

Decision Summary
Cimarron Mining Corporation Site
Operable Unit 1
Record of Decision

September 1990

002695

DECLARATION FOR THE RECORD OF DECISION
CIMARRON MINING CORPORATION SITE
OPERABLE UNIT 1, CARRIZOZO, NEW MEXICO

Statutory Preference for Treatment as a
Principal Element is Met
and Five-Year Review is Not Required

SITE NAME AND LOCATION

Cimarron Mining Corporation
Carrizozo, Lincoln County, New Mexico

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Cimarron Mining Corporation site in Carrizozo, Lincoln County, New Mexico, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

This decision is based upon the contents of the administrative record file for the Cimarron Mining Corporation site.

The United States Environmental Protection Agency and the New Mexico Environmental Improvement Division agree on the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

This final remedy addresses remediation of shallow ground water contamination at the Cimarron Mining Corporation (Operable Unit 1) mill location. The principal threats posed by the site will be eliminated or reduced through treatment and engineering controls.

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The major components of the selected remedy include:

- o Pump and discharge ground water to the Carrizozo Publicly Owned Treatment Works (POTW)
- The discharge will comply with the pretreatment standard of 5 milligrams per liter (mg/l) of cyanide as cited in 40 CFR 413.24 Subpart B and deemed relevant for this action. Sampling will be conducted onsite prior to the discharge entering the POTW collection system. Current data indicates pretreatment will not be necessary.
- Biological activity within the existing treatment lagoons, in addition to effluent chlorination and photodecomposition will provide treatment to reduce the cyanide concentration to acceptable concentrations.
- Monitoring of the treatment plant effluent and sludge will be conducted to ensure no adverse impacts on the POTW processes.

CRITERIA: A treatment goal of 200 micrograms per liter (ug/l) of cyanide will be utilized, if possible, for remediation of the shallow ground water. New Mexico Water Quality Control Commission Regulation requires protection of all ground water of less than 10,000 milligrams per liter (mg/l) total dissolved solids for potential future beneficial use as a source of drinking water. In addition, this treatment goal will provide protection of the lower, currently used drinking water zone, from potential future migration of contamination.

o Ground Water Monitoring

- The ground water monitoring program may be amended and/or eliminated if data indicates effective remediation has occurred.

In addition to the ground water remedy, the following measures will be implemented:

- o Removal of the process chemical drums, and decontamination of tanks and associated piping;
- o Filling in the discharge pit and cinder block trenches with onsite soils and waste pile material and covering with clean fill;
- o Plugging of the onsite abandoned water supply well; and
- o Inspection and maintenance of the existing fence.

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STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies (or resource recovery) to the maximum extent practicable and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy will not result in hazardous substances remaining onsite above health-based levels, a five-year review of the remedial action is not required.

Robert E. Layton Jr.
Robert E. Layton Jr., P.E.
Regional Administrator
U.S. EPA - Region 6

9/21/90
Date

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Decision Summary
Cimarron Mining Corporation Site
Operable Unit 1
Record of Decision

I. Location and General Description

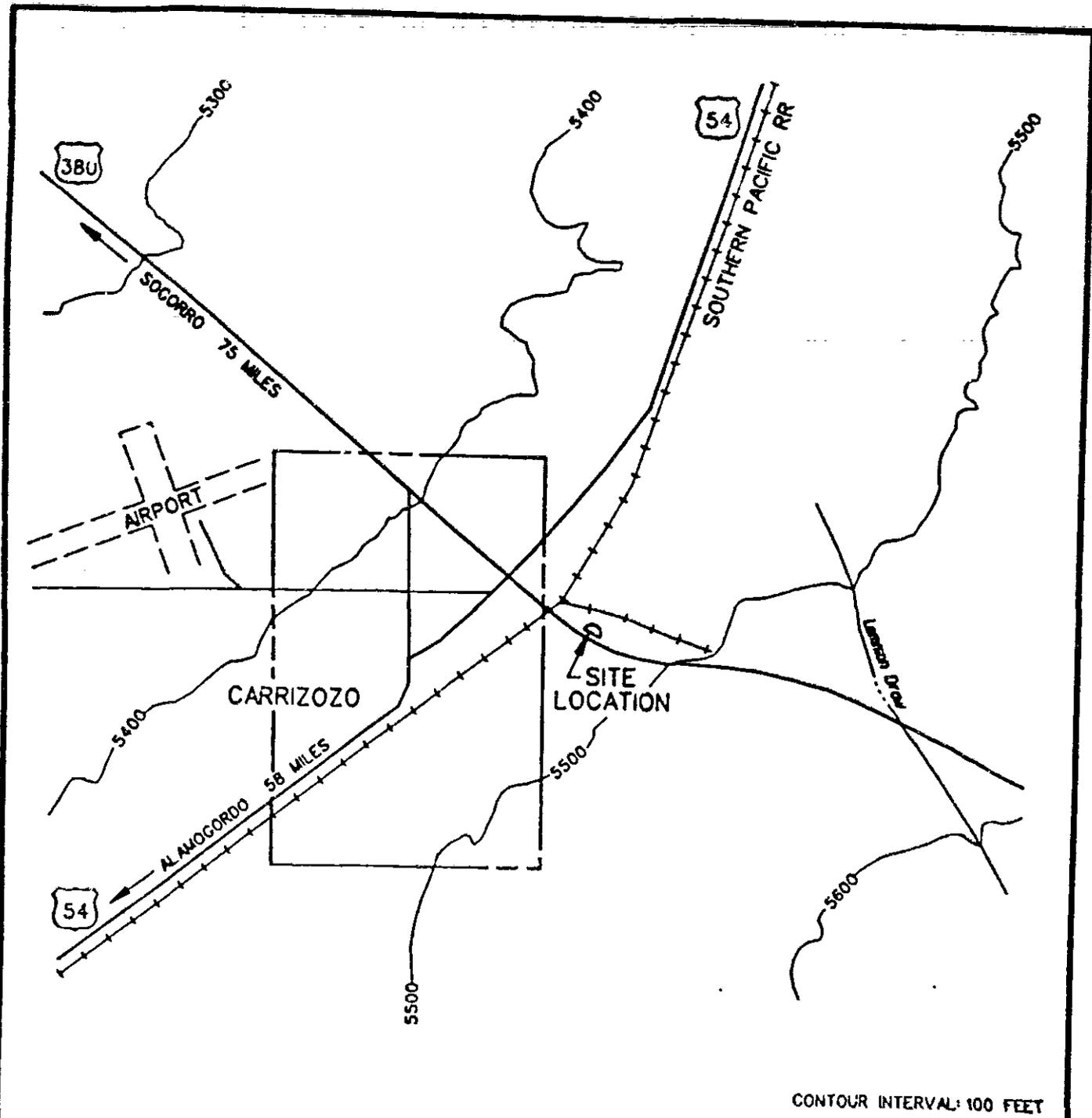
The Cimarron Mining Corporation site is located approximately 1/4 mile east of Carrizozo, Lincoln County, New Mexico and approximately 100 miles south-southeast of Albuquerque. The site is about 10.6 acres in size, and is located in the NE 1/4 Section 2, Township 8S, Range 10E, on the north side of U.S. Highway 380 (Figure 1). The facility consisted of a conventional agitation mill, which resulted in unpermitted discharge of contaminated liquids, the stockpiling of contaminated liquids, and the stockpiling of tailings and other waste sediment. Access to the site is restricted by a 8-foot fence. Approximately 1500 people live within a two mile radius of the site.

While conducting the RI field work at the Cimarron site, the existence of another abandoned mill became known. The other location, known as Sierra Blanca, exists approximately one mile to the south of Cimarron (Figure 1). The two mills were owned by the same parent company (Sierra Blanca Mining and Milling Company) and, for a short period, operated concurrently. File information discusses a possible spill at Cimarron, which prompted all milling operations to be relocated to Sierra Blanca. Investigation of the Sierra Blanca mill is being performed as a second operable unit of the Cimarron NPL site, and the results will be presented as a separate RI/FS report.

II. Site History and Enforcement Activities

The Cimarron Mining Corporation site is an inactive milling facility originally owned by Zia Steel Inc., and used to recover iron from ores transported to the site. The iron recovery process took place between the late 1960's and 1979 and involved crushing of the ore material, formation of a pumpable slurry by mixing with fresh and recycled water, and collection of the ferric (iron) portion using a magnetic separator. Cyanide was not used in this original process, and tailings were transported from the site and used as fill material. In 1979, the site was sold to Southwest Minerals Corporation, which apparently began using cyanide soon thereafter to extract precious metals from ore. Details on the operation between 1979 and 1981 are not available other than a 1980 New Mexico Environmental Improvement Division (NMEID) sample analysis report, which noted the presence of cyanide contamination.

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SOURCE: USGS, Cimarron East-West, NM 7.5' Quadrangles, 1982.

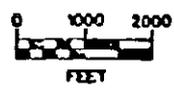


FIGURE 1

**SITE LOCATION MAP
CIMARRON MINING CORPORATION**



QUADRANGLE LOCATION

CAMP DRESSER & MCKEE INC.

Southwest Minerals, a subsidiary of the Sierra Blanca Mining and Milling Company, operated without the required permits necessary for conducting cyanide processing at the site. In mid-1981, the operation was expanded by adding several large mixing tanks, cyanide solution tanks, thickeners, and associated pumping and conveying equipment. NMEID sent a certified notice of violations to Cimarron Mining Corporation on June 22, 1982, for discharging into a non-permitted discharge pit and, in July 1982, the site ceased operation. No legal action was taken by the state; the company filed for bankruptcy in July 1983, and a court assigned bankruptcy trustee was appointed for the site.

NMEID field inspections of the site in February 1980, June 1982, and in May and June 1984 revealed the presence of cyanide and elevated metals in shallow ground water, soil and mill tailings.

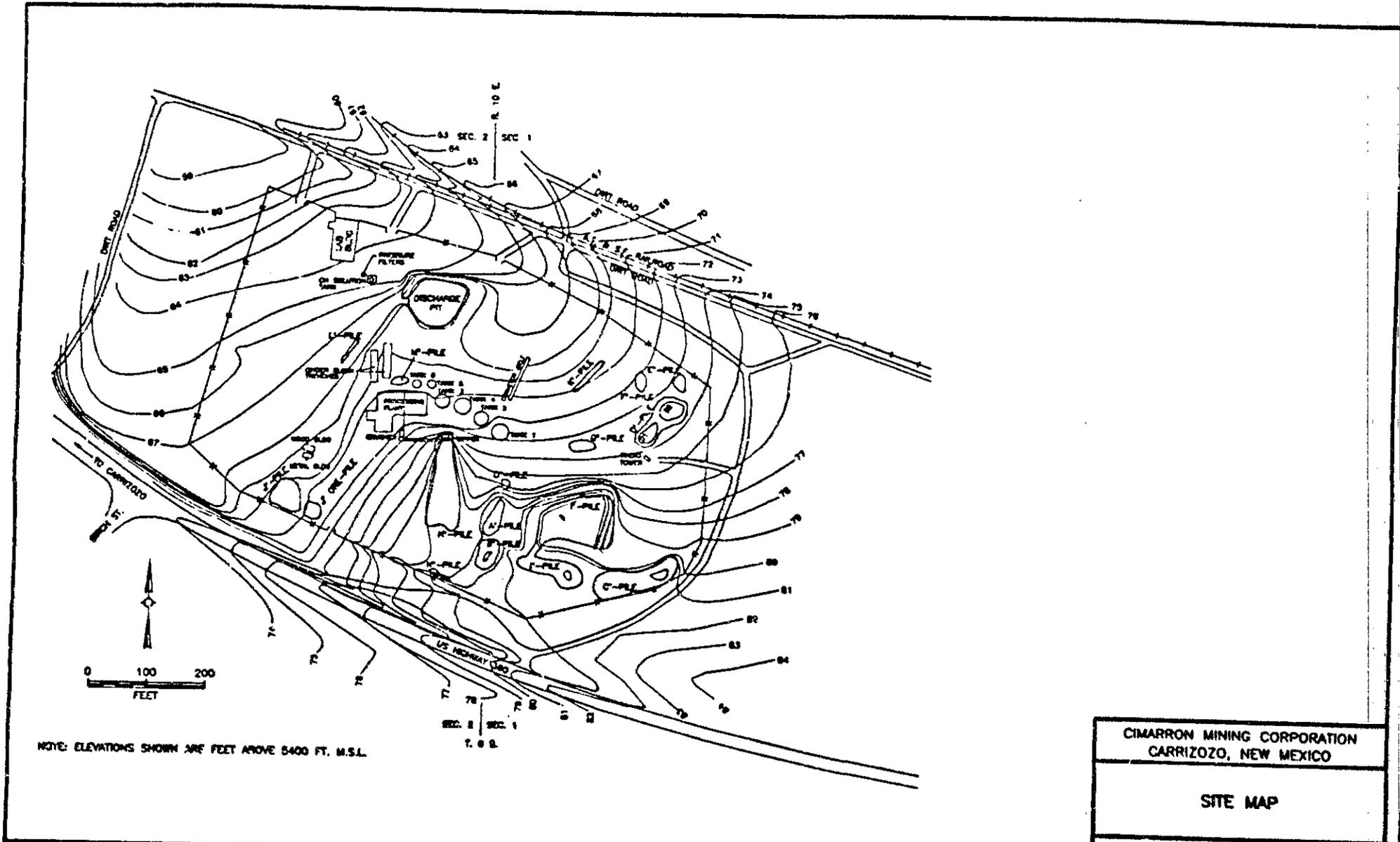
An Expanded Site Inspection (ESI) was conducted from January to October 1987, by an EPA Field Investigation Team (FIT). The objective of the ESI was to collect additional data for the Hazard Ranking System (HRS) and facilitate RI/FS planning. A topographic base map indicating locations and elevations of on-site features is presented in Figure 2.

On-site activities performed during the ESI included surface and subsurface soil sampling, visual inspection of process tanks, sampling of remnant materials in the tanks, quantifying waste volumes, sampling and geologically describing subsurface soil borings during installation of monitor wells, sampling ground water in the monitor wells and in nearby water supply wells, testing in-situ permeability at the monitor wells, and identifying adjacent land uses.

Based on the findings of the site investigations and the preparation of the HRS package, the Cimarron Mining Corporation site was proposed for addition to the National Priority List (NPL) on June 24, 1988. On October 4, 1989, the listing was promulgated.

In March 1989, EPA tasked the firm of Camp Dresser and McKee, an Alternative Remedial Contracts (ARCs) contractor to conduct a Remedial Investigation and Feasibility Study (RI/FS) for the site. A preliminary sampling program was conducted on June 19-23, 1989, to sample existing monitoring wells and known contaminant source areas. Results of the preliminary sampling program were utilized to refine the sampling plan for the extensive RI field investigation.

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NOTE: ELEVATIONS SHOWN ARE FEET ABOVE 5400 FT. M.S.L.

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CIMARRON MINING CORPORATION CARRIZOZO, NEW MEXICO	
SITE MAP	
MARCH 1990	FIGURE 2

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The extensive RI field work and feasibility study began in August 1989 and was completed in June 1990. The data generated was used to estimate the extent and magnitude of contamination at the Cimarron Mining site and to develop and evaluate remedial alternatives. The alternatives evaluated included various pump and treat alternatives for the shallow ground water, institutional controls and no action.

III. Community Participation

Community interest in the Cimarron Mining site has been relatively high due to the close proximity of the site to the town of Carrizozo.

Major community interest has focused on alleviating the stigma of a hazardous waste or Superfund site as it relates to the community and the desire to have an expeditious solution to allow future industrial development of the site.

A public "open house" workshop was conducted in May 1989 to inform the community of the RI/FS activities and process and to answer any questions. Approximately 35 people attended including out of town individuals, representatives of the local newspapers and the New Mexico Bureau of Mines.

Questions and comments ranged from concerns regarding the level of site contamination, potential impacts on the community and possible solutions to a disregard for the previous analytical data from the site and an unwillingness to accept the potential of long term impacts from the site contamination.

Numerous informal status briefings have been conducted with various interested citizens and local officials including presentations, by invitation, at the local chapter of the Rotary Club.

In March 1990, a second public workshop was conducted to notify the community of the preliminary RI results and to answer questions. Approximately 25 people attended this workshop. Most questions involved around potential remedial solutions and the schedule of future activities. A major portion of the meeting involved discussions of the "Sierra Blanca" operable unit and the responsible party status of the town of Carrizozo, which leased the property to the operators of the mill.

