Source: Bond Gold Colosseum, Inc., Undated) illustrates the flow of ore and materials through the entire beneficiation operation.

#### 3.2.2.1 Crushing and Grinding

Ore is dumped out of the haulage trucks into a 185-ton hopper with a vibrating feeder. Oversize material (greater than 6-inch) goes to the swing jaw crusher (48 inch by 60 inch) and undersize material (minus 6-inch) goes to a conveyor for transport to the crushed ore stockpile. The jaw crusher reduces the ore from a size of up to 3 feet to less than 6 inches. The crushed ore drops onto the conveyor for transport to the crushed ore storage pile. The crushed ore stockpile contains a 10-day supply for the Carbon-In-Pulp (CIP) plant, with a total capacity of 33,000 tons.

Water sprays are used to control dust at the 185-ton hopper when haulage trucks are dumping ore. The ore crushing unit (including the vibrating feeder, the jaw crusher, the conveyors and the feeders) is equipped with a wet scrubber to collect dust. Slurry from the wet scrubber is pumped to the common mill discharge sump for mixing with the ore slurry. During EPA's visit, the jaw crusher was not operating due to sampling of the wet scrubber. According to Colosseum, the testing of the wet scrubber was for particulate emissions levels and for lead concentrations in the emissions.

Three feeders beneath the stockpile convey ore at the rate of 150 tons per hour to the semi-autogenous grinding (SAG) mill. As the ore is conveyed to the SAG mill, it passes under a lime silo where lime is added to the ore at the rate of two pounds per ton. The purpose of the lime addition is to maintain a pH of 10.8 in the leach circuit. A baghouse is used to collect lime particulate emissions from the lime silo. The conveyor and grinding equipment are equipped with exhaust venting to a wet scrubber. All storm water runoff from the pile and the immediate mill area is directed to the tailings impoundment.

The SAG mill is rubber-lined and measures 21 feet by 13 feet. Water and ore are continuously added to the SAG mill during operation. Grinding media, five-inch steel balls, are charged to the SAG mill daily. The SAG mill grinds the ore to approximately 3/4-inch and maintains 70 percent solids by weight in the discharge slurry. The slurry exiting the SAG mill passes over a grate for the removal of resistant pebbles. These pebbles are sent to a cone crusher for crushing with the crushed product being conveyed back to the SAG mill.

The slurry passing through the grate enters the common mill sump where additional water is added. The slurry is then pumped to a cyclone for sizing. Oversized material (greater than 80 mesh) is sent to a 14- by 24-foot ball mill for additional grinding. The ball mill grinding media are abraded balls from the SAG mill, typically two to three-inches in diameter, and new three inch balls. The ball mill discharge slurry is about 76 percent solids by weight. In the ball mill, ore is ground so that 100 percent passes minus 80 mesh (the feed size for the CIP) and 80 percent passes 120 mesh before it exits the ball mill into the common mill sump. The slurry in the common mill sump is pumped to the cyclone for sizing. Undersized material (approximately 18 percent solids) continues to the CIP, by way of a thickener, and oversize material (i.e., over 120 mesh) is returned to the ball mill for further grinding.

On its way to the thickener, the ore slurry passes over a trash screen, which removes oversized material that has made it through the cyclone sizing operation. This material is typically wood and paper, which makes it through the cyclones because of its low specific gravity. The "trash" is returned to the tailings sump and disposed of as tailings. According to Colosseum, the amount of "trash" is less than 0.01 percent of the tailings. The slurry enters the thickener along with a flocculent, an anionic polymer, A-207. The thickener dewaters the slurry to approximately 56 percent solids by weight. Overflow (water) from the thickener is recycled into the mill makeup water tank and the thickened slurry is typically pumped to a pre-aeration tank (tank 1) to oxidize any sulfides present prior to entering the CIP tanks.

The SAG mill is powered by a 2,500 horsepower direct current variable speed motor for efficient grinding. The Ball mill is powered by a constant speed 2500 horsepower alternating current motor. The grinding units receive maintenance once per week with a complete lubrication. The rubber liners in the SAG mill are replaced every four to six months.

#### 3.2.2.2 Carbon-In-Pulp

Colosseum used the Carbon-In-Pulp technique to leach the precious metals from the ground ore slurry. Ore slurry is pumped to a leach tank where sodium cyanide (NaCN) is added and the slurry is agitated. This cyanide/ore mixture is pumped to the first tank and then gravity flows through a series of tanks for the recovery of the precious metals. Activated carbon is transferred by airlifts through the tanks countercurrent to the flow of the ore/cyanide slurry. Gold and silver cyanide complexes adsorb on the carbon, creating loaded carbon at the front of the circuit. At Colosseum, the circuit maintains a constant ore/cyanide slurry flow of 700 gallons per minute. Tank 1 (130,000 gallon capacity) is normally the first tank in the leach circuit. Compressed air is sparged into the slurry to enhance dissolved oxygen content. The total sulfur content of the ore processed is kept at less than 2.5 percent to limit oxygen consumption. Tank 1 was not in use at the time of EPA's visit due to a change in the sulfide content of the mined ore. During normal operation, slurry from tank 1 gravity flows to tank 2, where 15 percent sodium cyanide (NaCN) is added; tank 2 is agitated. Since tank 1 was not in use during the site visit, tank 2 was the first step in the CIP operation at that time. This tank is sampled every 2 hours and cyanide content is maintained at 0.6 pounds per ton of solution, the optimal concentration for leaching the ore.

There are seven steel CIP tanks, numbered three through nine. The leached slurry is pumped into tank number 3 and leaves through tank 9. At the same time, coarse carbon gravity flows into tank 9 and travels toward tank 3, countercurrent to the slurry flow. Each tank holds 130,000 gallons of ore slurry and six tons of carbon. The carbon is advanced from tank to tank by airlifting the slurry to external screens that discharge the carbon to the preceding tank. Compressed air is bubbled along screens in the tanks to aid circulation by inhibiting screen blinding. The ore slurry gravity flows to the next tank. The ore slurry has a 24-hour residence time for the entire circuit. The gold concentration of the slurry, initially 2.0 to 2.5 ppm in the first tank, drops to less than 0.01 ppm in the final tank as it is adsorbed by the carbon. The spent ore slurry (tailings) gravity flows to an aeration tank, tank 10, for a final screening of any carbon that may have become inadvertently entrained in the spent ore. Tailings, containing approximately 260 ppm weak acid dissociable

(WAD) cyanide, gravity flow from the aeration tank to tank 11 for cyanide destruction using the INCO $SO_2$ Process (see section 3.3.1). In 1991, 928,444 tons of ore were leached in the CIP circuit.

All tanks in the CIP circuit are surrounded with secondary containment. According to facility personnel, the secondary containment has sufficient capacity to handle "all spills", but the exact volume of secondary containment was not obtained. Any spillage is reportedly pumped back into the process tanks.

#### 3.2.2.3 Carbon Stripping

Loaded carbon containing as much as 120 troy ounces of gold per ton of carbon, is pumped in batches from the CIP tanks to a stripping column. The stripping column is a 20-foot tall, rubber-lined steel tank with a capacity of 3.8 tons. A solution of 1.5 percent cyanide and one percent caustic (sodium hydroxide) is heated to 240°F and circulated in the stripping column (the pH of this solution and its method of heating was not obtained). This stripping solution creates a chemical environment that favors the dissolution of gold from the carbon and the creation of gold cyanide complexes. When the stripping cycle is complete, the pregnant solution, containing approximately 250 ppm gold, is sent to a pregnant solution tank. It is unclear how long the carbon stripping cycle takes to remove the gold/cyanide from the carbon.

At the end of the stripping cycle, the carbon contains four troy ounces of residual gold per ton. A hydrochloric acid solution (concentration of hydrochloric acid was not obtained) is used to clean the carbon before it is regenerated and sent back to the CIP circuit. Carbon fines collected from the regeneration operation are currently stored on-site, but will be sent to an off-site smelter for the recovery of residual precious metals after the mill closes. Approximately 0.035 pounds of carbon per ton of ore leached are lost to attrition. Further information about the disposition of the acidic cleaning solution or the carbon regeneration operation was not obtained.

#### 3.2.2.4 Electrowinning, Electrorefining, and Smelting

The company uses electrowinning to recover the gold from the pregnant solution. Pregnant solution is pumped from the pregnant solution tank to two parallel 32-cubic-foot cells, and circulated at a rate of approximately 20 gallons per minute. As the solution circulates through the electrowinning cells, gold is precipitated onto steel wool. Residence time for the pregnant solution is up to 19 hours or until the gold concentration in the solution falls below 20 ppm. The now barren solution is recycled to tank 2, the leach tank.

The gold-laden steel wool cathodes are transferred from the electrowinning cells to a 32-cubic-foot electrorefining cell containing stainless steel plates and filled with electrolyte containing five percent sodium cyanide and 1.5 percent sodium hydroxide recirculated at 50 gallons per minute. The polarity is reversed and gold on the steel wool is plated onto the stainless steel sheets. Residual gold also accumulates on the bottom of the cell as gold sludge. Gold is scraped from the plates and the bottom of the cell and sent to the furnace for melting. The gold furnace is operated two or three times per week. According to Colosseum, the use of chemicals in the electrorefining operation is according to strict procedures. All spent solutions are recycled or returned to the mill circuit as chemical additions to assist in gold extraction.

The furnace is charged with gold foil and gold sludge, and borax, silica, and potassium nitrate, which are used as a flux. The furnace has an exhaust hood that leads to a high stack operating with no scrubber or emission control device. The furnace is powered by clean burning propane. According to Colosseum, furnace stack

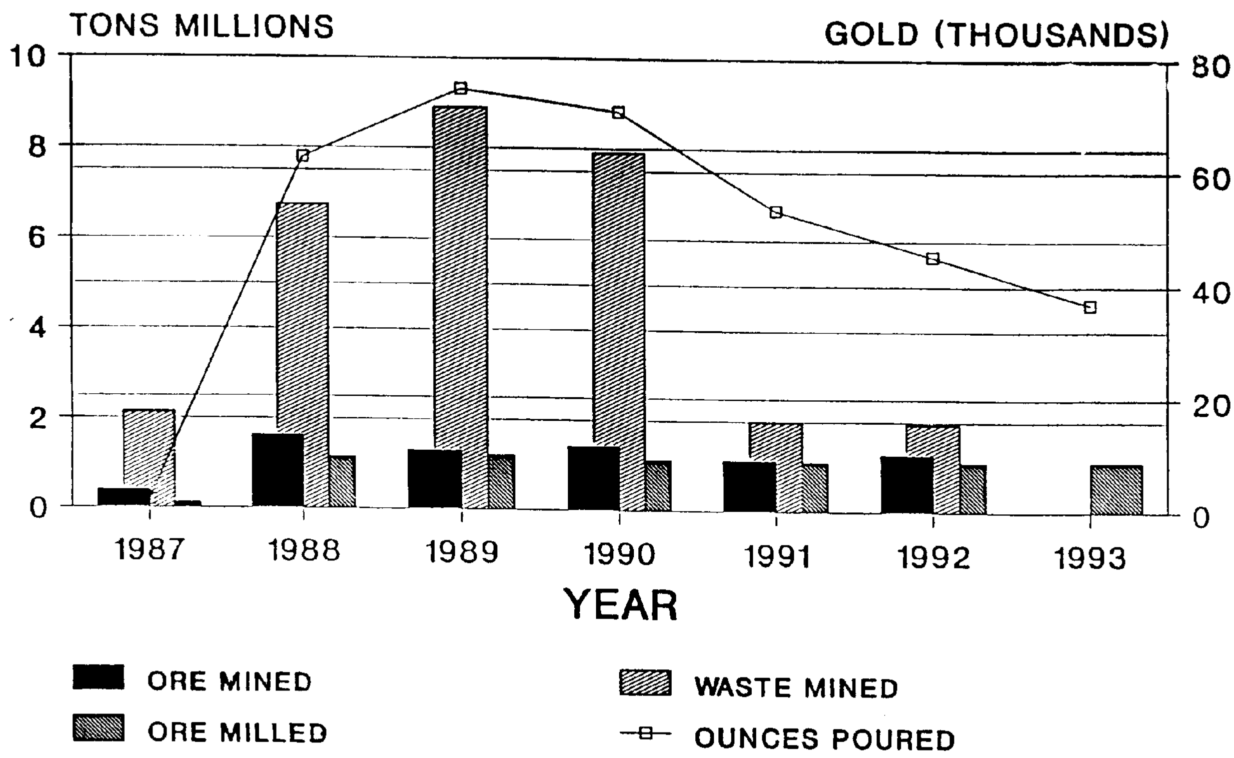


**Figure 3-9. Life of Mine Statistics**

(Source: Colosseum Inc., Undated)

emissions were reviewed by the Air Pollution Control District and no emission control device was deemed necessary. The furnace stack was given the identification number 08004 during the 1989 Air Toxics Emission Inventory. No further information was obtained on the operation of the furnace used to melt the gold and pour doré bars. According to Colosseum personnel, slag from the melting and pouring operation is first panned for coarse gold and then sent back to the SAG mill. The doré, averaging 70 percent gold and 30 percent silver, is sent to several different off-site refiners. In 1991, 61,553 troy ounces of gold were poured. Recovery of gold from ore averages 92 percent in the CIP/electrowinning circuit.