The RI/FS documents for the Cimarron Mining site and a Proposed Plan of Remedial Action were released for public comment in July 1990. Public notices were published in the Lincoln County News, fact sheets were mailed to interested individuals and the documents were available for review in local repositories. An "open house" public workshop to discuss the Proposed Plan was conducted on July 16, 1990.

Approximately 10 people attended this workshop. Most comments on the proposed plan of pumping the shallow ground water and discharging to the POTW for treatment focused on a need for additional information in laymans terms in order to form an opinion. No comments were presented which adamantly opposed the proposed pump and discharge to the POTW alternative.

On July 30, 1990, a formal public meeting was held to discuss and accept public comments on the proposed plan of pumping shallow ground water and discharging to the POTW for treatment. The meeting was conducted at the Carrizozo City Hall and approximately 20 people attended. Presentations summarized the purpose of the meeting, the Remedial Investigation, the Feasibility Study and the remedy selection process. The proposed remedy of pump and discharge to the POTW for treatment was endorsed by the New Mexico Bureau of Mines and officials of the town of Carrizozo. In general, this proposed plan was acceptable to the public with relatively few comments relating to the remedy cost, time of implementation and technical capabilities of the POTW to remove contaminants.

IV. Scope and Role of the Operable Unit

The principal threat at the Cimarron Mining site is ground water contamination (approximately 4000 parts per billion cyanide) and it is primarily contained in the shallow ground water which is encountered at approximately 55 feet. Soils and mill tailings contamination, as discussed in the Risk Assessment portion of the RI/FS documents, is not significant and does not present a public health threat. The deeper primary drinking water aquifer, encountered at approximately 120 feet was found to be uncontaminated directly beneath the area of highest contamination although minimal contamination (24 ppb cyanide) was detected in an upgradient on-site production water well. This contamination is believed to be due to poor well construction rather than percolation from the upper, more highly contaminated water bearing zone. The Feasibility Study has evaluated remedial alternatives which address the major shallow ground water contamination based on the potential for migration of contamination to the lower primary drinking water aquifer. Consideration has also been given to achieving a clean-up goal of 200 ug/l cyanide based on the potential future beneficial use of the shallow ground water as a source of drinking water as required by the New Mexico Water Quality Control Commission Regulations.

Modeling indicates that remediation of the major area of ground water contamination (approximately 500,000 gallons) will prevent any significant off site or lower drinking water zone impacts. Because the major contamination will be removed and treated and threats to public health and the environment will be alleviated, the five year review of the remedy will not be required.

As previously discussed, the Sierra Blanca milling location which is located approximately 1 mile south of the Cimarron location, will be addressed as a second operable unit.

V. Site Characteristics

The climate in the Carrizozo area is semi-arid characterized by relatively long, hot summers and mild winters. The total annual precipitation reported by the Office of State Climatologist averages 13.2 inches, while total lake evaporation averages 62.4 inches. The average measured temperatures in the Carrizozo area range between 70.9° and 40.4°F. The lowest recorded temperature was -18°F during January 1971 and the highest was 105°F during June of 1981.

Native vegetation in the vicinity of Carrizozo and the site is characteristic of the Desert grassland association, typically found in this part of New Mexico at elevations of 4,200 to 6,000 feet. Trees are generally absent and small shrubs and grasses dominate. The tailings piles and many of the waste piles are largely devoid of plant life. Volunteer species have invaded the site locally, especially in low traffic areas and where site processes resulted in high moisture.

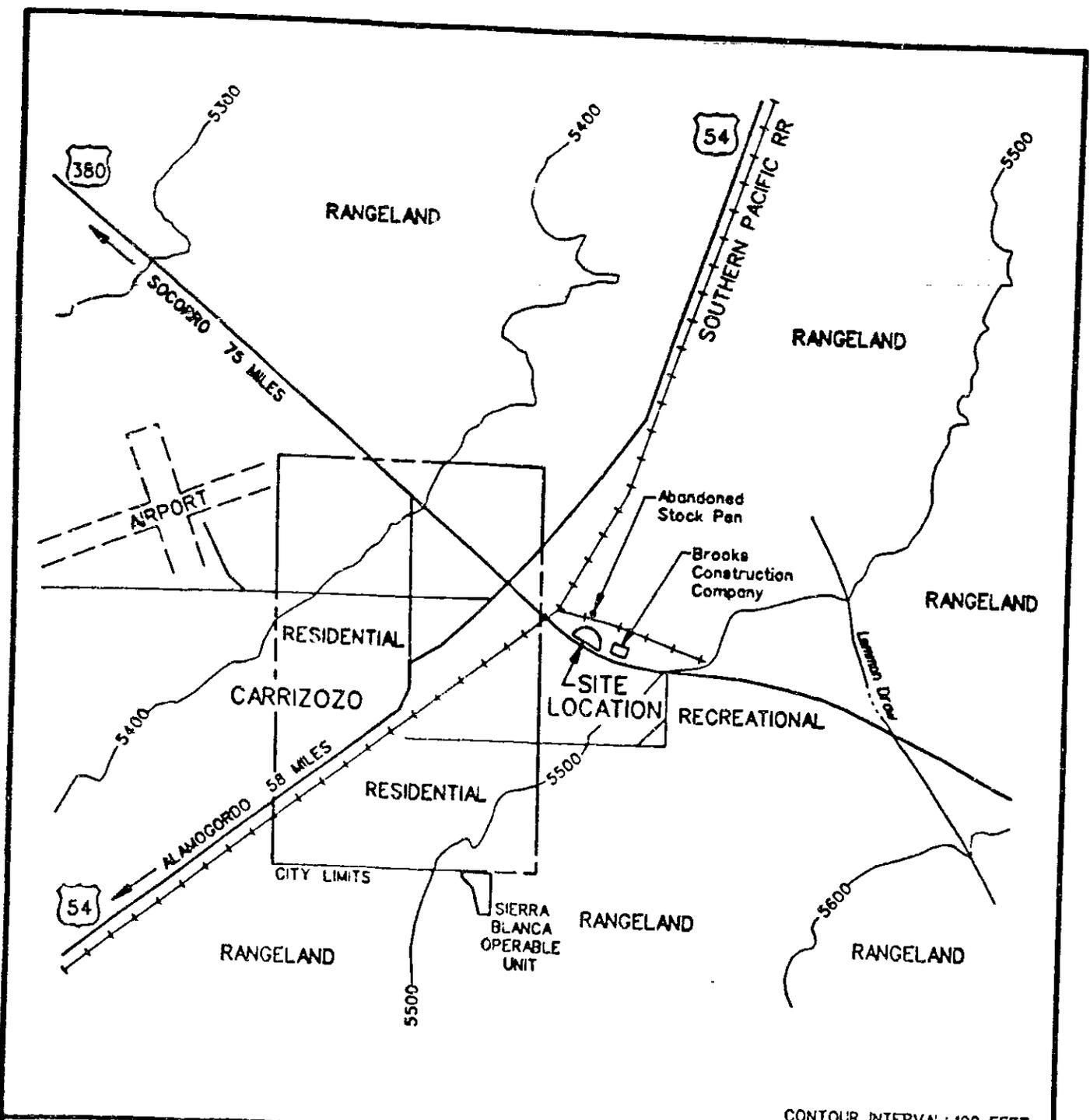
Several species of lizards and snakes survive in this habitat. In addition, several small mammals including the mice, rabbits and coyotes are common. The pronghorn (antelope) are larger mammals also common to the area.

The land surrounding the site supports agricultural, commercial, recreational and residential uses (Figure 3). The predominant land use north of the site is fenced range land. A stock pen is located immediately north of the site and was utilized in the past to hold stock prior to loading onto rail transports. A construction company yard and buildings are located on the adjacent property to the east of the site. U.S. Highway 380 and right-of-way borders the site to the south with recreation facilities beyond. The recreation facilities consist of a golf course, a little league field, a playground, and a picnic area. Railroad tracks and right-of-way for Highway 54 are west of the site.

Based on a 1982 U.S. Geological Survey Topographic map of the area, 1,200 people reside within a one-mile radius of the site and about 1,500 reside within a two-mile radius of the site. The closest inhabited residence in Carrizozo is approximately 1/4 mile south of the site. The main population center of Carrizozo is approximately 3/4 mile from the site. Census data for the region indicate that the population of Carrizozo is relatively stable, with less than five percent increase in population between 1970 and 1988.

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CONTOUR INTERVAL: 100 FEET

SOURCE: USGS, Cimarron East-West, NM 7.5' Quadrangles, 1982.



FIGURE 3
 SITE AREA LAND USE MAP



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Geology

The Cimarron Mining Corporation site is situated near the axis of the northern portion of the Tularosa Basin. This basin forms an elongated valley that extends more than 200 miles from the vicinity of Carrizozo, New Mexico, southward into Chihuahua, Mexico.

Regional Stratigraphy

The northern portion of the basin, in the vicinity of Carrizozo, consists of Quaternary aged alluvial material underlain by Tertiary to Permian aged rocks. Figure 4 illustrates the surface exposure of these deposits. A stratigraphic column is shown as Figure 5.

Most of the rocks in the area are of sedimentary origin. The rocks range from Permian limestones, sandstones, and shales to Cretaceous sandstones, coals, and shales. Intrusive and extrusive igneous rocks originated during the Tertiary times, and basaltic lava beds were deposited during the late Quaternary time. The lava flowed from a vent a few miles north of Carrizozo and formed an extensive lava bed, referred to as the Malpais, in the northwest portion of the area. Alluvial material is at the surface throughout most of the area with only scattered outcrops of Tertiary and older rocks. Outcrops of Permian rocks are restricted to the western portion of the area.

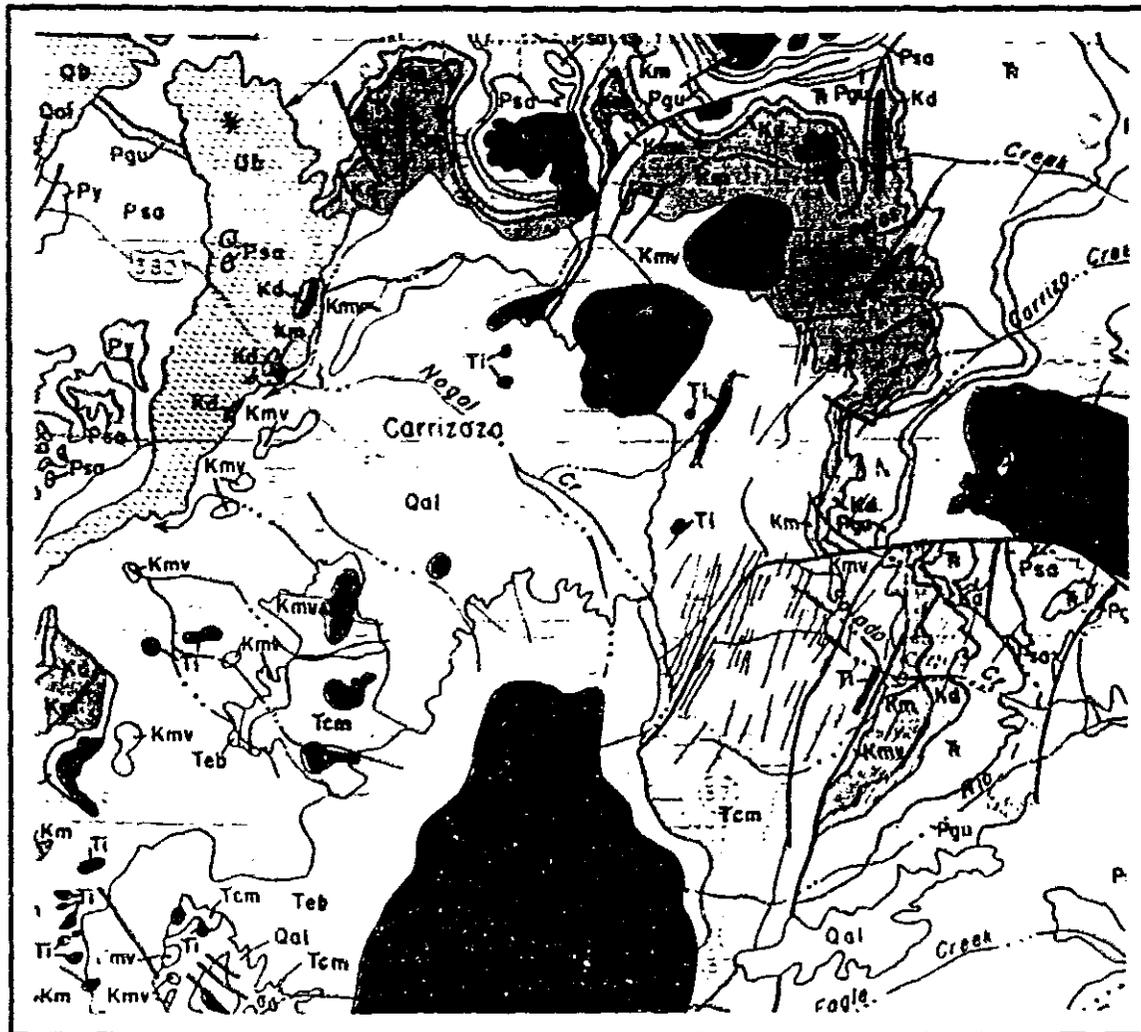
Site Geology

The site geology is based upon the results of the RI field investigation in which eight monitor wells were installed and three additional boreholes were drilled. The boreholes and monitor wells were continuously sampled, where possible, during drilling.

Site Stratigraphy

The stratigraphy at the site was found to consist of two principal units. The uppermost unit is a fine grained alluvium consisting of brown to tan calcareous and sulfate rich silty clays and clayey sands. This unit, which is present to depths of 16 to 27 feet, was found to be unsaturated in the vicinity of the site. The lower unit, extending to a depth of at least 200 feet, is a fine grained Cretaceous unit consisting of interbedded shales and fine grained sandstones and siltstones. The Cretaceous units were observed to have fractures and joints to a depth of at least 70 feet below the surface. Most of the fractures and joints appeared to be sealed by iron precipitates.

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Source: New Mexico Bureau of Mines and Mineral Resources, Bulletin 67, Plate 2 (Griswold, G.B., 1959).

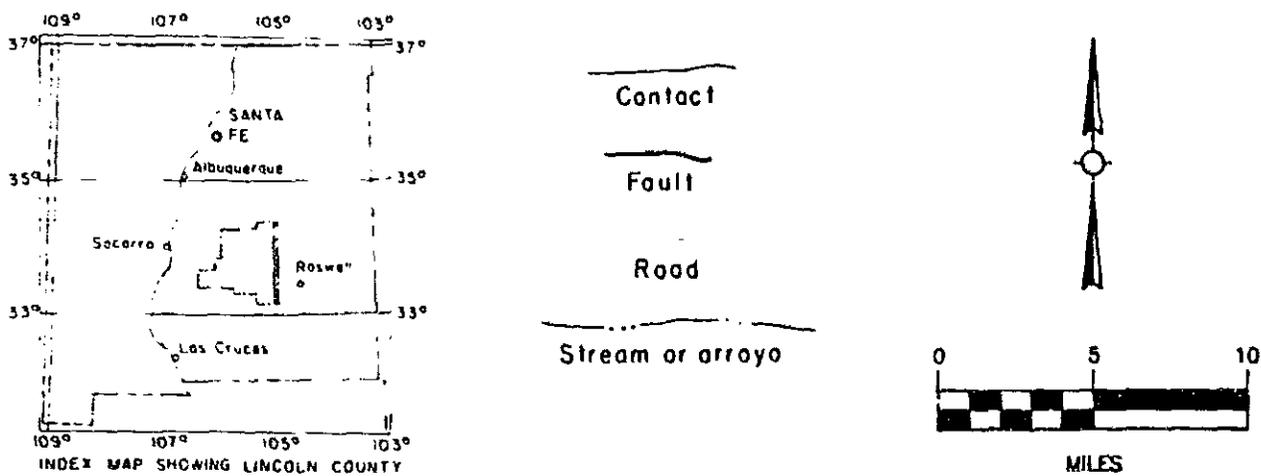


FIGURE 4
SURFACE GEOLOGY MAP

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EXPLANATION

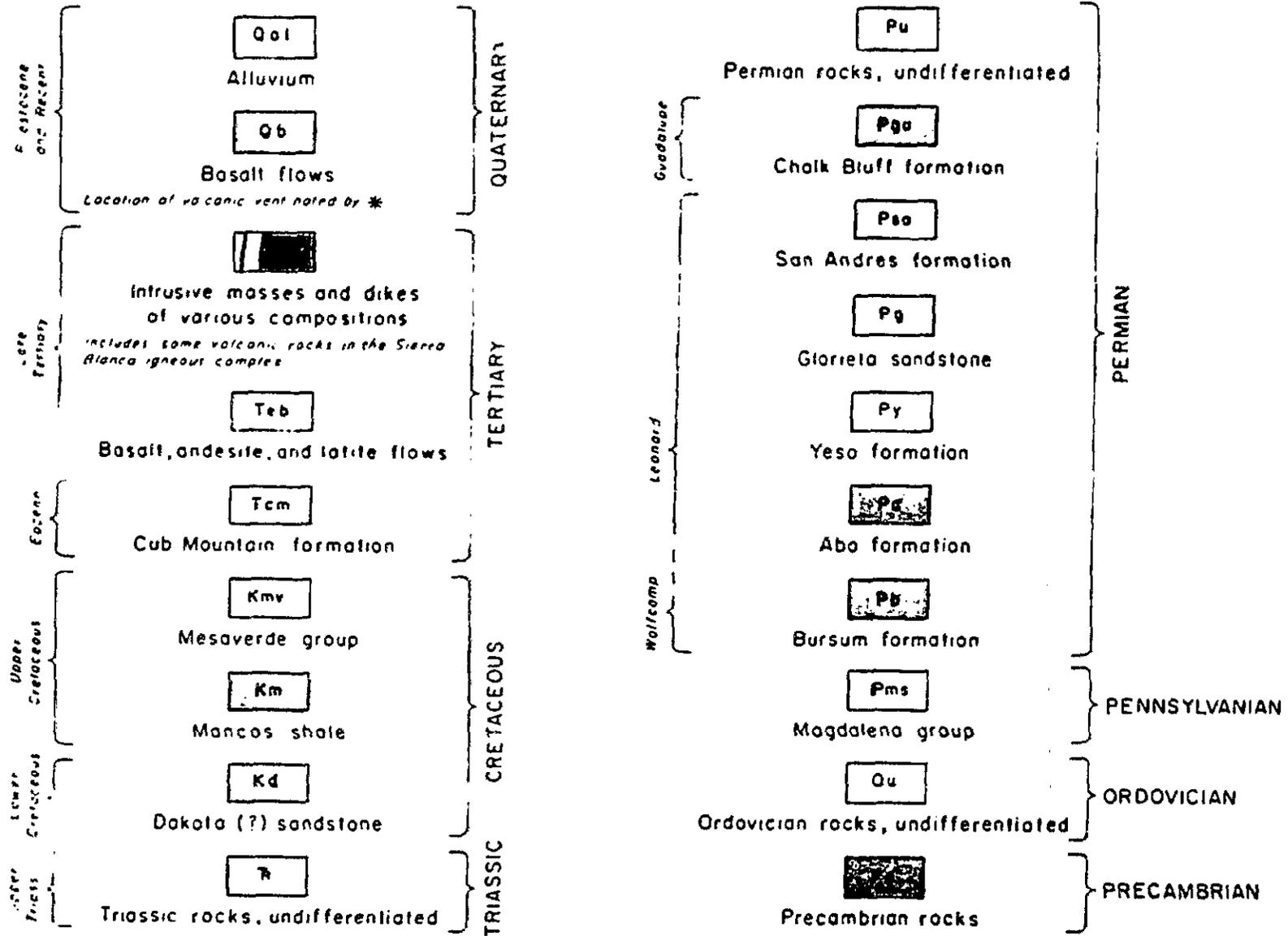


FIGURE 5
STRATIGRAPHIC COLUMN

Source: New Mexico Bureau of Mines and Mineral Resources, Bulletin 67, Plate 2 (Griswold, G.B., 1959).

CAMP DRESSER & McKEE INC.

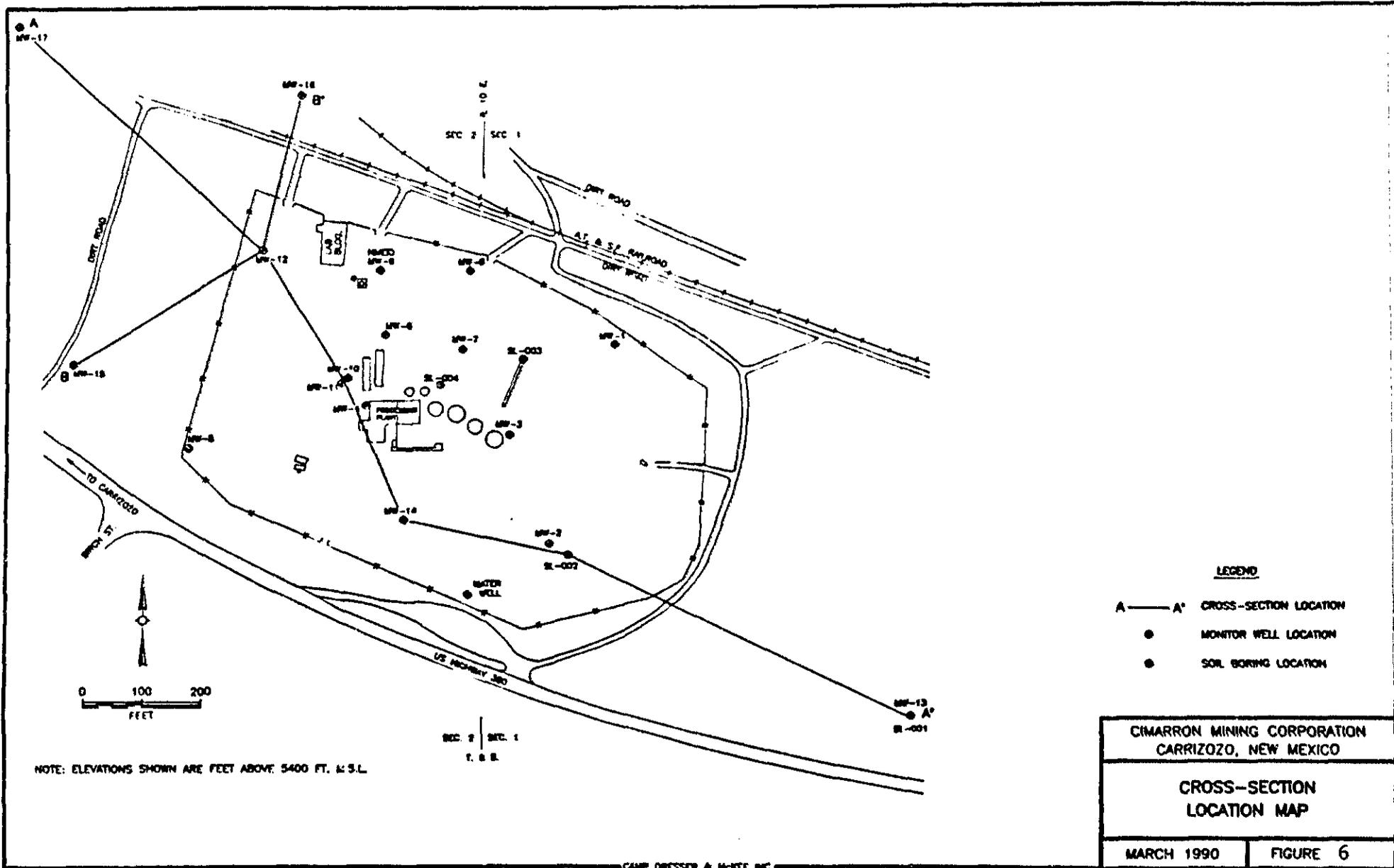
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Two geological cross-sections, as located in Figure 6 have been developed from information gathered during the RI. Figure 7 is a southeast to northwest cross-section which shows the Quaternary alluvium overlying the dipping Cretaceous beds. As shown in this figure, the individual units within the Cretaceous sediments are generally discontinuous in the direction of the dip over most of the site. Figure 8 is a south to north cross-section which shows that some of the units may be laterally continuous across the site in a direction perpendicular to the dip of the Cretaceous units.

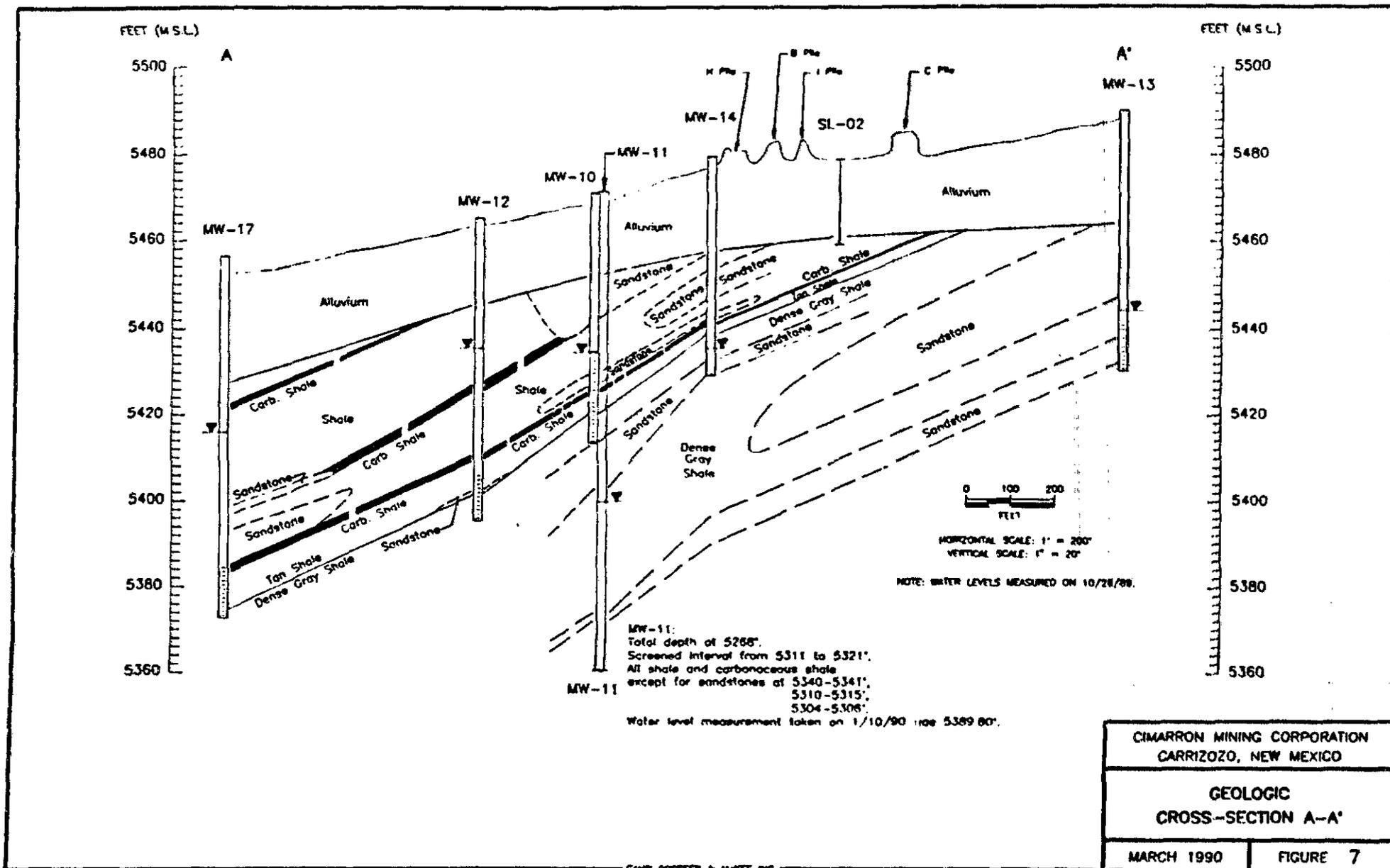
Topography

The ground surface is unpaved and slopes down to the northwest across the site. Figure 9 illustrates the topography and the noted drainage patterns across the site. The abandoned railroad spur on the north end of the site provides a drainage pathway along the northern boundary of the site, sloping down to the northwest. The northwest portion of the site is sloped from the main milling area to the railroad spur drainage near the northwest corner of the security fence. A drainage pathway is also present on the south side of the site, sloping to the west, bending north along the western boundary of the site, and converging with the drainage from the main milling area near the northwest corner of the site. Surface drainage also flows from the tailings area on the east side of the site into the railroad spur drainage on the northeast end of the site which eventually converges with the rest of the site drainage pathways at the northwest corner of the site.

Water was observed to flow across the surface along the indicated pathways during two separate storm events which occurred during the RI field investigation. The overall slope is approximately 1.1° to the northwest but may vary from 0° around the noted ponding areas to as much as 85° around the "H" pile. There is a man-made depression of a foot or less forming the ponding area west of the "D" pile. The water which collected in the ponding areas noted on Figure 9 was observed to disappear within a day of the storm event by a combination of evaporation and soil saturation. Water was also observed to collect in the two cinder block trenches north of the processing plant. This collected water also disappeared within a few days. Additionally, some storm water drainage enters the discharge pit.