## 3.3 MATERIALS AND WASTE MANAGEMENT

The following section describes the specific wastes and materials generated and managed at the Colosseum Mine. Wastes managed on-site include waste rock and tailings, also called spent ore, from the CIP operation. In addition, other materials not typically considered wastes, such as mine water and low-grade ore, are managed on-site during the active life of the facility. Because these materials ultimately become wastes when intended for disposal (e.g., at closure of the facility), they are also addressed in this section. Figure 3-8 illustrates the life-of-mine statistics on waste rock, ore, and gold.

### 3.3.1 Waste Rock Piles

Colosseum has been removing waste rock from the two pits since the commencement of mining in 1987. The years 1988, 1989 and 1990 witnessed the greatest rate of waste rock generation at the site. Over these three years, approximately 23 million tons of waste rock were excavated and placed in piles onsite. In 1991, approximately two million tons of waste rock were removed from the two open pits. Colosseum has tested waste rock material using the acid-base accounting method for determining acid generating potential. According to Colosseum, results indicate that waste rock is not acid generating.

Waste rock excavated from the two open pits is disposed of in four different waste rock dumps. According to the Draft EIS, these waste rock piles were designed to cover 130 acres and accommodate up to 40 million tons of rock at the conclusion of mining. These four waste piles, designated as the East, West, North and Southwest piles, were formed by trucks dumping material into small ephemeral drainages adjacent to the two mine pits (see Figure 3-5). Most haulage distances are less than one-half mile. No liners underlie the waste piles and the dumps rest upon Precambrian crystalline rocks (see section 3.4.3). The mine dumps exist at their natural angle of repose (specific angle was not obtained), but are graded on occasion to provide access and to maintain the waste dump surface for receiving rock. Information on runoff controls at the waste rock piles was not obtained.

The current volume of rock contained in the waste piles and the height and size of the dumps was not obtained. The planned heights and elevations of each waste rock pile were included in the Draft EIS as follows: West dump would extend from an elevation of 5,250 feet above sea level to an elevation of 5,860 feet above sea level (total height of 610 feet), East dump would extend from an elevation of 5,435 feet above sea level to 5,920 feet above sea level (total height of 495 feet), Southwest and North dumps would range between 300 and 400 feet in height (Bureau of Land Management, et al., 1985a). No underdrain or sediment collection dams were proposed for these piles, according to the EIS. The EIS presented the following rationale for this decision (Bureau of Land Management, et al., 1985a):

- The slope of the waste rock surface will direct storm water runoff flow back toward the open pits;
- Due to low annual precipitation and high annual evaporation, percolation of storm water runoff is unlikely, and;
- In the event of storm water infiltration, any leachate created would contain the same compounds as the surrounding host rock; no sulfides were to be disposed of in the waste rock piles.

According to Colosseum personnel, at the end of mining, the waste rock piles will be graded to eliminate any "mesa-like" appearance. Original closure plans included the installation of two ground-water monitoring wells downgradient of the waste rock piles. However, since the site visit, Colosseum has indicated that they do not intend to install the monitoring wells. No additional information was provided.

### 3.3.2 Low-Grade Stockpile

At the time of EPA's visit, the low-grade stockpile contained 1.3 million tons of ore (a one year supply) grading 0.033 troy ounces of gold per ton (the lower grade cutoff between waste rock and low-grade ore was not determined, nor was the low-grade/high-grade cutoff). According to Colosseum personnel, this ore will be milled at the close of mining and no reclamation effort will be necessary. The stockpile area will be recontoured, topsoil added if available, and revegetated. No information was obtained about the construction of the pile. According to Colosseum, storm water runoff from the stockpile area is directed to the tailings impoundment. (It is not known if this stockpile was milled prior to closing the mill in May of 1993.)

### 3.3.3 Open Pits

According to Colosseum, mining of either pit is no longer economically feasible. However, given an increase in the price of gold, mining could resume. As a result, the two open pits have remained since mining ceased in July, 1992. As noted previously, the final depth of the South Pit is estimated to be 800 feet (no final depth was obtained for the North pit). Maps of the ore body indicate that abandoned underground workings were present in the South Pit prior to open pit mining (these workings are presumably the old Colosseum Mine) (Bureau of Land Management, 1985a). The EPA team did not observe adit or shaft openings in the walls or floor of the South Pit.

As noted in section 3.2.1, ground water discharges at a low rate into the pit bottom. The Reclamation Plan notes that a permanent pool of water (from ground water discharges or surface water runon) is not anticipated to collect in either pit. The perimeter of the pit is to be graded or bermed to intercept and divert runoff. According to the Reclamation Plan, any ground water which collects in the pit is expected to evaporate (Bond Gold Colosseum, Inc., Undated). No contingency plans were included in the Reclamation Plans in the event water formed an intermittent or permanent pool in the pit. No further reclamation of the pits is anticipated

**Table 3-3.  Chemical Analysis of Tailings Solids - Common Mineral Components (Unprocessed Ore Analysis)**

| Parameter | Concentration (percent) |
|---|---|
| Silicon Dioxide | 75.90 |
| Titanium Oxide | 0.06 |
| Aluminum Oxide | 12.40 |
| Ferric Oxide | 0.61 |
| Manganous Oxide | 0.03 |
| Magnesium Oxide | 0.17 |
| Calcium Oxide | 0.16 |
| Sodium Oxide | 0.21 |
| Potassium Oxide | 8.51 |
| Phosphorus Pentoxide | 0.09 |
| Total | 98.14 * |

KEY:    * Loss on ignition accounts for an additional 1.16 percent.

Source:  Bureau of Land Management, et al., 1985a.

with the exception of fencing and the posting of signs warning of potential danger to trespassers (Bond Gold Colosseum, Inc., Undated).  According to Colosseum, the South Pit currently has standing water in the bottom, which was not anticipated during project planning.  The Colosseum Mine is now conducting a ground water study, and will continue to work with the State Water Quality Control Board to develop a closure plan for the South Pit.

### 3.3.4 Cyanide Destruction Reactor

Colosseum uses the International Nickel Company (INCO) $SO_2$ cyanide destruction process to decompose free and complexed cyanide species in the tailings slurry.  The INCO process injects $SO_2$ and air into a well-agitated vessel to oxidize cyanide in the tailings slurry and create inert cyanate complexes.  At Colosseum, the solution is mixed with a 250 horsepower agitator as 2,000 standard cubic feet per minute of low pressure air is injected into the tank.  Because acid is produced in the oxidation reactions, lime is added to the reaction tank to maintain a pH range of 8.5 to 9.0.  Copper sulfate may be added to act as a catalyst for the oxidation reactions.

The tailings typically contain 50 percent solids by weight and 225 ppm WAD cyanide. Tank 11, a 13,025 cubic foot (100,000 gal) reactor tank, detoxifies tailings from the aeration tank in the CIP circuit in approximately 2.3 hours. A 2.3 hour residence time in a 100,000 gallon tank maintains a flow rate of 724 gpm, similar to the CIP flow rate. According to Colosseum, the final total cyanide concentration of the tailings slurry is less than 1.0 ppm. Detoxified slurry flows to the tailings sump and is tested every two hours for WAD cyanide. As required by Colosseum's waste discharge requirements, Colosseum collects at least three samples of tailings slurry per day to make one composite sample. The tailings slurry composite sample is separated into a solid fraction sample and a liquid fraction sample for analysis. These are shipped to an independent lab for total cyanide content analysis (see section 3.4.3). (Colosseum, Inc., 1992d)

### 3.3.5 Tailings Impoundment

Tailings from the INCO process are sent to a tailings sump at the mill which drains to the tailings impoundment via a pipeline (information on the tailings sump and pipeline was not obtained). Before designs for the tailings impoundment and cyanide destruction system were approved, Colosseum conducted a pilot program to determine the final composition of the tailings before cyanide destruction (details of the pilot

**Table 3-3. Comparison of Original Estimate of Tailings Liquid Composition and Actual Annual Tailings Water Analyses**

| Parameter | Estimated* Composition | 1988** | 1989*** Min - Max | 1990*** Min - Max | 1991*** Min - Max |
|---|---|---|---|---|---|
| Cond, mmhos/cm | NA | 6,540 | 7,110-9,210 | 3,320-7,440 | 5,720-7,670 |
| Ph, su | NA | 8.39 | 6.6-8.7 | 8.24-8.82 | 8.24-8.48 |
| WAD CN, ppm | NA | 0.00 | 0.0-0.8 | 0.02-0.17 | 0.07-0.14 |
| Total CN, ppm | NA | 0.01 | 0.21-0.45 | 0.02-0.26 | 0.03-0.18 |
| Free and WAD Cyanide, ppm | 106 | NA | NA | NA | NA |
| TDS, ppm | NA | 5,100 | 4,800-6,183 | 2,300-5,500 | 3,600-5,600 |
| Sulfate, ppm | 700 | 3,300 | 2,700-4,100 | 1,400-3,800 | 1,800-3,500 |
| Sodium, ppm | 2,200 | 670 | 490-880 | 260-760 | 370-750 |
| Copper, ppm | 52.8 | 0.36 | 0.0-1.6 | 0.22-2.8 | 0.09-1.7 |
| Iron, ppm | 39.4 | 0.11 | 0.00 | 0.00 | 0.00-<0.1 |
| Zinc, ppm | 31.9 | 0.0 | 0.11-2.5 | 0.08-0.25 | 0.02-0.12 |
| Lead, ppm | NA | NA | NA | <0.002-0.003 | <0.002-0.01 |

KEY: * - Data are from the Draft EIS, based on laboratory pilot tests of the ore.
** - Data presented for 1988 are from one quarter.
*** - Data presented for 1989, 1990 and 1991 are maximum and minimum values from quarterly sampling events.
NA - Not Available
ppm - parts per million
su - standard units
mmhos/cm- micromhos/centimeter

Source: Colosseum, Inc., 1992; Bureau of Land Management, 1985a.

**Table 3-4. Minor and Trace Constituents of Colosseum Tailings Solids**

| Parameter | Concentration (mg/kg) |
|---|---|
| Antimony | <0.05 |
| Arsenic | 29.00 |
| Barium | 13.00 |
| Ceryllium | 0.44 |
| Cadmium | 4.30 |
| Chromium (total) | 6.70 |
| Cobalt | 5.50 |
| Copper | 158.00 |
| Lead | 158.00 |
| Mercury | 0.01<br>1 |
| Molybdenum | 1.50 |
| Nickel | 4.80 |
| Selenium | 0.15 |
| Silver | 0.27 |
| Vanadium | 2.80 |
| Zinc | 868.00 |
| Thallium | <1.00 |

Source: Bureau of Land Management, et al., 1985a.

program were not available) (Bureau of Land Management, et al., 1985a). Tables 3-2 and 3-3 present the analytical results of tailing samples created in the pilot program. Table 3-4 presents a comparison of the estimated composition of tailings liquid (prior to cyanide destruction) as determined in the pilot tests and the actual composition of tailings liquid (after cyanide destruction) as sampled and analyzed throughout the life of the mine.

The tailings impoundment occupies the head of a canyon, approximately one-half mile south of the mill site (see Figures 3-4 and 3-5). The impoundment began receiving tailings in 1988. The native ground at the tailings impoundment location consists of shallow alluvial deposits covering Precambrian gneisses. As required by the reclamation plan for Colosseum, topsoil in the area to be occupied by the tailings impoundment was removed and stockpiled around the tailings impoundment (no further information was obtained on the topsoil stockpiles) (see section 3.4.1).

The tailings dam was constructed on top of a compacted foundation soil overlying Precambrian bedrock. A rock core was emplaced over the foundation soil and covered with compacted fill. The dam was designed to be raised by lifts (as production required) to a final design elevation of 5,375 feet above sea level. The impoundment created behind this dam would cover 150 acres and contain precipitation and runon from a 10,000 year, 24-hour storm event. The dam was also designed to withstand the Maximum Credible Earthquake (see section 3.1.4). Two small retention dams were also constructed along the perimeter of the tailings pond to prevent overflow into areas outside the tailings impoundment. An emergency spillway was constructed in 1991 on the northwest boundary of the tailings impoundment (Bureau of Land Management, 1985a; Colosseum, Inc., 1991). The emergency spillway was part of the original design and was constructed to handle the runoff from the PMF after the tailings area has been reclaimed. Waters overtopping the spillway would flow to the dry drainage below the tailings impoundment (the elevation of this spillway was not available). The approved reclamation plan required the construction of diversion channels for any ephemeral streams located in the tailings impoundment area if the tailings dam was not designed to store runoff from the Probable Maximum Flood (PMF) (it is unclear what recurrence interval was determined for the PMF storm). According to Colosseum, since the tailings dam was designed to store the runoff from the PMF, no diversion channels are required.

Green's Well (a livestock watering well) and mine shafts leading to abandoned underground tungsten workings in Precambrian gneisses, were in the middle of the proposed tailings impoundment location. As a condition of Colosseum's waste discharge requirements, these shafts and tunnels were to be backfilled and sealed to prevent discharges of tailings water into the ground water (see section 3.4.3). Information on the methods used to backfill and seal these openings was not obtained.