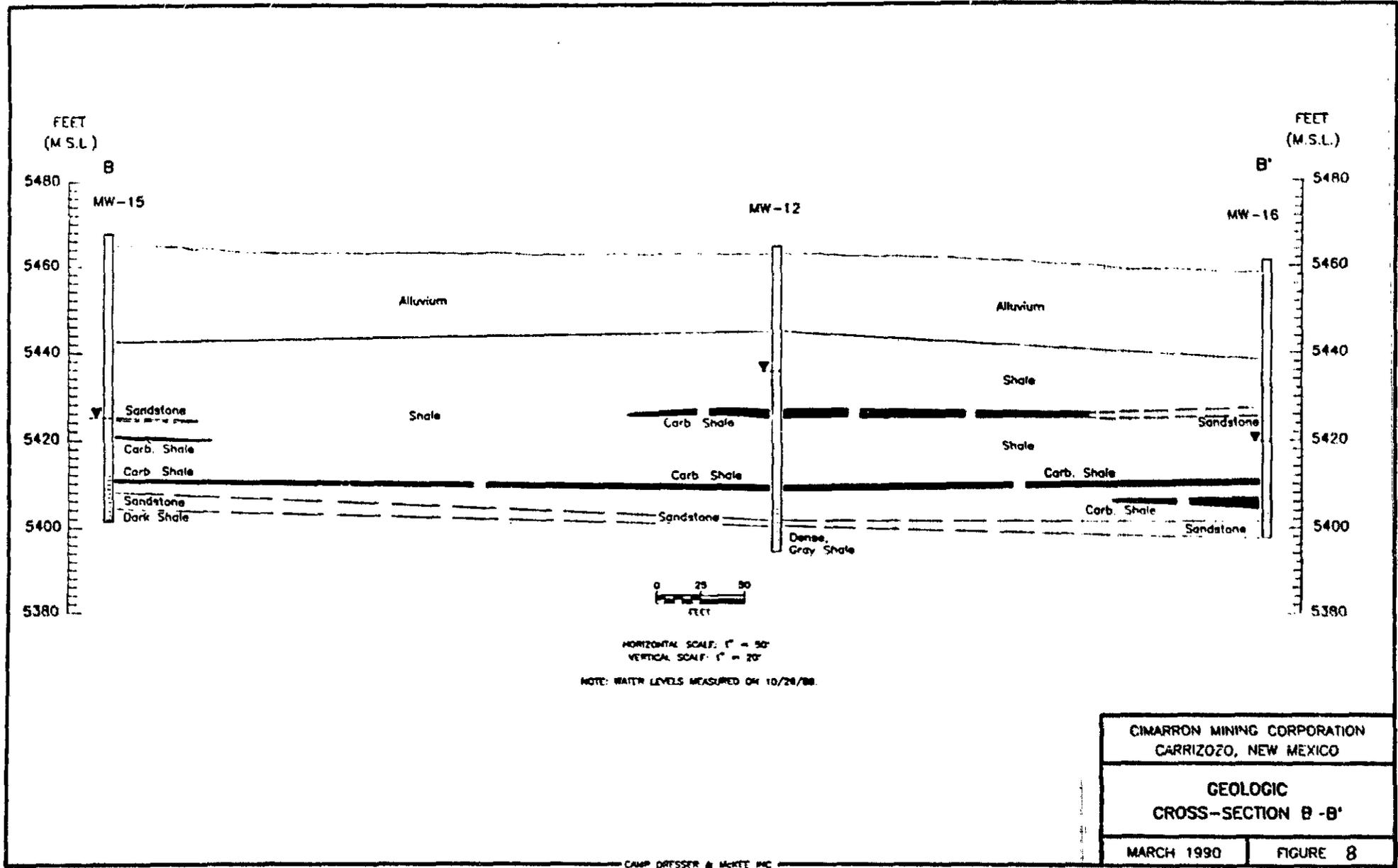


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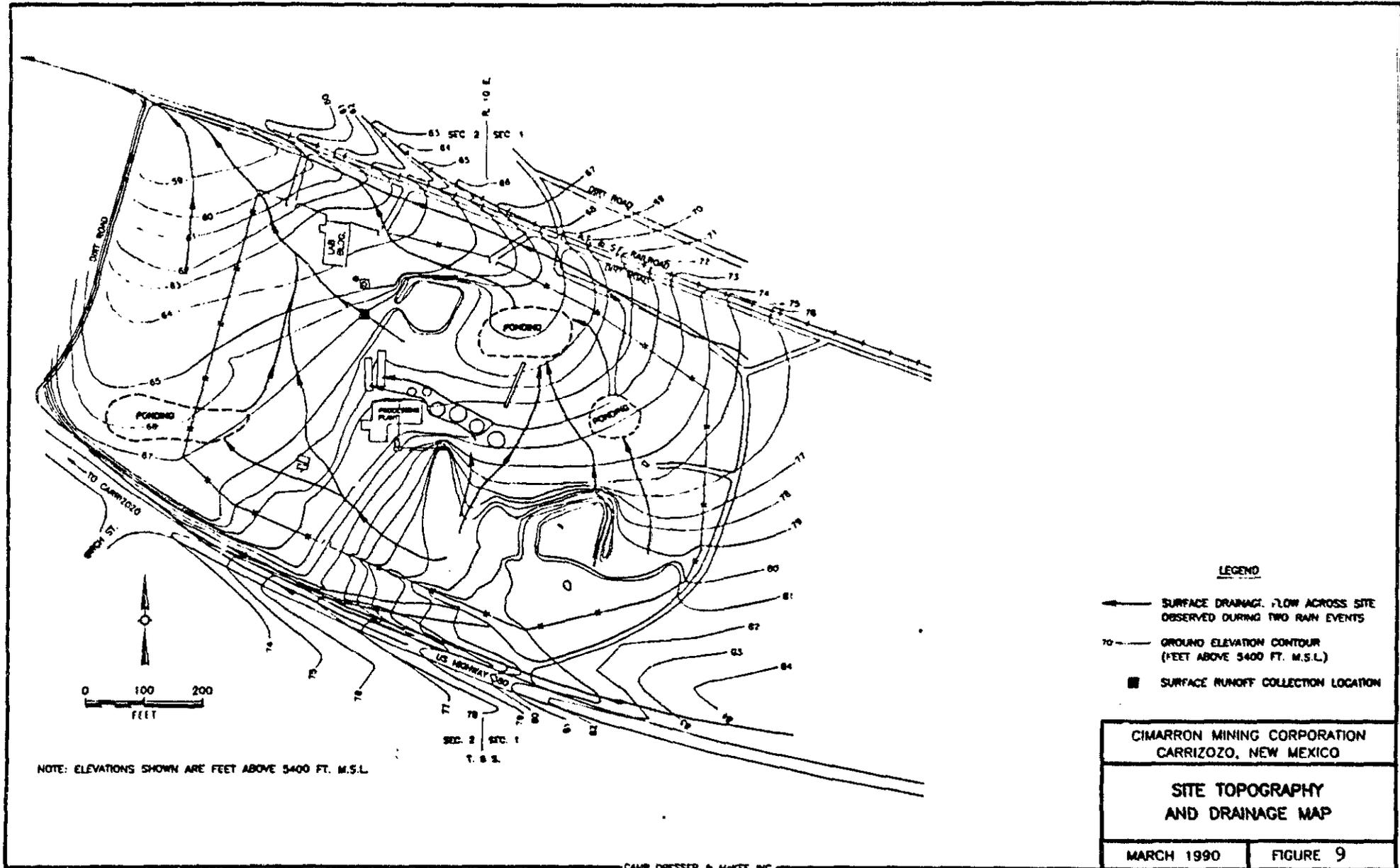


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NOTE: ELEVATIONS SHOWN ARE FEET ABOVE 5400 FT. M.S.L.

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LEGEND

- ← SURFACE DRAINAGE FLOW ACROSS SITE OBSERVED DURING TWO RAIN EVENTS
- GROUND ELEVATION CONTOUR (FEET ABOVE 5400 FT. M.S.L.)
- SURFACE RUNOFF COLLECTION LOCATION

CIMARRON MINING CORPORATION CARRIZO, NEW MEXICO	
SITE TOPOGRAPHY AND DRAINAGE MAP	
MARCH 1990	FIGURE 9

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Hydrogeology

Regionally, ground water exists in both the alluvial deposits and the sedimentary rocks. Although all material below the water table is potentially water saturated, the very low permeability of some deposits, such as shales, siltstones, and lignites, effectively prevents water penetration in significant quantities. Fine-grained porous material, although water saturated, will not yield significant water to wells because of low permeability. Significant aquifers are within the relatively coarse alluvial material or in underlying porous or fractured sedimentary rocks. Both the alluvial and Cretaceous aquifers have highly variable yields from a few gallons per minute (gpm) to several hundred gpm. No other units in the area produce significant amounts of ground water.

Shallow ground water occurs primarily in unconfined water table conditions at depths ranging from about 20 to 200 feet. East of the malpais or lava flow, the water table slopes to the west and northwest as does the ground surface. Elevation contours on the water table and ground water flow directions are depicted in Figure 10. The gradient steepens in areas of lower permeability or where other significant barriers to flow exist. Ground water may pond behind zones of low permeability such as dipping shales or intrusive igneous rocks. At some locales, springs occur where the ponded region of the water table intersects the land surface.

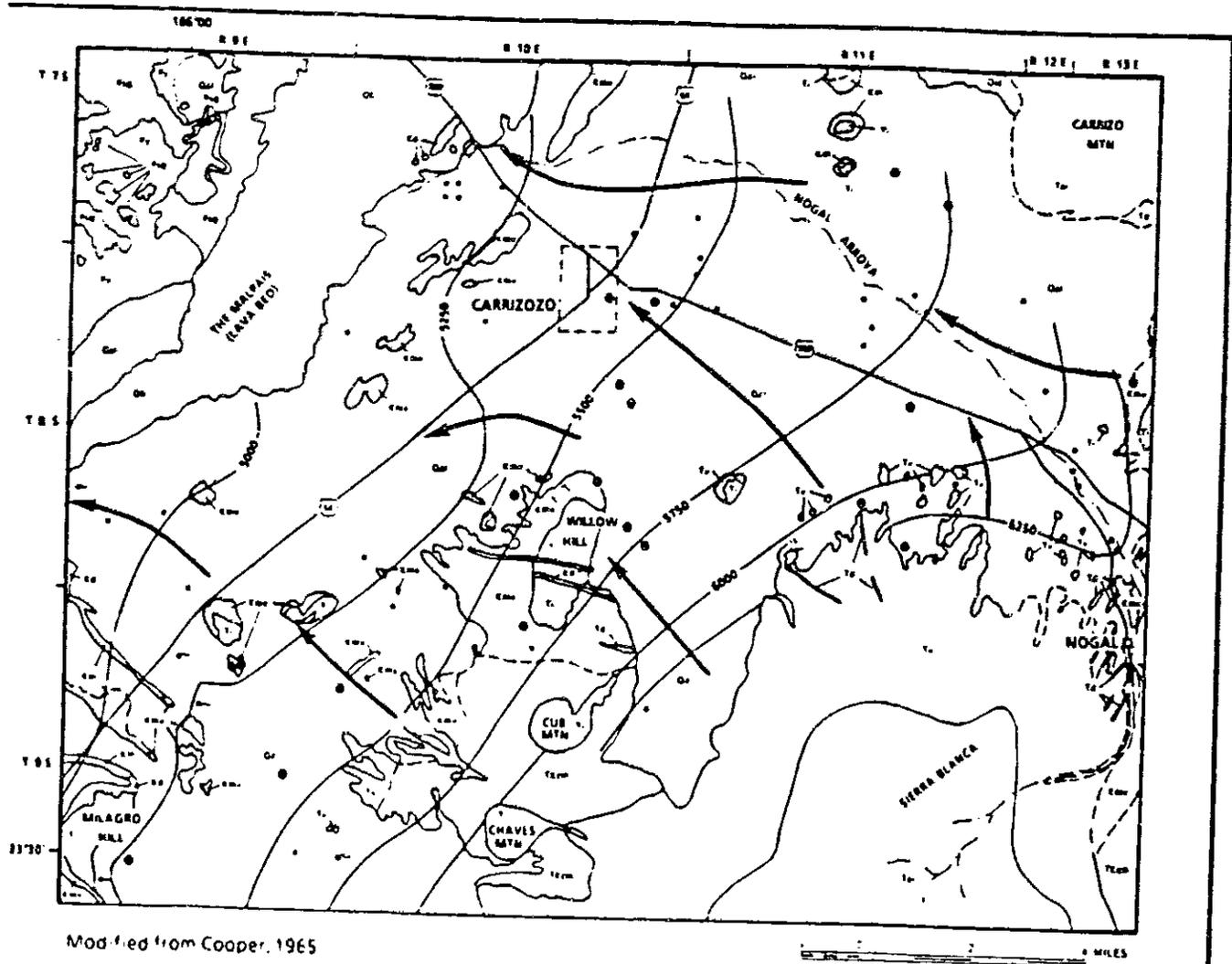
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Regional Ground water Quality

Many of the rocks in the area are of sedimentary origin, with relatively high concentrations of chloride and sulfates in some locals. In a significant number of private wells in the area, these dissolved constituents exceeded drinking water standards. Concentrations of these and other constituents are not high enough to prevent use of ground water throughout most of the area, and due to their origin, are not considered in violation of regulations by the State of New Mexico.

Occurrence and Availability of Ground water

Ground water in the area is recharged chiefly by runoff from the mountains in the southern and eastern parts of the area. Some limited direct recharge from local precipitation in the arid basin may also occur in some areas where the shallow water table is near the ground surface, however, at the Cimarron site, this mode of recharge is expected to be negligible or nonexistent. The Hydrologic Evaluation of Landfill Performance (HELP)



Modified from Cooper, 1965

SEDIMENTARY ROCKS		IGNEOUS ROCKS	
QUATERNARY	Qal - Alluvium - Clay, Silt & Gravel	Qb - Basalt Flow	
	Qld - Landslide Debris		
TERTIARY & CRETACEOUS	TKcm - Cub Mountain Formation - Sandstone, Quartzite, Conglomerate	Tv - Extrusive	
		Ti - Intrusive	
CRETACEOUS	Kmv - Mesa Verde Group - Coal Bearing Sandstone & Shale	Tei - Extrusive and Intrusive	
	Kin - Mancos Shale - Dark Fissile Shale	Td - Dike	
	Kd - Dakota Sandstone - Buff Sandstone		
TRIASSIC	T _{RD} - Dockum Group - Red Beds, Siltstone, Sandstone Conglomerate	— 5500 —	Water-table contours, elevation in ft above MSL
PERMIAN	Psg - Giorietta Sandstone and San Andreas Limestone: - Limestone, Gypsum and Sandstone	↙	Direction of Groundwater Flow
	Py - Yeso Formation: - Gypsum, Siltstone, Limestone, Sandstone	○	Well in alluvium
		⊙	Well in Cretaceous rocks
		●	Well in alluvium and Cretaceous rocks
		⊕	Spring

FIGURE 10

STRATIGRAPHY, SURFICIAL GEOLOGY, AND GROUNDWATER ELEVATIONS IN THE NORTHERN TULAROSA BASIN

CAMP DRESSER & McKEE INC.

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Site Ground water Use

There is one water well on the site which was installed by Cimarron Mining Corporation to supply water for the gold extraction process. This well is no longer in use. No reliable well completion records are available. The well is at least 126 feet deep and the screen location is not known. This water well is located in the southeast corner of the site, upgradient of the most contaminated area of the site, but is in an area where some low level cyanide contamination is present in the shallow zone. Some cross contamination of water units has apparently occurred through this hydraulic connection between ground water zones. Cyanide was found at a concentration of 24 ppb in the deep well. Although the cyanide concentration of 24 ppb in the deep well is below the 200 ppb standard, it is evidence of the potential for the downward migration of contamination.

Site Ground water Quality

The quality of the shallow ground water at the site is poor in terms of TDS, chloride and sulfate content. Table 1 contains the results of chemical analyses performed on the 17 monitor wells and one water well on the site.

Classification of Ground water

It is the policy of EPA's Superfund program to use as a guide the framework provided by EPA's Ground water Protection Strategy (U.S. EPA, 1984) in determining the appropriate remediation for contaminated ground water. Three classes of ground water have been established on the basis of ground water value and vulnerability to contamination.

The various ground water classes are below:

Special ground water (Class I) is highly vulnerable to contamination because of the hydrological characteristics of the areas in which it occurs, and characterized by either of the following factors:

- o The ground water is irreplaceable; no reasonable alternative source of drinking water is available to substantial populations.
- o The ground water is ecologically vital; the aquifer provides the base flow for a particularly sensitive ecological system that, if polluted, would destroy a unique habitat.

TABLE 1

SITE WELLS WATER QUALITY PARAMETERS

Well	Calcium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Magnesium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Carbonate (mg/L)	Bicarbonate (mg/L)	Total Dissolved Solids (mg/L)
MW-01	271	192	7.7	90.6	365	925	0	115	2,010
MW-02	512	293	18.7	147	766	1,342	0	101	3,150
MW-03	420	241	12.7	136	696	1,153	0	95	2,780
MW-04	564	383	4.6	209	521	1,775	0	158	3,790
MW-05	780	586	4.5	289	1,870	2,032	0	118	5,950
MW-06	531	347	4.2	188	1,050	1,411	0	128	3,870
MW-07	422	296	7.9	162	742	1,124	0	205	3,010
MW-08	400	224	5.2	140	1,630	1,064	0	178	2,970
MW-09	699	418	2.9	249	1,556	1,914	0	98	5,090
MW-10	525		8.1	194	1,048	1,856	0	121	4,260
MW-12	143		5.0	66.7	447	695	0	126	1,960
MW-13	495	271	5.0	117	857	129	0	88	3,240
MW-14	186	243	7.6	110	268	772	0	371	2,000
MW-15	367	316	13.2	140	1,078	876	0	148	3,540
MW-16	192	113	10.5	73.2	25.1	505	0	265	1,540
MW-17	385	272	3.0	128	758	1,180	0	111	2,940
WW-01	45.1	275	2.1	130	748	1,272	0	95	2,920

WW-01 is the abandoned on-site water production well

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Current and potential sources of drinking water and water having other beneficial uses includes all other ground water that is currently used (IIA) or is potentially available (IIB) for drinking water, agriculture, or other beneficial use.

The shallow ground water not considered a potential source of drinking water and of limited beneficial use (Class IIIA and Class IIIB) is saline, i.e., it has a total dissolved solids level of 10,000 milligrams per liter (mg/L), or is otherwise contaminated by naturally occurring constituents or human activity that is not associated with a particular waste disposal activity or another site beyond levels that allow remediation using methods reasonably employed in public water treatment systems. Class III also includes ground water that is not available in sufficient quantity at any depth to meet the needs of an average household.

Class IIIA includes ground water that is interconnected to surface water or adjacent ground water that potentially could be used for drinking water. Class IIIB includes ground water that has no interconnection to surface water or adjacent aquifers. For Class IIIA ground water, establishing cleanup levels should take into consideration the degree of interconnection to Class I or Class II ground water or the rate of discharge to surface water so that levels of contaminants in higher class ground water do not increase as a result of the interconnection.

Aquifer testing results of the contaminated shallow ground water unit at Cimarron indicate that a pumping yield of only two gallons per minute (GPM) or less can be achieved. This is not enough yield to meet the needs of an average household. The shallow ground water body is separated from potential Class I or II aquifers by a thick shale unit, although some limited interconnection is possible through fractures, joints, and an abandoned well which intersects both zones.