As of December 1991, 4,805,250 tons of tails had been placed into the impoundment. Tailings are piped from the mill to a distribution pipeline that encircles the impoundment and discharged through subaerial deposition. Subaerial deposition of tailings produces a maximum density tailings, while providing reclaim water by avoiding excess interstitial water in the tails. According to Colosseum personnel, the dam was raised to a crest elevation of 5,341 feet above sea level in 1991 and it is anticipated that no further raising of the dam will be necessary before reclamation begins. During the site visit, the dam appeared to be about 100 feet high. According to Colosseum personnel, the current impoundment will contain the precipitation and runon from the 1,000 year, 24-hour storm event and it is now approved to store tailings to elevation 5,336 feet above sea level, with a final freeboard of five feet.

According to Colosseum personnel, the 17 inches per year in evaporation results in a net deficit of available water for the mine. Tailings water is reclaimed off the pond and pumped to the mine's process water tank. Ten piezometers placed along the downstream face of the dam record water levels in the core to ensure the correct functioning of the dam. (Colosseum, Inc., 1992b).

The tailings impoundment is unlined and an underdrain system collects tailings dam seepage and conveys the liquid to two ponds located downstream of the dam (size and capacity of the ponds was not obtained). Seepage enters the ponds at an average rate between 50 and 90 gallons per minute (variability is seasonal) and is pumped back to the tailings impoundment. According to Colosseum personnel, seepage in the first year of operation was at a rate greater than the pumping system could maintain. The underdrain system is valved and the flow was restricted to the pump capacity for the first year of operation. The tailings subsequently sealed the impoundment as designed and the flow has slowed to current levels. According to Colosseum, there was no discharge. The two seepage collection ponds are double-lined with 40-mil high density polyethylene (HDPE) liners. A leak detection system, consisting of geotextile fabric, six inches of sand and a network of perforated pipe draining to an inspection sump, was installed between the liners of each pond. The leak detection system is required to be checked visually each month, and, if liquid is present, a sample must be collected and analyzed for the parameters listed in the Monitoring and Reporting Program No. 87-20 for the Colosseum Gold Mine (see section 3.4.3) (California Regional Water Quality Control Board, Lahontan Region, 1987a; 1987b).

Several monitoring wells have been installed in the tailings impoundment area. Figure 3-4 illustrates the location of these monitoring wells. Five of these wells (MW4, MW5, West, South and Gorge Wells) are sampled on a quarterly frequency. Wells MW1, MW2 and MW3 were installed downgradient of the tailings impoundment and completed in Cambrian sedimentary units, alluvium and Precambrian gneiss, respectively (Sergent, Hauskins and Beckwith, Undated). According to Colosseum personnel, these latter three wells were dry upon completion and have never contained water. Monitoring results indicate that the tailings water may be migrating toward the West well. However, according to Colosseum, current studies may indicate that sulfate levels may not be the result of the tailings water. Colosseum, in cooperation with the State Water Quality Control Board, is conducting further studies to research this issue. Further information, including monitoring results, are presented in section 3.4.3.

Reclamation on the tailings impoundment will begin after all stockpiled ore has been leached in the CIP circuit, probably sometime in 1994. The approved reclamation plan for the tailings impoundment requires the following elements:

- Cover downstream slope of tailings dam with mine waste rock to minimize erosion. Reestablish vegetation through natural processes;

- Cover top of tailings impoundment with mine waste rock or salvaged topsoil (to the extent available). Grade top of tailings to direct surface runoff and prevent long-term ponding of precipitation. Reseed with indigenous plants or plants established successfully in a similar environment. Construct berms on the impoundment to discourage entrance. During the site visit, EPA viewed an experimental garden of transplanted indigenous plants. Certain species appeared to have made a successful transplant.

- Maintain seepage ponds for several years; and

- Retain diversion channels, if constructed around the tailings impoundment.

### 3.3.6 Other Wastes and Materials Reused/Recycled

Waste oil generated at the mine is collected by a contractor every ninety days for off-site recycling. The name of the contractor was not obtained. No information was obtained on the quantity of waste oil generated. Other oil/lubricant-contaminated wastes generated at the mine include: soil (from minor spills), oil filters and rags contaminated with used motor oil, used crater grease (from axle lubrication) and empty 55-, 15- and 5-gallon drums/pails with residual crater grease/motor oil (from lubricating operations). Specific quantities of these wastes were not obtained. These wastes are collected by Disposal Control Services and shipped off-site for disposal.

In 1991, Colosseum generated a wide variety of wastes at the laboratory and mill. Assorted wastes generated in the laboratory and mill, including borax, flocculent, fluorospar, paint and rubber cement, were collected and hauled off-site for disposal by Disposal Control Services (volumes of these wastes were not obtained). Colosseum annually generates approximately 1.5 barrels of lead-contaminated cupels from the fire assay process. Spent solvents are also generated (specific amounts were not obtained). All of these wastes are picked up and transported off-site for disposal by Disposal Control Services.

Spent electrowinning solutions are brought back to strength and reused. Spent carbon is regenerated and reused. Spent carbon stripping solutions are used as cyanide addition to tank 2. The CIP tanks are periodically drained and checked. The tanks are hosed clean and all residue is milled for contained gold. The ore slurry "trash" is treated as mill tailings. No information on the quantities of these wastes generated was obtained.

Paper and trash are hauled by Desert Disposal Services to a landfill in Barstow. Sanitary sewage is discharged to a septic tank at the mine (location of the septic tank was not obtained).

## 3.4 REGULATORY REQUIREMENTS AND COMPLIANCE

Colosseum is subject to both Federal and State regulatory requirements and their attendant permits. Two statutes, the National Environmental Policy Act and the California Environmental Quality Act, require that the proposed action (the mine operating plan) and alternative actions (i.e. alternatives to the plan) be evaluated for their environmental consequences. Because portions of the mine are located on lands administered by BLM in San Bernardino County, the BLM was designated the lead agency for NEPA compliance. The County was designated as the lead agency for CEQA (the County is also the permitting agency for reclamation and air pollution control as designated by the State). Through a Memorandum of Understanding among these two agencies and Colosseum, an Environmental Impact Report/Environmental Impact Statement (EIR/EIS) was prepared and approved for the Colosseum Mine.

### 3.4.1 Bureau of Land Management

As noted previously, the Colosseum mine site lies almost exclusively on Federal lands administered by the Bureau of Land Management. Mining on these lands is subject to regulations set forth in 43 CFR Part 3800, "Mining Under the General Mining Laws." These regulations were promulgated by the Bureau of Land Management under authority of the Federal Land Policy and Management Act (FLPMA). The regulations provide BLM with the authority to approve a Plan of Mining Operation on Federal Lands prior to commencement of operations, to require bonding, and to inspect mining operations to ensure the operator is complying with these regulations (45 FR 78902).

Pursuant to these regulations, the Colosseum mine submitted a Plan of Operations to BLM and the County of San Bernardino for approval (see section 3.4.2). Included as part of the mine operating plan is a reclamation plan that describes the planned activities before, during, and after the operation which will ensure the stabilization and reclamation of areas disturbed by mining.