Based on the above classification criteria and site data, the shallow ground water zone at the Cimarron site could be considered a Class IIIA aquifer. However, due to the limited availability of ground water in some areas of New Mexico, the New Mexico Water Quality Control Commission Regulations (NMQCCR) require protection of all ground waters of less than 10,000 mg/l total dissolved solids. Because of this criteria, this Record of Decision considers the NMQCCR 200 ug/l standard as a clean up goal based on the potential future beneficial use of the shallow ground water as a source of drinking water.

Preliminary RI Sampling

The results of the preliminary sampling verified that organic contamination is not present in the ground water at the site above detection limits. Cyanide was detected in all of the wells with highest concentrations in shallow monitoring wells 4 (2.84 mg/l) and 6 (0.498 mg/l). Preliminary sampling also indicated chromium, iron and lead were present in some of the shallow monitoring wells at concentrations greater than Federal and State drinking standards.

Drums (approximately 150) containing magnetic mineral concentrate were sampled however no organics or cyanide were detected. These drums were sold by the bankruptcy trustee and removed from the site prior to the extensive RI field investigation.

Surface and near surface soils in the spillage areas were also collected during the preliminary sampling program and analyzed for total cyanide and metals. Total cyanide was detected at the following depths and concentrations: 0" to 2" (6.4 mg/kg); 2" to 6" (7.3 mg/kg); 6" to 12" (1.5 mg/kg); and 12" to 18" (1.3 mg/kg). This indicated that most of the cyanide in the spillage areas is confined in the upper few inches of the soil. A similar pattern of decreasing concentration with depth was found for the metals chromium, copper, cobalt, iron, magnesium, manganese, nickel, uranium and zinc.

Based on the preliminary sampling program and full chemical analysis of the ground water and soils, it was determined that the contaminants of concern at the Cimarron site are cyanide and metals. The preliminary sampling program verified that no organics contamination is present at the site.

Extensive Sampling Program

As discussed above, the contaminants of concern were verified by the Preliminary Sampling Program to be cyanide and metals. To determine the degree and extent of contamination, all samples were analyzed for Target Analyte List (TAL) metals and total cyanide. To gather information useful in predicting mobility of contaminants and forms of cyanide, select samples were analyzed for pH, forms of sulfur, acid potential, neutralization potential, noncomplexed cyanide and cyanide amenable to chlorination. In addition, air samples were collected and analyzed for total cyanide (vapor and dust), total dust, total respirable dust, and TAL metals (as dust). To gather system chemistry information, in addition to that provided by the above analyses, ground water samples were also analyzed for various anions and cations, total suspended solids, total dissolved solids, and nitrate/nitrite. To provide information useful in evaluation of remedial technologies, in addition to that provided by above analyses, select samples were analyzed for gold, dry density and particle size distribution.

Soils at the Cimarron site were sampled to verify the nature and extent of contaminants in source areas and to determine the areal extent of surface contamination resulting from wind and water erosion processes and random waste disposal practices. This information is necessary for developing remedial action alternatives for the site.

Surface soil samples were, in most cases, collected from two separate levels of the surface/near surface soils. Since degradation and volatilization of cyanide may be greater at the soil/air interface than below the surface, and in order to assess potential transport of contaminants from the surface by wind, one of the two samples was collected from the top of the soil (0-2"). In order to assess the degree of cyanide contamination in the near-surface soils, and to gather information on the dynamics and vertical mobility of contaminants in the near-surface soils at the site, the second surface soil sampling location was collected from the 2-6" interval.

Samples were collected on a 200 foot grid in the apparently contaminated process area and along a transect leading away from the I tailings pile to the northeast, which is the prominent wind direction in the Carrizozo area. Surface soil sampling locations, including those locations sampled during the preliminary sampling program are shown in Figure 11.

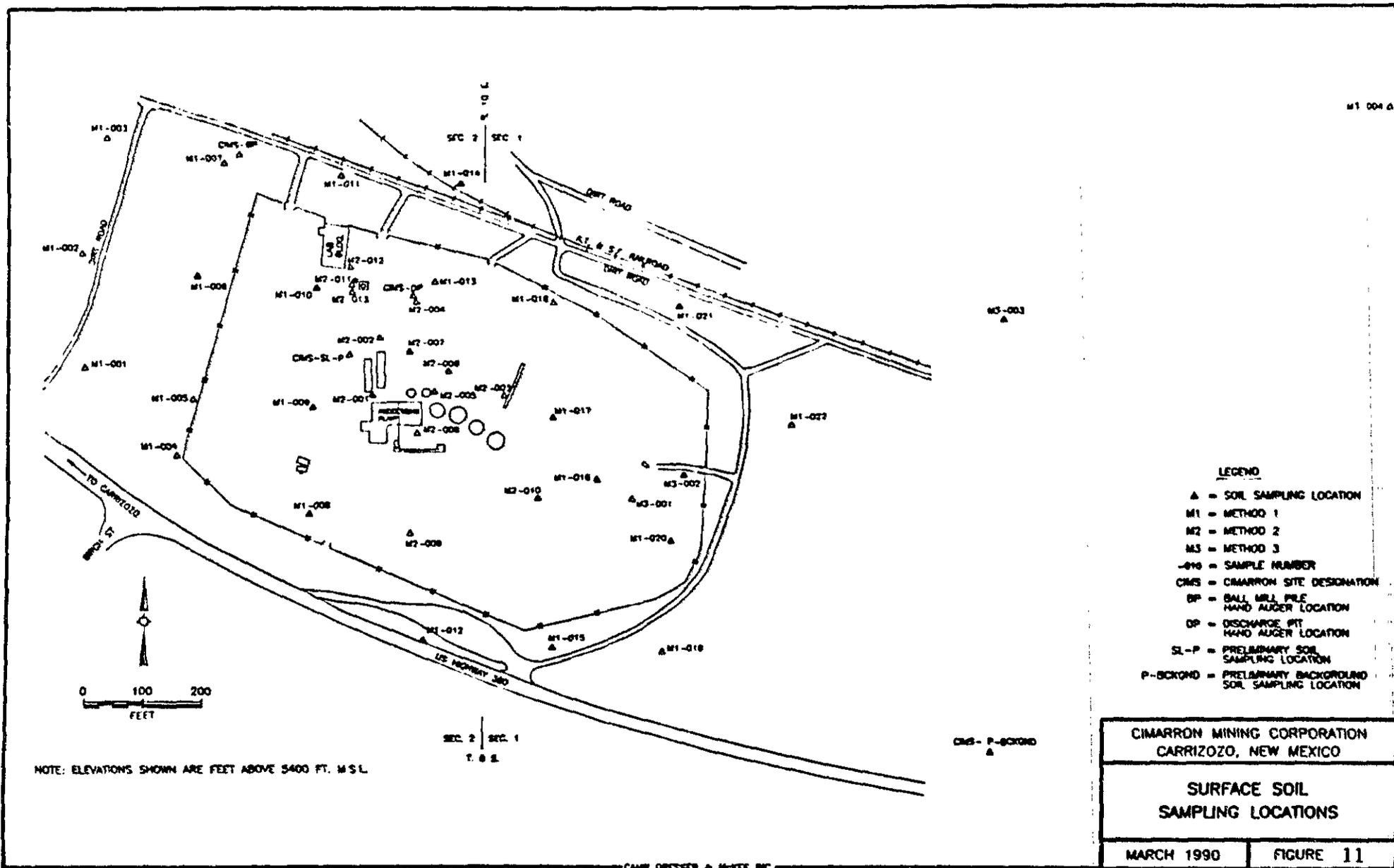
Typical background metals concentrations were compiled in order to provide for comparison with metals concentrations of samples collected in areas of the site affected by facility operations. Background cyanide concentrations were analytically undetectable.

Review of the data indicates that there are several metals which have distinctly higher concentrations in particular areas of the site. Those areas include processed and unprocessed waste piles, cyanide solution and tailings spill areas, and the cinder block trenches and the discharge pit. The metals with elevated concentrations in these areas are arsenic, barium, calcium chromium, cobalt, copper, iron, lead, magnesium, nickel, selenium, sodium, vanadium, and zinc.

With the exception of copper, cobalt and iron, these concentrations still fall into the range of typical concentrations listed for soils in the United States as shown in Table 2.

Cyanide was detected at only one M1 surface soil location. Total cyanide (2.1 mg/kg) was detected in sample M1-016, which was located in a drainage ditch at the northeast corner of the I pile. Total cyanide was also detected in the discharge pit (7.0 to 46.5 mg/kg), and sample locations M2-001, -002, -003, -005, -006, -010, -011, and -012 (1.2 to 40.5 mg/kg). Also included in the analysis was the concentrations of cyanide which would be amenable to destruction by chlorination. The percentage of cyanide amenable to chlorination is generally less than 50 percent of the total cyanide concentration. This indicates that a large

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TABLE 2
TYPICAL METALS CONCENTRATIONS IN SOILS
OF THE UNITED STATES
mg/kg (ppm)

Element		Range	Typical Medium	Source
Aluminum	Al	10,000 - 300,000	71,000	5
Antimony	Sb	1 - 150	6	3, 4
Arsenic	As	0.1 - 194	11	2
Barium	Ba	100 - 3,000	430	5
Beryllium	Be	0.1 - 40	6	5
Bromine	Br	1 - 10	5	5
Boron	B	2 - 130	10	5
Cadmium	Cd	0.01 - 0.70	0.06	1
Calcium	Ca	< 150 - 320,000	24,000	5
Chromium	Cr	1 - 1,000	100	3
Cobalt	Co	1 - 40	8	5
Copper	Cu	2 - 100	30	1, 5
Flouride	F	10 - 4,000	200	5
Iron	Fe	7000 - 550,000	38,000	5
Lead	Pb	2 - 200	10	5
Magnesium	Mg	600 - 6,000	5,000	5
Manganese	Mn	50 - 18,300	850	5
Mercury	Hg	0.01 - 0.03	0.03	1, 2
Nickel	Ni	5 - 500	40	5
Selenium	Se	0.1 - 2	0.3	2
Silver	Ag	0.01 - 8	0.4	5
Sodium	Na	750 - 7,500	6,300	2, 5
Vanadium	Va	20 - 50	100	5
Zinc	Zn	10 - 300	50	5

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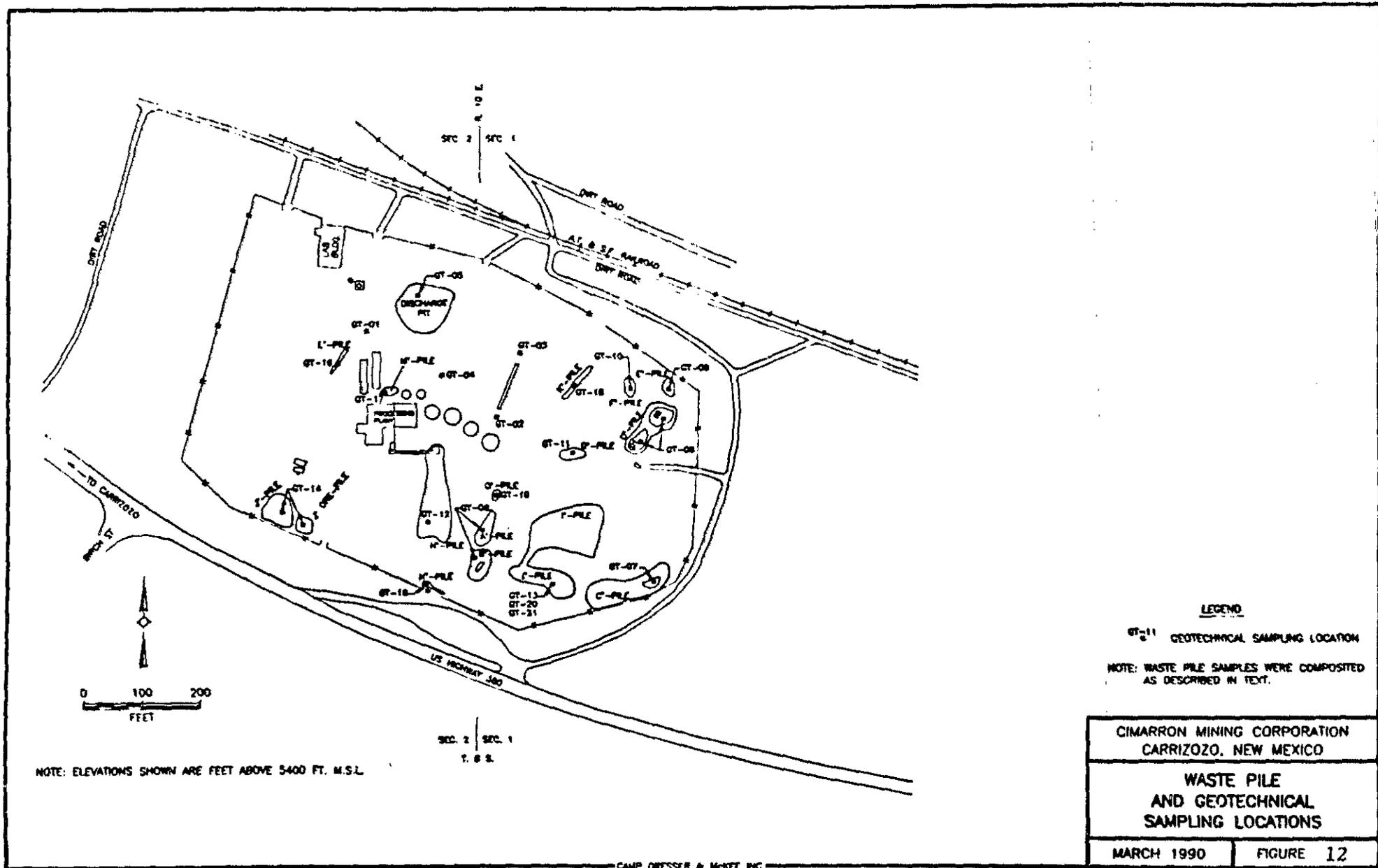
portion of the total cyanide is in the form of strong metal complexes. The wastepiles were sampled using a hand auger for chemical parameters, and a tube sampler for geotechnical samples. Samples for chemical analysis were collected at 6-inch intervals, until contact was made with the natural ground surface. The processed waste piles contain material which has been milled and subjected to cyanidation. These are identified as Waste Piles "C, I, J, K and L" as shown on Figure 12. The materials in these piles is distinguished by extremely fine grain size and brown to black color. The ore piles contain boulder sized ore which has not been processed. Waste piles "A, B, D, E, F, J-ore and N" are ore piles.

The remaining waste piles "G, H, M and O" are identified as miscellaneous. A review of the waste pile data indicates that the waste piles have concentrations of arsenic, barium, beryllium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, selenium, sodium, vanadium and zinc, which are greater than the concentrations found in background surface soil samples. Copper, cobalt, and iron are most elevated and are the only metals present at levels greater than the range of concentration listed as typical of soils in the United States.

Total cyanide was detected in the processed waste piles. The processed waste piles derived from the cinder block trenches have higher concentrations (24.3 to 33.9 mg/kg) of total cyanide than tailings piles C, I and K (4.7 to 12.6 mg/kg).

Subsurface samples were collected during the installation of the ground water monitor wells and from soil borings located in specific source areas. Subsurface soil samples were collected from eight monitor well locations and three borehole locations across the site. The samples were collected to determine the vertical extent of contamination at the site. Cyanide was detected at concentrations of 2.0 mg/kg at 2.5 to 3.0 feet and 1.8 mg/kg at 4.5 to 5.0 feet in the shallow subsurface at pile I (SL-002), and in samples collected in the discharge pit to 4.5 feet. Cyanide was not detected in any other subsurface soil samples. Concentrations of TAL metals in the Alluvial samples were compiled separately from the Cretaceous samples to allow for differences based on lithologies of the two units.

In general, barium, calcium, magnesium, manganese, potassium, sodium and vanadium concentrations are greater in Alluvial units than Cretaceous units. Beryllium, copper, lead, nickel, and zinc concentrations were



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generally greater in Cretaceous units than Alluvial units. Data indicate that elevated levels of TAL metals are present in the subsurface soils at the site at depths less than five feet in areas which had elevated levels of TAL metals at the surface. Sediments below five feet were not found to contain elevated concentrations of TAL metals.

Air samples for toxic metals, total cyanide, total dust and total respirable dust were collected at the site using air sampling pumps and associated filters which were provided by the CLP laboratory. Air samples were collected in the vicinity of tailings pile "I", the cinder block trenches (referred to as the Spill Area), an "upwind" site location, and a "downwind" site location.