Upon approval of the mine operating plan, Colosseum furnished to BLM (jointly with the State of California Department of Conservation, Division of Mines and Geology) a stand-by letter of credit (from the Royal Bank of Canada) to cover the cost of reasonable stabilization and reclamation of areas disturbed by mining at the Colosseum site. The letter of credit is in the amount of $762,181 and was to expire in February 1993 (Royal Bank of Canada, 1992). The bonding amount is reviewed yearly and adjusted as deemed necessary by the BLM and the State.

A list of mitigative measures was developed for the EIR/EIS. These were incorporated into the Operating Plan. These measures include:

- Elevate fresh water pipeline to allow unrestricted movement of the desert tortoise (an endangered species which lives in Ivanpah Valley)
- Apply dust suppressant on access road (Colosseum uses water soluble lignin sulfonate) twice a year
- Limit traffic on the mine access road (Colosseum provides transportation for employees in a 15-passenger van from Las Vegas to the mine)
- Purchase and set aside desert land suitable as tortoise habitat to mitigate loss of 10 acres of habitat caused by access road
- Install wildlife troughs
- Treat fresh rock surfaces (road cuts) with "Eonite" (which mimics desert pavement through a chemical reaction with rock)
- Fence around tailings impoundment
- Paint buildings to blend in with the environment.

The BLM (Needles Resource Area) inspects the Colosseum mine monthly to ensure compliance with the approved mine operating plan.

### 3.4.2 California Department of Conservation, Division of Mines and Geology

The California Department of Conservation, Division of Mines and Geology, provides technical support for the lead agencies (i.e., counties or cities) with responsibility for enforcing the requirements of the State's Surface Mining and Reclamation Act (SMARA). For Colosseum, the lead agency is the County of San Bernardino. The State legislature passed SMARA in 1975 to ensure that minded lands in California are reclaimed. SMARA is triggered when a mine disturbs over one acre of land or produces over 1,000 cubic yards of waste/ore per day. Regulations for the implementation of SMARA were promulgated under California Code of Regulations, Title 14, Chapter 8, Subchapter 1, Article 1. Surface Mining and Reclamation Practice. The most significant reclamation requirements outlined in this regulation is the submittal of a reclamation plan to the lead agency by the mining facility. Upon approval of the plan, the lead agency issues a permit to the facility to operate. A reclamation plan for the Colosseum Mine was submitted to the County of San Bernardino for approval in conjunction with the development and approval of the EIR/EIS.

Although the County of San Bernardino was identified in the EIR/EIS as the lead agency for the State, the Division of Mines and Geology is the beneficiary (jointly with BLM) of the stand-by letter of credit provided by Colosseum to insure the performance of reclamation activities (Royal Bank of Canada, 1992). The County inspects the mine yearly for compliance with the approved reclamation plan.

### 3.4.3 California Regional Water Quality Control Board, Lahontan Region

The California Regional Water Quality Control Board also is responsible for regulating discharges of mine wastes to land under the California Code of Regulations Title 23, Chapter 3, Subchapter 15, Article 7, Discharges of Waste to Land. These regulations require that facilities discharging waste to land submit a report of this discharge to the Regional Board. Upon receipt of the report, the Board reviews the information, classifies the wastes and issues waste discharge requirements to the facility in the form of a Board Order.

The Colosseum mine, as a gold cyanide mill, is subject to the zero discharge requirements of 40 CFR 440(j): that is, it may not discharge mill effluent (including tailings) to waters of the United States. Thus, no NPDES permit has been issued to the facility by the Lahontan Regional Water Quality Control Board.

Colosseum is not authorized to discharge to surface waters but two wastes generated at the Colosseum mine are subject to the requirements of State regulations: tailings and waste rock. The Lahontan Region Board classified the tailings produced at Colosseum as Group B wastes. These wastes are defined as wastes that consist of or contain hazardous wastes that qualify for a variance under Section 66310 of Title 22 of this code, or wastes that consist of or contain nonhazardous soluble pollutants in concentrations that exceed water quality objectives for, or could cause degradation of, waters of the state. The Board exempted these wastes from the liner requirement, based on a geotechnical report prepared for the project that indicates that only limited amounts of groundwater underlie the project site and that hydraulic interconnection between the project site and major aquifers (Ivanpah and Shadow Valley) appears to be limited. (This report was not obtained). However, additional monitoring requirements were included in the permit to provide early detection of wastewater migration.

The waste rock was classified as a Group C waste by the Lahontan Regional Board. These wastes are defined as wastes which would be in compliance with the applicable water quality control plan, including water quality objectives, other than turbidity. No liner is required for disposal areas receiving Group C wastes.

Colosseum operates under the California Regional Water Quality Control Board, Lahontan Region Board Order No. 6-87-20, Revised Waste Discharge Requirements for Colosseum Gold Mine, San Bernardino County, California and the accompanying Monitoring and Reporting Program No. 87-20 for the Colosseum Gold Mine, San Bernardino County, California. The Order prohibits the discharge of any detoxified wastewater, waste rock or detoxified tailings slurry except into an authorized disposal site. Further, the Order limits the concentration of cyanide (total and WAD) in tailings discharged to the tailings impoundment. Total cyanide may not exceed 1.0 mg/l and WAD cyanide may not exceed 0.5 mg/l in the liquid tailings fraction, as averaged over a period of 30 consecutive sampling days. For the solid fraction, total cyanide may not exceed 18.0 mg/kg and extractable total cyanide may not exceed 0.5 mg/l. The Order also contains a (standard) narrative requirement that discharges to the waters of the State shall not contain substances in concentrations that are toxic to, or produce detrimental physiological responses in humans, plants, animals, or aquatic life.

In addition to the effluent limitations specified in the waste discharge requirements, the Order contains requirements and prohibitions for specific components at the site as well as general requirements and prohibitions. These include:

3.4.3.1 Cyanide Detoxification Facility (INCO)

- Effectively seal all cyanide leaching facilities (including leaching tanks and collection ponds), to prevent the exfiltration of any liquids used in the extraction or detoxification processes

3.4.3.2 Tailings Impoundment

- Provide seepage detection systems on collection ponds
- Construct the collection ponds and tailings impoundment in compliance with the requirements for Group "B" mining wastes, except as allowed for the tailings impoundment (i.e., the waiving of liner requirements)
- Discontinue use of seepage collection pond and tailings impoundment upon presence of liquid (containing in excess of 0.2 mg/l free cyanide) in the leakage detection system

- Cease discharge of tailings to the impoundment in the event free cyanide (exceeding 0.2 mg/l) or any other monitored parameter exceeding 20 percent of background concentrations are detected in ground water or surface water outside the boundaries of the tailings impoundment

- Backfill and seal as necessary, all adits and/or tunnels located within the tailings impoundment site, to prevent discharges of tailings water directly into the groundwater

- Discharge, bypass, or divert no cyanide leaching solution, neutralization water, or tailings slurry from the collection, transport, treatment or disposal facilities to adjacent land areas or surface waters

- Discharge no surface flow of any leaching solution, neutralization water, or tailings slurry from the authorized disposal sites to adjacent land areas or surface waters

- Construct the tailings impoundment and waste rock disposal areas to protect against overflow, washout, inundation, structural damage or a significant reduction in efficiency resulting from precipitation and peak surface runoff flows from the 100-year, 24-hour storm event

- Maintain a vertical distance between the liquid surface elevation and the lowest point of a pond dike or invert of an overflow structure of at least 2.0 feet

#### 3.4.3.3 Waste Rock Piles

- Construct the waste rock piles in compliance with the for Group "C" mining wastes.

#### 3.4.3.4 General Requirements

- Cause no pollution or threatened pollution from the discharge (to land)

- Cause no nuisance in the treatment or discharge of waste

- Comply with the engineering plans, specifications, and technical reports submitted with the completed report of waste discharge

- Dispose of all cyanide-contaminated waste materials, other than tailings, at a Class I disposal site or neutralize and discharge at a Class III disposal site

- Store all hazardous material containers in a secured storage facility that is not susceptible to the elements, vandalism or potential public contact

- Post signs warning the public of the presence of cyanide.

Several other provisions were included in the Order, including the submittal of a final closure plan 180 days prior to beginning any partial or final closure activities or at least 120 days prior to discontinuing the use of the site for waste treatment, storage or disposal. One of the more important provisions of the Board Order is the required compliance with Monitoring and Reporting Program No. 87-20.

The monitoring and reporting program establishes the requirements for water quality monitoring and reporting with respect to the discharge of waste to land at Colosseum.  The program requires the recording of information, the sampling and analysis of liquids, ground water, surface water and the quarterly reporting of the information and results of the analyses.  Pursuant to the program, Colosseum records a number of production statistics, including the total quantity of ore processed, the total quantity of detoxified tailings discharged to the tailings impoundment, and the total quantity of waste rock placed at each of the four dump sites (a report containing all of this data was not obtained).

As discussed in section 3.3.1, Colosseum is required to collect two composite samples daily (composites of three individual samples) of the solid and liquid fractions of the tailings slurry.  Both the solid and liquid fractions are to be analyzed for total dissolved solids (reported in mg/l) and total cyanide (reported in mg/l). The liquid fraction has to be analyzed for WAD cyanide (reported in mg/l); the solid fraction has to be analyzed for extractable cyanide (reported in mg/l).

The tailings impoundment return water must be sampled weekly (one grab and one 24-hour composite) and analyzed for TDS, total cyanide and WAD cyanide.  Results of these analyses were not obtained.Ground water monitoring requirements also are included in the monitoring and reporting program.  Table 3-5

**Table 3-5. Results of Required Ground Water at the Colosseum Mine**

| Parameter | Minimum and Maximum Concentrations in Ground Water Monitoring Wells at Colosseum | | | | |
|---|---|---|---|---|---|
| | West Well* | MW5** | MW4*** | Gorge Well**** | South Well***** |
| Conductivity, mmhos/cm | 920 -1,493 | 1,419 - 1,697 | 1,022 - 1,300 | 1,117 - 1,365 | 842 -939 |
| pH | 6.6 - 7.48 | 7.15 - 7.86 | 7.34 -7.79 | 7.11 - 8.04 | 6.92 - 7.47 |
| WAD Cyanide, ppm | <0.005 - <0.125 | <0.005 - <0.125 | <0.005 - <0.125 | <0.005 - <0.125 | <0.005 - <0.125 |
| Total Cyanide, ppm | <0.005 - <0.25 | <0.005 - <0.25 | <0.005 - <0.25 | <0.005 - <0.25 | <0.005 - <0.02 |
| TDS, ppm | 490 - 850 | 760 -1,000 | 590 - 662 | 500 - 690 | 370 - 470 |
| Sulfate, ppm | 50 -290 | 94 - 250 | 57 - 140 | <1.0 - 90 | 18 - 69 |
| Sodium, ppm | 36 - 63 | 51 - 71 | 70 -95 | 42 - 58 | 29 - 43 |
| Copper, ppm | <0.01 - 0.03 | <0.0015 - 0.03 | <0.001 -0.04 | <0.002 - <0.02 | <0.002 - <0.02 |
| Iron, ppm | <0.02 - 0.15 | <0.02 - 0.1 | <0.002 - .17 | <0.02 - .67 | <0.02 - 0.13 |
| Zinc, ppm | <0.02 -8.1 | <0.01 - 0.07 | <0.005 - 0.04 | .82 - 8.3 | <0.03 - 5.3 |
| Lead, ppm | <0.01 - <0.2 | <0.002 - 0.002 | <0.001 - 0.003 | <0.002 - .003 | <0.001 - <0.2 |

KEY: *Data represent monthly sampling from Sept 1987 to Sept. 1988, quarterly monitoring from Jan. 1989 to Dec. 1990, and monthly sampling from Jan. 1991 to Dec. 1991.

**Date represents monthly sampling from Jan. 1988 to Oct. 1988 and quarterly sampling from Oct. 1988 to Dec. 1991.

***Data represents monthly sampling from Nov. 1987 to Oct. 1988 and quarterly sampling from Jan. 1989 to Dec. 1991.

****Data represents monthly sampling from Nov. 1987 to Oct. 1988 and quarterly sampling from Jan. 1989 to Dec. 1991.

*****Data represents monthly sampling from Jan. 1988 to Oct. 1988 and quarterly sampling from Jan. 1989 to Dec. 1991.

Source: Colosseum, Inc., 1992a.

presents analytical results for the six wells containing water (beginning in 1987 for West, MW4 and Gorge wells and 1988 for MW5 and South wells). All but the Gorge well (also known as the East well) are local to the tailings impoundment. MW1, MW2 and MW3 are dry and have never been sampled. Established limits for these wells were not available, but, a general provision of the waste discharge requirements dictates that free cyanide may not exceed 0.2 mg/l and other monitored parameters may not exceed 20 percent of background concentrations in ground water. It is unclear what background concentrations were established for the monitored parameters.

Colosseum's Annual Water Quality Monitoring Report for 1991 states that levels of sodium, sulfate, TDS and conductivity are in excess of the permitted levels for the West well. Colosseum initially thought that these high levels probably result from the migration of tailings water pooled along the western edge of the impoundment near the West well (see Table 3-5). However, the Colosseum Mine now believes that baseline sulfate levels were artificially lowered by pumping away surface waters during construction. The Colosseum Mine has collected soil samples up gradient of the West well that indicate that surface runoff to the well could be a natural cause for the current sulfate levels. The results and the interpretations are currently being discussed with State Water Quality Control Board staff.