The samples were collected over a two day period. Total dust and TAL metals samples were collected on the same filter. Total respirable dust was collected at the same time and place but with a separate pump and filter. Total cyanide samples were collected on the second day of sampling. The total cyanide included both the gas vapor concentration collected through an impinger system and the dust concentration collected on the filter system. Only two samples contained detectable levels of TAL metals. The afternoon sample from the 5-foot height station at the "spill" area by MW-4 had detectable beryllium. The morning sample from the same station had detectable silver. Cyanide (total) was detected in several of the samples at low levels (0.5547 to 30.84 ug/m³).

Eight monitor wells, in addition to the nine already existing at the site, were installed during the RI. There are now seventeen monitor wells and one abandoned water well on or adjacent to the Cimarron site. In addition, there are numerous private and public water supply wells in the vicinity of the Town of Carrizozo. In June 1989, the nine existing monitoring wells were sampled for organics and inorganics analyses to verify the contaminants of concern and to provide information used to select the number and location of additional wells. All of those wells, plus the new wells, were sampled once during the extensive sampling conducted during the RI.

In addition to the on-site monitor well, ten area residential wells and one spring were sampled in order to evaluate the area ground water quality and chemistry and to compare them with the site ground water quality and chemistry. There was no detectable impact from the site on the ground water quality of the residential wells or spring. Cyanide was not detected in any of the residential wells. Comparison of metals concentrations between the residential wells and the site monitor wells also indicates that the residential wells have not been impacted.

The site monitor wells and the abandoned water well were sampled to determine the degree and extent of ground water contamination across the site. Some metals are present at elevated levels in the on-site ground water; and as shown in Table 3 chromium, lead, iron, manganese and selenium are at concentrations exceeding State and Federal drinking water criteria. Selenium, and the nonmetals chloride, sulfate, and total dissolved solids which are at concentrations exceeding the drinking water standards are also high in the off-site residential wells which indicates that these constituents are naturally high in the Carrizozo area ground water. The pattern of fluoride concentrations across the site, and fluoride's non-association with the milling process, indicate that fluoride is naturally high in the shallow ground water unit at the site. Total cyanide and nitrate concentrations exceed drinking water standards in several on-site wells. Nitrate, which can be a byproduct of cyanide biodegradation, appears to be associated with the cyanide contamination.

Concentrations of cyanide which exceed the State and proposed Federal criteria of 0.2 mg/L have been detected in wells MW-4, MW-5, MW-6, MW-8, and MW-10. Figure 13 indicates the extent of cyanide contamination in the shallow ground water.

The deep well (MW-11) installed near the cinder block trenches and screened between 147 and 157 feet, is not contaminated with cyanide, and indicates that the contamination has not reached the deeper ground water zones in the most contaminated area of the site. Low level cyanide contamination (0.024 mg/L), was found in the abandoned deep water production well in the southeast corner of the site. This is probably due to a cross-connection between the upper and lower zones created by this well. The shallow ground water zone in this area of the site is slightly contaminated with cyanide (0.040 mg/L in MW-02).

During the field investigation a storm event occurred which resulted in surface water runoff across the site which was collected. The storm water runoff had total cyanide and TAL metals concentrations which could indicate the possibility that cyanide and metals are being mobilized by heavy precipitation events. Of note, the runoff sample had 0.031 mg/L of total cyanide, 0.048 mg/L of arsenic, 0.0008 mg/L of mercury, 0.0004 mg/L of cadmium, and 0.026 mg/L of lead. Iron and manganese were detected at 75 mg/L and 1.19 mg/L, respectively. The concentrations of cyanide and metals detected in this runoff sample may be somewhat elevated above actual concentrations in the runoff water. As noted in the sample collection discussions in Section 4.2.11 of the Remedial Investigation Report, the samples were very turbid, with a high amount of suspended solids resulting

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SUMMARY OF SITE MONITOR WELL SAMPLES EXCEEDING WATER QUALITY STANDARDS

TABLE 3

Sample I.D.	Chromium (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Selenium (mg/L)	Cyanide (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	TDS (mg/L)
MM-001	0.07	526	0.07	1.88	1.90	1.90	2.80	365	925	2,010	2,010
MM-002	0.18	977	0.12	2.13	2.80	2.40	766	766	1,342	3,150	3,150
MM-003	0.07	95.2		1.76	2.40	2.40	696	696	1,153	2,780	2,780
MM-004		3.1		1.29	1.40	1.40	521	521	1,775	3,790	3,790
MM-004-2*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MM-004-2-S*	NT	NT	NT	NT	4.25	4.33	4.25	4.33	NT	NT	NT
MM-005	6.6	6.6	0.11	0.11	1.070	7.08	1.070	1.070	14.6	2,032	5,950
MM-006	4.4	4.4	0.11	0.11	1.050	7.08	1.050	1.050	22.4	3,870	3,870
MM-007	18.4	18.4	0.36	0.36	742	7.08	742	742	11.2	3,010	3,010
MM-008	11.0	11.0	0.16	0.16	1.630	7.08	1.630	1.630	11.2	2,970	2,970
MM-008-2*	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
MM-009	7.2	7.2	0.43	0.43	1.556	7.08	1.556	1.556	22.4	5,090	5,090
MM-009-S	6.5	6.5	0.43	0.43	1.496	7.08	1.496	1.496	23.3	5,160	5,160
MM-009-C	4.2	4.2	0.38	0.38	1.526	7.08	1.526	1.526	25.1	5,130	5,130
MM-010	6.3	6.3	0.51	0.51	1.048	7.08	1.048	1.048	59.3	4,260	4,260
MM-010-S	8.8	8.8	0.51	0.51	1.040	7.08	1.040	1.040	58.1	4,670	4,670
MM-010-C	10.9	10.9	0.54	0.54	996	7.08	996	996	57.1	4,230	4,230
MM-011	5.9	5.9	0.15	0.15	150	7.1	150	150	695	2,500	2,500
MM-012	4.8	4.8			447	2.1	447	447		1,960	1,960
MM-013	4.2	4.2			857	3.1	857	857		3,240	3,240
MM-014	4.2	4.2			268	3.8	268	268		2,000	2,000
MM-015	13.9	13.9	0.32	0.32	1,078	3.8	1,078	1,078	71	3,540	3,540
MM-016	5.0	5.0							505	1,540	1,540

TABLE 3 cont'd

SUMMARY OF SITE MONITOR WELL SAMPLES EXCEEDING
WATER QUALITY STANDARDS
(Continued)

Sample I.D.	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Selenium (mg/L)	Cyanide (mg/L)	Fluoride (mg/L)	Chloride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	TDS (mg/L)
MW-017	2.1 ^(1,2)		0.16 ⁽²⁾	0.014 ⁽¹⁾			758 ^(1,2)		1,180 ^(1,2)	2,940 ^(1,2)
MW-017-S	2.4 ^(1,2)		0.16 ⁽²⁾			3.2 ^(1,2)	688 ^(1,2)		1,160 ^(1,2)	2,810 ^(1,2)
MW-017-C	1.6 ^(1,2)		0.16 ⁽²⁾	0.016 ⁽¹⁾		2.6 ^(1,2)	686 ^(1,2)		1,150 ^(1,2)	2,920 ^(1,2)
MW-001	0.3 ⁽²⁾					2.5 ^(1,2)	748 ^(1,2)	16.8 ^(1,2)	1,272 ^(1,2)	2,970 ^(1,2)

¹ Exceeds the primary Safe Drinking Water Act Standards.

² Exceeds the secondary Safe Drinking Water Act Standards.

³ Exceeds the New Mexico Water Quality Act Standards.

NT - Sample not tested for this parameter.

S - Split sample.

C - Co-located sample.

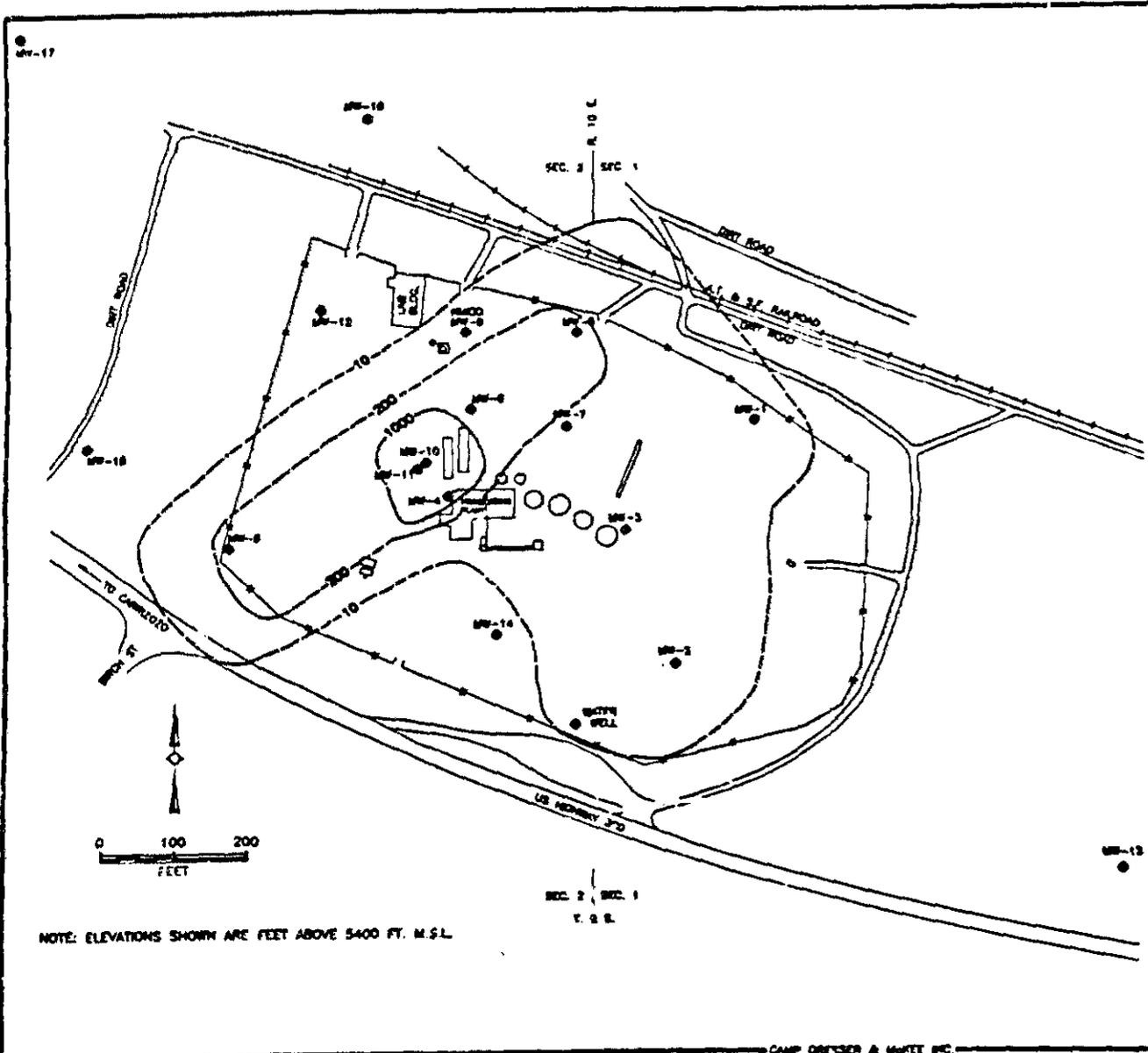
⁴ Sample location retested because cyanide concentrations on first RI sampling round was not consistent with historical cyanide concentrations.

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from the sample collection method which resulted in an inordinant amount of suspended materials from the sampling location. The detected metals and cyanide concentrations may reflect the suspended solids concentrations which were dissolved after sample preservation, rather than concentrations actually present in the storm water runoff.

In addition, the sample collection location was in a known surficially contaminated area. The concentrations measured in this sample would be greatly decreased as this water mixes with other storm water runoff from uncontaminated areas as it leaves the site.

Surface soil sampling was situated within the major pathway of surface water runoff leaving the site. No cyanide was detected in the soil samples, indicating that significant concentrations of cyanide do not appear to leave the site by the drainage pathway.

Contaminant Sources

Based on the evaluation of the milling process, findings of previous investigations and the RI field investigation, the sources of environmental contamination at the Cimarron site are cyanide and elevated metals within the processed waste material (tailings piles I, C and K and cinder block trench sediment piles J and L), cyanide solution and tailings spillage areas (around process facilities), and cyanide solution recycling and disposal areas (cinder block trenches and the discharge pit). Contaminated material is also present in the on-site process tanks and in process chemical drums, however that material is contained and does not presently serve as a source of contaminant transport to the environment. Negotiations with the site bankrupt trustee has resulted in an agreement that the process chemical drums will be removed regardless of the final remedy selected.

The unprocessed waste piles at the site do not contain cyanide, but do contain elevated levels of various metals.

Evaluation of the ground water contamination at the site indicates that although some cyanide contamination has occurred below tailings piles, I, C, and K, the major sources of cyanide contamination of the ground water are the cinder block trenches, and to a lesser degree, the discharge pit. During operation of the plant, concentrated cyanide solution was stored in the cinder block trenches for recycling, and disposed in the discharge pit. The discharge pit is an unlined impoundment and the cinder block trenches have cracked, leaky concrete bottoms. Based on these findings, and the findings of the application of the computer

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modeling, it is surmised that most of the ground water contamination from cyanide occurred during the period of plant operation. These areas of continual contact of cyanide solution with underlying soils would have established saturated conditions to the ground water surface, allowing direct communication between contaminated liquids and the ground water. Since direct contact of cyanide solution to the soils has not occurred since the mill closed in 1982, it is expected that current transport of cyanide contamination to the ground water is negligible. Without continued contact with overlying cyanide solution, the saturated conditions would disappear.

Re-formation of saturated conditions between the surface source areas at the site and the ground water surface is unlikely due to the dry climate of the Carrizozo area and the vertical length of the current saturation break (dry soils) between the ground surface and the ground water surface (30 ft). This is supported by the results of the computer modeling application.

The computer modeling application did not, however, consider collection of runoff water. The cinder block trenches and the discharge pit act to collect storm runoff water from their surrounding areas. This increases the chances of infiltration to the ground water during storm events, but this potential migration route could be closed by filling in and grading those locations.

The findings of the computer modeling application can also be applied to assessment of contaminant migration from the tailings piles. As is the case for the cinder block trenches and the discharge pit, tailings piles I, C and K would have created saturated conditions to the ground water during the period of plant operation. The tailings were applied to their disposal locations in a slurry form.

VI. Summary of Site Risks

An assessment of the potential human health risks associated with the existing conditions at the Cimarron Mining Site was prepared using the standard four step risk assessment process. In the first step, Hazard Identification, the nature of the risks potentially posed by the site is qualitatively identified. This includes determination of the contaminants present at the site, their toxic effects, and identification of potentially exposed populations and possible exposure pathways. In the next two steps, Exposure Evaluation and Toxicity Assessment the two necessary components of risk (exposure and toxicity) are further examined and are quantified to the extent possible. Finally, in the fourth step, Risk Characterization, exposure and toxicity data are combined to develop estimates of health impacts.

Hazard Identification

The initial step in performing a human health risk assessment consists of a qualitative evaluation of the potential risks posed by the site. This includes assessment of the presence of potentially toxic compounds at the site and of the potential for human exposures to these compounds.

The Cimarron site ceased operation as a milling facility in 1982. No occupational activities have taken place on the site since that time. Therefore, occupational exposures are not included in this health risk assessment. The pathways representing the greatest current potential for exposure to contaminants at the site are incidental soil contact and ingestions during visits to the site, and inhalation of fugitive dusts migrating from the site. Contaminant exposures via these pathways to current residents of Carrizozo nearest to the site are one focus of this assessment. In addition, to assist in the determination of appropriate remediation strategies for this site, several potential future exposure scenarios are also evaluated. These include evaluation of soil ingestion and inhalation of dust for potential future on-site residents.

Exposure Assessment

Following hazard identification, a more detailed examination of potential exposure routes is undertaken. Potential exposures to contaminants and the corresponding health risks under current conditions in the site area and for a hypothetical future residential population on the site are evaluated. Specifically, potential risks from incidental ingestion and dermal contact with soils and sediments at the site, inhalation of contaminated dusts, and consumption of contaminated ground water are assessed. Once potential exposure populations and pathways have been identified, the magnitude of exposures via each pathway are estimated in a two step process. First, contaminant concentrations in the environmental media of concern (e.g.; water, air, or soil) are determined using either monitoring data or environmental models. Then, human exposures or contaminant intake rates are quantified based on data and assumptions regarding environmental intake rates, physiological parameters, and activity patterns. The likelihood of occurrence of each exposure pathway and the potential existence of subpopulations with special susceptibilities to particular contaminants or exposures are also considered.

The environmental media of primary concern at the Cimarron site are ground water, soil, and air (contaminated with fugitive dust). Surface water and sediments do not appear to play a major role in exposures in the vicinity of the site.

The nature of the inorganic contaminants present at the site suggests that dermal absorption will not contribute significantly to exposures, as these substances are typically poorly absorbed through the skin. Ingestion of contaminants, via drinking water or incidental ingestion of soil, and inhalation of fugitive dust present the most significant routes of exposure. Ingestion of agricultural crops affected by site contaminants, e.g., crops irrigated with contaminated ground water or cattle ingesting contaminants via water and grazing, may also contribute to total exposures, however, the magnitude of exposure from this pathway is expected to be insignificant relative to the primary pathways identified above.

- Surface Soils and Waste Piles

Direct contact with contaminated soils typically is a primary pathway of contaminant exposure, particularly where such soils occur close to residential areas. As discussed above, however, the Cimarron site is not in immediate proximity to any residential areas, nor does it offer any identified recreational opportunities. Therefore, it is unlikely that, under current conditions, any individual would visit the site with high frequency or that regular, ongoing exposures via soil contact would occur. Occasional visitation, however, is possible, and could result in direct contact with soils at the site.

Potentially, future exposures which differ in character from current exposures could take place if development were to occur on or near the site. As with occasional visitation, exposures via contaminated soils could occur following direct contact with soils if such a development were to occur, and exposure routes would include absorption following dermal contact with soils and incidental ingestion. Under a residential scenario, such exposures can be assumed to occur daily over the entire duration of residence on the site. In light of census data for the region indicating that the population of Carrizozo is relatively stable, with a less than 5% increase in population between 1970 and 1988, the probability of any residential development on the site is negligible. To be thorough in the evaluation and to assist in assessment of remedial options for the site, however, exposure from onsite residence is included in the exposure assessment and risk characterization.

- Subsurface Soils

Exposures to soils more than six inches below the surface have been excluded from this assessment because significant contact with these soils is unlikely under the scenarios evaluated. Elimination of these soils from the evaluation will not alter exposure or risk estimates, as the concentrations of contaminants at the site were found to diminish significantly with soil depth.

- Tank Sediments

Contaminated sediments stored in tanks on the site present no avenue for exposure under current conditions because the sediments are contained and virtually inaccessible at this time. In the event that one of these tanks should rupture, or the contained sediments should otherwise be dispersed on the ground, exposures could occur following direct contact with the sediments. In such an instance, exposures would be similar to those for exposure to soils and waste piles, as described above.

- Air

The exposed, unvegetated soils present at the site may be subject to wind erosion. Following erosion, soils may be carried by the wind, and individuals downwind of the site could be exposed to site contaminants via inhalation of windblown dust. Additionally, such exposures could be experienced by individuals onsite following potential future development of the area. The magnitude of exposure depends on how well the surface material is entrained; particle size; concentration of contaminants in the dust; wind speed and direction; duration of exposure; and numerous other factors that influence suspension and transport of dry soils.

- Ground water

Data obtained during the remedial investigation indicate that ground water in the shallow aquifer under the site is contaminated with cyanide, and also contains elevated concentrations of some metals. No current exposures to contaminated ground water are believed to be occurring, as samples from residential wells, and site data, indicate that the residential wells have not been impacted by site contamination. Additionally, the residential wells are completed in different deeper ground water units than the contaminated shallow water body under the site.

Potentially, future exposures could occur if ground water from the shallow aquifer under the site were to be used as a source of potable water. Development of water from the shallow aquifer located under the site, however, is unlikely due to several factors. Due to high mineral content, the palatability of the water in the shallow aquifer is poor, and therefore does not present an attractive source of domestic water. Hydrogeologic and hydraulic information also indicates that withdrawal of water from this aquifer is difficult and may not provide enough water for household use. Based on these factors, the site ground water unit can be characterized as a Class IIIA aquifer. Additionally, if the site was to ever be developed as residential area, the city of Carrizozo water distribution system would likely be used as the water supply. However, to provide an indication of possible health risks that might arise should this water be tapped for domestic uses, consumption of this water is evaluated.

- Surface Water

No bodies of surface water or perennial streams exist on the site or in nearby areas. Some drainage occurs across the site following storms. Because of soil absorption and evapotranspiration in the arid environment, however, all surface water disappears within a few days. Due to the ephemeral nature of surface water at and in the area of the site, it is not considered to present a significant pathway for human exposures to contaminants, and is not included further in this evaluation.

Toxicity Assessment

The toxicity assessment portion of the risk assessment complies available information on the potential adverse health impacts of the contaminants of concern. This includes a qualitative discussion of the types of effects associated with each contaminant, the nature of the evidence indicating each type of effect, available dose-response data and toxicity factors, and an evaluation of the certainty of the qualitative and quantitative toxicity information. Identified quantitative toxicity factors, e.g., reference dose (RfDs) for noncancer health effects and cancer potency factors (CPFs) for carcinogens, are used to calculate risk estimates.

Cancer potency factor (CPF's) have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of $(\text{mg}/\text{kg}\text{-day})^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in $\text{mg}/\text{kg}\text{-day}$, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of $\text{mg}/\text{kg}\text{-day}$, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intake of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Risk Characterization

In the risk characterization, quantitative estimates of exposure and toxicity are combined to develop estimates of human health risk. Both carcinogenic and noncarcinogenic health impacts are examined. Where appropriate, risks encountered via different exposure pathways are combined to develop estimates of overall risks to total exposures associated with the site. Corresponding with exposure estimates, conservative screening level estimates of individual risks are calculated in most of the scenarios examined.

Summary of Baseline Risk Estimates

Potential exposures to the site contaminants and the corresponding health risks under current conditions in the area and for a hypothetical future resident population on the site are evaluated

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in the endangerment assessment. Specifically, potential risks from incidental ingestion and dermal contact with soils and sediments at the site, inhalation of contaminated dusts, and consumption of contaminated ground water are assessed.

Incidental ingestion of soil was evaluated for exposures by adults and children from Carrizozo and for hypothetical future on-site residents. Soil ingestion did not result in contaminant exposures in excess of the acceptable health based limits in any of the scenarios examined.

Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6} or $1E-6$). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper-bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site.

The cancer risk value associated with onsite residence (2.9×10^{-5}) is higher than for the other soil ingestion scenarios evaluated. This finding is expected since this scenario assumes 30 years of daily exposure, whereas the risk values for adults and children in Carrizozo are based on a single visit. Excess lifetime cancer risks associated with soil ingestion are 2.3×10^{-9} and 4.7×10^{-9} for Carrizozo adults and children, respectively. Under the scenarios described above, to reach an incremental risk of 10^{-6} , an adult would have to visit the site more than 430 times (or once a month for more than 35 years). A young child would have to visit the site more than 210 times, or once per week for 4 years, to achieve this risk level.

Due to the low absorption of contaminants across skin, risks associated with dermal absorption from soil are significantly lower than those associated with incidental ingestion. Using the assumptions for Carrizozo child dermal exposures to soil, a young child would have to visit the site 4000 times, or daily for 11 years, to attain an incremental lifetime cancer risk of 10^{-6} .

Inhalation exposures to site contaminants by residents of the town of Carrizozo result in an excess lifetime cancer risk of 4.7×10^{-8} . Actual risk is likely to be significantly lower since the primary contributor to this value is hexavalent chromium. In the absence of information on chromium speciation, these calculations conservatively assumed that all of the chromium reported in site samples was in this form, an assumption which is likely to overestimate the amount of hexavalent chromium actually present at the site. Inhalation exposures by hypothetical future onsite residents are ten-fold higher, with a total excess lifetime cancer risk of 4.7×10^{-7} . Again, this value is due mostly to an assumed exposure to hexavalent chromium.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposure within a single medium or across media.

Ground water contained in the shallow aquifer under the site contains eleven compounds at concentrations that are elevated above established MCL values. Of these, oral RfD values exist for five compounds; chromium, cyanide, manganese, nitrate, and selenium. Evaluation of risks associated with consumption of these compounds at the maximum concentration detected in the ground water indicates possible RfD exceedance for cyanide and nitrate by adults and for chromium, cyanide, and nitrate by a child. None of the compounds present at values above the MCL are believed to be carcinogens following oral exposure. The noncarcinogenic Hazard Index derived from the potential RfD exceedance is 4.1 for adults and 9.5 for children.

As part of the baseline risk assessment for the Cimarron Mining Site, an environmental risk assessment was performed to evaluate potential ecological hazards posed by site contamination. The purpose of this risk assessment is to quantify, to the extent possible, harmful ecological effects to terrestrial fauna and flora inhabiting the site or potentially coming into contact with site-related materials.

The specific literature was searched for information on environmental impacts of cyanide and cyanide compounds. Special emphasis was placed on those studies involving species and ecosystems similar to those found at the site. As reported below, limited data were located for certain of the animal species found at the site, including coyotes, wild birds, and rabbits.

The primary medium of concern for ecological exposures is contaminated soil which may be incidentally ingested during feeding or may be in contact with plant roots. Soil concentrations used in the exposure scenarios were developed based on review of the available data on cyanide concentrations in the various types of soil samples collected at the site.

Available data in the literature on cyanide toxicity to plants were insufficient to perform a quantitative evaluation and an assessment of plant ecological risk was not possible. No data are available to allow assessment of toxic concentrations in soil. However, it should be noted that cyanide has not been detected in any of the wells reportedly used for irrigation purposes.

Analyses performed based on available data indicate virtually no concern for ecological hazards due to cyanide at the Cimarron site. For both coyotes and rabbits, estimated intake rates were well below reported oral lethal doses. For coyotes, the most probable case hazard quotient was in the no concern range. For rabbits, the most probable case hazard quotient was in the possible concern range, however, this value was obtained using very conservative assumptions. Since local wild bird species reportedly do not tend to feed on the ground surface, exposure and consequent potential hazard are likely to be negligible. No quantitative estimates could be made for effects on plant species due to lack of appropriate toxicity data.

VII. Description of Alternatives

Remedial Objectives

Remedial action objectives are proposed in order to protect human health and the environment. The objective specifies the contaminant(s) of concern, exposure routes(s) and receptors(s), and an acceptable contaminated range for each exposure route. Preliminary remediation goals are based, where possible, on the baseline risk assessment and Federal and State ARARs.

As determined by the Endangerment Assessment concentrations of cyanide and metals in soils, waste piles and sediment at the Cimarron site do not constitute the need for remedial action. Site ground water, however, has been impacted by cyanide and associated nitrate contamination to a degree that remedial action is considered appropriate. Although federal drinking water standards are not considered due to the characterization of the site ground water as Class IIIA, remediation is appropriate in the source area ground water so as to control potential impacts of migration from the contaminated upper ground water zone to potential underlying drinking water aquifers.

Also, consideration has been given to utilizing the New Mexico Water Quality Control Commission Regulations (NMWQCCR) standard of 200 ug/l cyanide as a remediation goal due to the potential future beneficial use of the shallow ground water as a source of drinking water. NMWQCCR require protection of all ground water of less than 10,000 mg/l total dissolved solids. The table below outlines the final remediation goal and corresponding risk.

Remediation Goal and Corresponding Risk

<u>Final Remediation Goal</u>		<u>Corresponding Risk Level</u>		
<u>Medium</u>	<u>Chemical</u>	<u>Remediation Goal</u>	<u>Point of Compliance</u>	<u>Reasonable Maximum Exposure Pathway Risk (HAZARD INDEX*)</u>
				<u>Child</u> <u>Adult</u>
Ground Water	Cyanide	200 ug/l	On Site Shallow Ground Water	.1 .3

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*Values represent the greatest estimated risks to an individual or group subject to reasonable maximum exposures assuming a hypothetical onsite residence utilizing the shallow ground water as a source of drinking water. A hazard index less than or equal to 1 anticipates no adverse health effects over a lifetime exposure.

The degree of metals contamination in the site ground water does not constitute a need for specific remedial action towards those metals.

The degree and extent of cyanide contamination in site ground water was defined during Remedial Investigations. The major sources of that contamination were the cinder block trenches and, to a lesser degree, the discharge pit during the period of plant operation. Continued migration of contamination from these source areas to the ground water is expected to be minimal since application of the computer modeling indicates that infiltration of precipitation to the ground water at the site occurs in only small amounts due to site lithology and area climatology. Migration of the contamination apparently occurred during the period of plant operation when saturated conditions would have existed between the surface sources and the ground water surfaces.

As shown in Figure 13, the area of highest cyanide contamination of ground water (exceeding approximately 200 ug/L total cyanide) is in the area of the cinder block trenches. Treatment of ground water in this area of the site would effectively address cyanide contamination in the shallow zone and the potential impact of migration to lower drinking water aquifers.

Accordingly, remedial action alternatives for the site focus on removal of the heavily contaminated area of shallow ground water below the cinder block trenches, with some continued monitoring to ensure long-term effectiveness.

The computer modeling application did not, however, consider collection of storm runoff water at the source areas of the site. The cinder block trenches and the discharge pit act to collect storm runoff water from their surrounding areas. This increases the chances of infiltration to the ground water during storm events, but this potential migration route could be alleviated by filling in and grading those locations.

Potential remedial action alternative technologies were evaluated to address the shallow ground water contamination at the Cimarron site. This evaluation was performed by progressing through the series of analyses which are outlined in the National Contingency Plan, (NCP), in particular, 40 CFR Section 300, along with various guidance documents issued by the EPA, Office of Solid Waste and Emergency Response (OSWER).

This process addresses the Superfund Amendments and Reauthorization Act (SARA) Section 121 requirements of selecting a remedial action that is protective of human health and the environment, that is cost-effective, that at least meets Federal and State requirements that are applicable or relevant and appropriate, and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Additionally, SARA Section 121 and the guidance documents referenced above require EPA to give preference to remedies which employ treatment which permanently and significantly reduces the mobility, toxicity, or volume of hazardous substance as their principal element.

Alternate technologies were identified using best engineering judgement following the guidelines presented in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988), Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (EPA, 1988), and the Handbook for Remedial Action at Waste Disposal Sites (EPA, 1988).

The initial step in determining the appropriate remedial action for the Cimarron Mining site was to identify suitable remediation technologies. A review and analysis of the available remediation methods was conducted and feasible alternatives were developed and are presented in Table 4.

A total of six alternatives for the Cimarron site remediation were analyzed in detail. The alternatives consist of the following:

- Alternative 1 - No Action.
- Alternative 2 - Institutional Controls
- Alternative 3 - Pump and Evaporate Ground Water
- Alternative 4 - Pump and Discharge Ground Water to POTW
- Alternative 5 - Pump, Treat and Discharge Ground Water to POTW
- Alternative 6 - Pump, Treat and Recharge Ground Water

The detailed evaluation process is a structured format, designed to provide relevant information needed to adequately compare and evaluate feasible alternatives to allow selection of an appropriate remedy for the site by EPA through the Record of Decision (ROD) process. The remedy must meet the following statutory requirements:

- o Be protective of human health and the environment;
- o Attain ARARs (or provide ground for invoking a waiver);
- o Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- o Satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element, or provide an explanation in the ROD as to why it does not.

Nine evaluation criteria have been developed to address the statutory requirements listed above and to address additional technical and policy considerations that have proven to be important for selecting remedial alternatives. These criteria are listed and briefly described below:

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TABLE 4

GROUNDWATER REMEDIATION ALTERNATIVES

General Response Action		1	2	3	4	5	6
Technology Type	Area or Volume	No Action	Institutional Controls	Pump & Evaporate	Pump & Discharge to POTW	Pump, Treat & Discharge to POTW	Pump, Treat & Recharge
Monitoring	All wells twice per year	●	●	●	●	●	●
Deed Restrictions on Well Development	Entire site		●				
Groundwater Collection via Extraction Wells	Area of heaviest cyanide contamination			●	●	●	●
Oxidation Treatment	Area of heaviest cyanide contamination					●	●
On-Site Disposal	Evaporation			●			
	Recharge						●
Off-Site Disposal	POTW				●	●	

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- o Overall Protection of Human Health and the Environment - How well the alternative reduces risks to human health and the environment, through treatment, engineering or institutional controls.
- o Compliance with ARARs - How well the alternative complies with all applicable or relevant and appropriate requirements or, if a waiver is required, how it is justified.
- o Long-Term Effectiveness and Permanence - How well the alternative maintains long-term effectiveness in protection of human health and the environment. Alternatives which afford the highest degree of long-term effectiveness and permanence are those that leave little or no waste at the site.
- o Reduction of Toxicity, Mobility or Volume through Treatment - Anticipate performance of the specific treatment technologies that an alternative may employ and their ability to destroy or irreversibly treat contaminants.
- o Short-Term Effectiveness - How well the alternative protects human health and the environment during construction and implementation of a remedy.
- o Implementability - Whether the alternative is technically and administratively feasible and whether the required goods and services are available.
- o Cost - Analysis of capital and O&M costs of each alternative to determine cost-effective remedies. Cost estimates are developed with relative accuracy (-30% to +50%) and are presented as present worth costs so that alternatives can be reasonably compared.
- o State Acceptance - To be completed for the most part after the public comment period; this criterion describes the preference of the State or support agency.
- o Community Acceptance - To be completed for the most part after the public comment period; this criterion reflects the preferences of the community.