The monitoring and reporting program also requires the quarterly sampling of eight springs, labeled as S-11 to S-18 (the location of these springs was not obtained), for the following parameters: conductivity, pH, temperature, total cyanide, WAD cyanide, TDS, sodium, sulfate, zinc, copper and iron. No analytical data on the sampling of these springs was obtained.

As noted in section 3.3.2, the leakage detection sumps must be visually inspected each month for the presence of liquid. If liquid is detected, it must be analyzed for: total cyanide, WAD cyanide, TDS, sodium and sulfate.

The Regional Water Quality Board also requires Colosseum to provide financial assurances that monies are available to ensure closure upon abandonment of the facility. The bond was in the form of a stand-by letter of credit from the Royal Bank of Canada in the amount of $735,000 (Royal Bank of Canada, 1992a). This bond is separate from the reclamation bond described in section 3.4.1.

### 3.4.4 Air Pollution Control District, San Bernardino County

Colosseum holds fourteen permits issued by the Air Pollution Control District, San Bernardino County, California, for the operation of various components of the Colosseum Mine (San Bernardino County Air Pollution Control District, 1991a). These are shown in Table 3-6

**Table 3-6. Air Pollution Control Permits**

| Permit Number | Unit Covered | Special Conditions of the Permit |
|---|---|---|
| B001822 | Ore Crushing Unit | • Unit must only operate concurrently with the wet scrubber permit #001830<br>• Ducting to the wet scrubber must be maintained as air tight.<br>• Dust control water sprays must be functioning at the ore bin when ore is dumped by haulage trucks.<br>• Mining is limited to 31,000 tons of rock per 24-hour day.<br>• Operator must maintain a log of mining rates. |
| B001823 | Leach and Carbon Adsorption | • Water sprays must be working during the addition of ore to the crushed ore stockpile.<br>• Water sprays shall be used in severe weather conditions (strong winds) when ore in not being added to the stockpile. |
| B001824 | Leach and Carbon Adsorption | • Equipment must be maintained and operated consistent with manufacturer's recommendations and/or sound engineering practices. |
| B001825 | Tailings Thickener and Treatment Unit | • Equipment must be maintained and operated consistent with manufacturer's recommendations and/or sound engineering practices. |
| B001826 | Carbon Stripping and Regeneration Unit | • Equipment must be maintained and operated consistent with manufacturer's recommendations and/or sound engineering practices. |
| B001827 | Cyanide Destruction Unit | • Operate concurrently with and vented to the functioning lime bin baghouse (permit C001832)<br>• Equipment must be maintained and operated consistent with manufacturer's recommendations and/or sound engineering practices. |
| B001828 | Plant Air Compressors | • Equipment must be maintained and operated consistent wit manufacturer's recommendations and/or sound engineering practices. |
| B001830 | Scrubber - Venturi | • Operate concurrently with the crushing unit and appurtenai equipment.<br>• Maintain entire system consistent with manufacturer's recommendations and good engineering practices.<br>• Maintain log on-site<br>• Conduct emission tests (within 90 days of receipt of this permit) on outlet of scrubber to determine compliance. |
| C001831 | Water Sprays (Fine Ore) | • Maintain in good working order consistent with sound engineering practices to ensure emissions compliance.<br>• Operate when fine ore is added to stockpile.<br>• Operate during severe weather (strong winds). |

**Table 3-6. Air Pollution Control Permits (continued)**

| Permit Number | Unit Covered | Special Conditions of the Permit |
|---|---|---|
| B001832 | Lime Bin Dust Collector | • Maintain a minimum inventory of bags at 50 percent of the required bags.<br>• Maintain an on-site log of all inspections, repairs, and maintenance performed. |
| B001833 | Lime Bin Dust Collector | • Maintain a minimum inventory of bags at 50 percent of the required bags.<br>• Maintain an on-site log of all inspections, repairs, and maintenance performed. |
| B002295 | Portable Lime Slaking Unit | • Operate in accordance with recommendations of the manufacturer and sound engineering principles.<br>• Ensure sufficient liquid in Porta Batch Mixing Tank prior to connecting of pneumatic devices. |
| B002588 | Cone Crusher | • Ensure that the materials processed contain sufficient natu and natural moisture for compliance.<br>• Provide piping to effect any necessary addition required to avert water freezing.<br>• Construct to be air tight as practicable to preclude fugitive emissions and to allow retrofit of control equipment in the future. |
| T003024 | Gasoline Dispensing Facility (Non-Retail) | • Post toll free telephone number. |

Source: San Bernardino County Air Pollution Control District, 1991a through 1991n.

, along with a listing of special conditions imposed upon each unit. General conditions the permits include:

- Comply with all applicable rules and regulations of the San Bernardino County Air Pollution Control District, and

- Ensure that construction, maintenance and operation of the stationary source is in compliance with all applicable provisions of Federal, State and District regulations.

### 3.4.5 Other Permits

The Colosseum Mine also holds permits from the California State Division of Safety of Dams and the Environmental Health Services Department, San Bernardino County, California.

Colosseum Mine was issued a permit (number 2800) by the Division of Safety of Dams for the operation of the mine tailings dam. An annual operational report is submitted to the Division containing a number of statistics (e.g., the current dam crest level, the total tailings deposited in the impoundment throughout the year, etc) (Colosseum, Inc., 1992b). The requirements of this permit were not obtained.

The mine is a small quantity generator of hazardous waste and is identified by the mine's EPA Hazardous Waste Number CAD982459968. The mine has two hazardous waste permits issued by the Environmental Health Services Department, San Bernardino County, California. Permit No. 8709080011 allows Colosseum to handle hazardous materials. Permit No. 8709080010 allows Colosseum to generate hazardous waste. The requirements of these permits were not determined (County of San Bernardino, Environmental Health Services, Undated).

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**APPENDIX 3-A**

**COMMENTS SUBMITTED BY COLOSSEUM ON DRAFT SITE VISIT REPORT**

[Comments not reproduced for this electronic version. Copies may be obtained from U.S. EPA, Office of Solid Wastes, Special Waste Branch.]

## APPENDIX 3-B

## EPA RESPONSE TO COMMENTS SUBMITTED BY COLOSSEUM INC.

EPA Response to Comments Submitted by
Colosseum, Inc. on Draft Site Visit Report

EPA has revised the report to address all of the comments made by Colosseum, Inc., submitted following their review of the Draft Site Visit Report dated September 1992. In some cases, EPA made changes to wording suggested by Colosseum, either for brevity, in order to attribute changes to Colosseum, or to enhance clarity.