Each of the six alternatives for Cimarron ground water contamination are individually evaluated then comparatively analyzed on the basis of the first seven of the nine criteria above. The last two criteria (State and community acceptance) were fully addressed after the public comment period.

The No Action alternative (Alternative 1) provides a baseline for comparing other remedial alternatives for the Cimarron site. Because no remedial activities would be implemented to mitigate contamination present at the site under this alternative, long-term human health and environmental risks for the site are as presented in the baseline risk assessment. Alternative 1 would consist of continued monitoring on a periodic basis.

Criteria Assessment

Alternative 1 is implementable, however, it provides no treatment, engineering, or institutional measures to control the exposure of receptors to contaminated ground water, with the exception of the agreement with the bankruptcy trustee regarding removal of the process chemical drums on site. No reduction in risks to human health and the environment would occur.

No controls (in addition to the already existing fence) for exposure and no long-term or short-term site management measures are included under Alternative 1. This alternative provides no reduction in the toxicity, mobility, or volume of the contaminated ground water underlying the site. All existing and potential future risks associated with the site would remain. With respect to soils, risks are minimal as presented in the baseline risk assessment. With respect to ground water the baseline risk assessment indicates noncarcinogenic Hazard Index of 4.1 for adults and 9.5 for children. A Hazard Index of less than or equal to 1 is considered acceptable, with no adverse health effects.

As previously discussed, the shallow aquifer at the Cimarron site can be classified as a Class IIIA ground water due to its general poor quality. As a result Federal drinking water standards are not applicable or relevant and appropriate at the site. Consideration must be given, however, to the possibility of contamination migrating from the shallow zone to a usable lower zone. Also, New Mexico Water Quality Control Commission Regulations require protection of all ground water of less than 10,000 mg/l total dissolved solids for potential future beneficial use as a source of drinking water.

Capital costs are zero since 17 ground water monitoring wells exist at the site. Annual operation and maintenance costs include semi-annual ground water sampling and analysis for TAL metals and cyanide for a period of 30 years. Present worth analysis of O&M costs is based on a discount rate of nine percent over a 30-year period, and total \$32,025.

Alternative 2 - Institutional Actions

Alternative 2 consists solely of institutional control measures designed to isolate receptors from site-based risks. Under this alternative, no actual remedial measures to directly address contaminated ground water are implemented; rather, legal controls, such as site access and land and ground water use restrictions, are employed to minimize the likelihood of receptor contact with contaminated media. Monitoring of ground water as described for Alternative 1 is included under Alternative 2 to ensure that the risks to human health are being addressed by the institutional controls.

One institutional control at the Cimarron site consisting of site restriction by fencing has been previously implemented. Access restrictions by fencing would be maintained under Alternative 2, as well as under other site alternatives. Other institutional control measures that could be implemented consist of land use restrictions or deed notices, and restrictions and zoning ordinances which would limit activities on the site. They could possibly include ground water use restrictions which would prevent the unlikely construction of ground water extraction wells in contaminated areas. These additional measures could also be selectively included as elements of other remedial alternatives.

Criteria Assessment

The use of institutional control measures provides a greater degree of protection of human health than the No Action alternative alone, since institutional actions can reduce the potential exposure of receptors.

Access restrictions and ground water use limitations can prevent the direct ingestion of contaminated ground water. Land use restrictions further limit activities on the property, and could be implemented in a manner such that the only activities permitted on-site would minimize potential exposure.

This alternative does not address the potential for contamination migration from the site to accessible off-site drinking water aquifers. Although reduction in the potential for human exposure would be recognized under this alternative, only limited long-term effectiveness would be likely due to difficulties in enforcement. Additionally, this alternative provides no reduction in the toxicity, mobility, or volume of contaminants at the site through treatment. No short term effectiveness concerns are identified for this alternative.

Although Alternative 2 is readily implementable, associated costs are difficult to assess given the potential complexity of rezoning and establishing deed restrictions or deed notices and ground water use limitations. Capital expenditures under this alternative include costs for warning signs and additional fencing, as well as initial administrative costs for deed, access, zoning and well permitting restrictions.

Annual costs associated with this remedial action are attributed to ground water monitoring costs. Total present worth of this alternative is \$145,000. This includes capital costs in combination with the present worth of annual O&M costs over 30 years at an annual discount rate of nine percent.

Alternative 3 - Pump and Evaporate Ground water

Description

Alternative 3 consists of collection of contaminated ground water followed by on-site evaporation, which includes some natural degradation. Ground water collection using extraction wells to bring the shallow ground water to the surface for treatment is common to Alternatives 3, 4, 5 and 6.

The suggested locations of the recovery wells and monitor wells are also shown in Figure 14. The number of recovery wells and their locations was established in the feasibility study merely for comparing various ground water remediation alternatives. The actual number of recovery wells and their locations will be further refined in the Remedial Design in consultation with the New Mexico Environmental Improvement Division. The suggested locations were chosen for the following reasons:

- o Recovery wells would be located directly adjacent to the primary source(s) of ground water contamination (the cinder block trenches). The locations are chosen so as to allow removal of the primary source of potential continued migration of cyanide contaminated ground water.
- o The wells would be installed deep enough to capture the entire vertical extent of the area of heaviest ground water contamination, and provide adequate available drawdown for efficient well pumping.
- o The positioning of the wells with respect to nearby monitor wells (MW-04, MW-05 and MW-10) enable monitoring of drawdown and ground water quality within the area influenced by the extraction wells.

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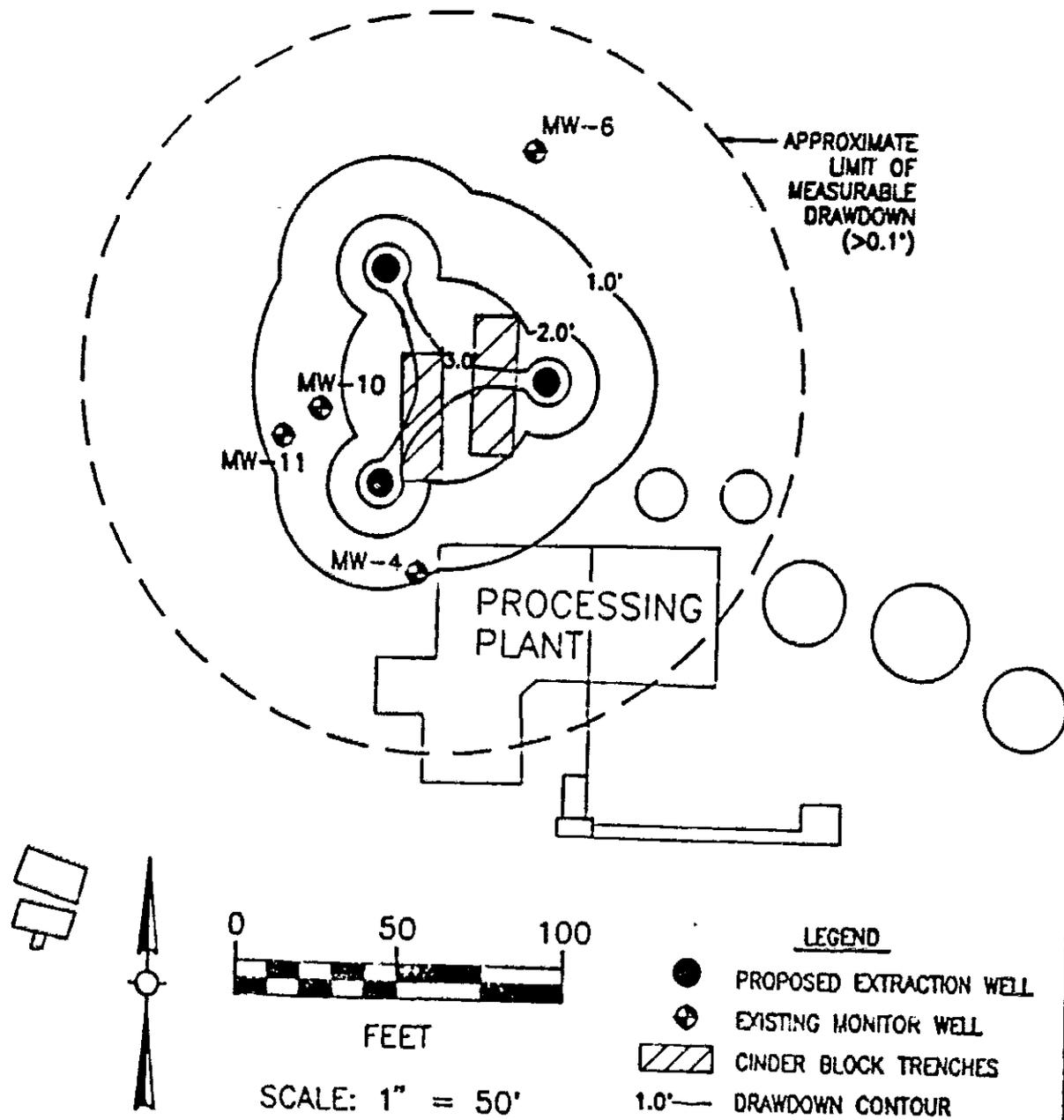


FIGURE 14

PROPOSED EXTRACTION WELL LOCATIONS

CAMP DRESSER & MCKEE INC.

Under Alternative 3, water brought to the surface by the recovery wells will be placed in an on-site evaporation area. Figure 15 shows an on-site evaporation area of approximately 103,000 ft². This area would be bermed around the perimeter from three to nine feet to assure adequate storage during wet weather periods. A synthetic membrane or other liner system would be needed to prevent direct infiltration. This liner would be anchored within the berms, and would be resistant to ultraviolet degradation. A total suspended solids (TSS) plus total dissolved solids (TDS) concentration of approximately 4,900 parts per million (ppm) was measured in monitor well MW-10 ground water during the RI.

Based on an estimated 2,600 lbs. dry solids per cubic yard (typical), approximately 51 cubic yards of residual would remain at completion of the estimated remediation period. The level of contamination of the residual solids in the evaporation basin would require quantification prior to disposal of those solids.

Demobilization activities following clean-up would consist of dismantling the extraction well system, regrading the evaporation area, and disposal of the liner material.

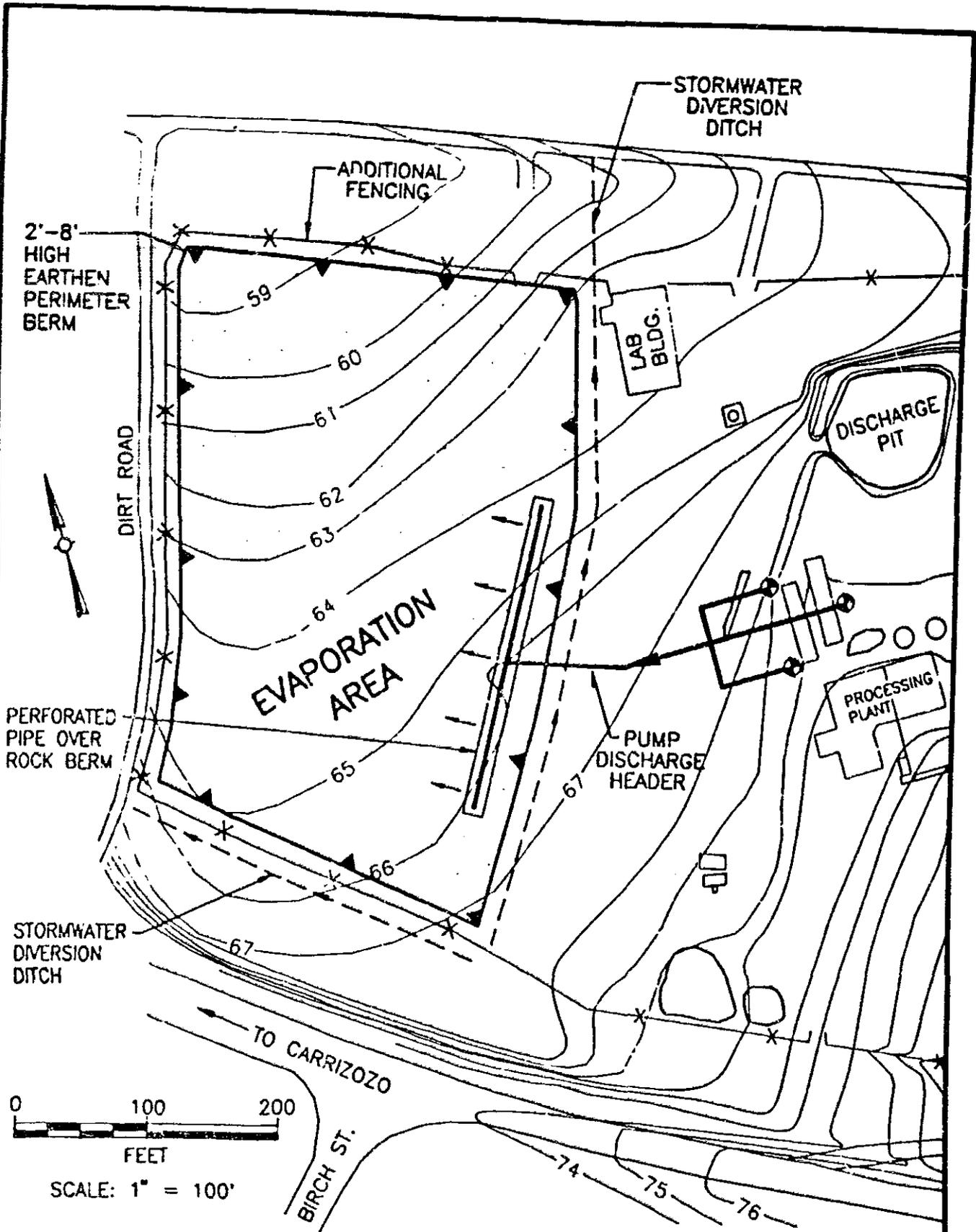
Alternative 3 would serve to protect human health and the environment since the contaminated ground water within the source zone would be collected and evaporated. Residual solids from evaporation would require analysis prior to disposal. The alternative would be in compliance with ARARs.

The long-term effectiveness in protecting human health and the environment is higher for Alternative 3 than for Alternatives 1 and 2, in that a reduction in toxicity and volume of cyanide in the shallow aquifer would result. Short-term concerns could be addressed by ensuring that the evaporation pond is inaccessible to the public. Alternative 3 is readily implementable.

The total projected capital cost is \$160,900.

Operational costs associated with the system are estimated based on labor at \$60/hour for 24 hours/month over 13 months for a total of \$18,800. Total present worth cost of annual ground water sampling is \$32,025. Total present worth cost for Alternative 3 is \$212,000.

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NOTE: ELEVATIONS SHOWN ARE FEET ABOVE 5400 FT. M.S.L.

FIGURE 15
**ALTERNATIVE 3
 PUMP & EVAPORATE GROUND WATER**

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Alternative 4 - Pump and Discharge Ground water To POTW

Description

The extraction well design previously described for Alternative 3 is identical for Alternative 4. A proposed site plan for Alternative 4 is present in Figure 16. A two-inch diameter PVC well discharge header would be installed below grade using a trenching machine. The pipe would be brought above grade and secured inside the existing 24-inch diameter storm water culvert underneath U.S. Highway 380. On the south side of the highway, the pipe would be buried for approximately 200 feet to the existing PVC sewer tap, located above grade. The extraction well pumps would transport the estimated maximum 6 gpm flow of ground water to this sewer tap.

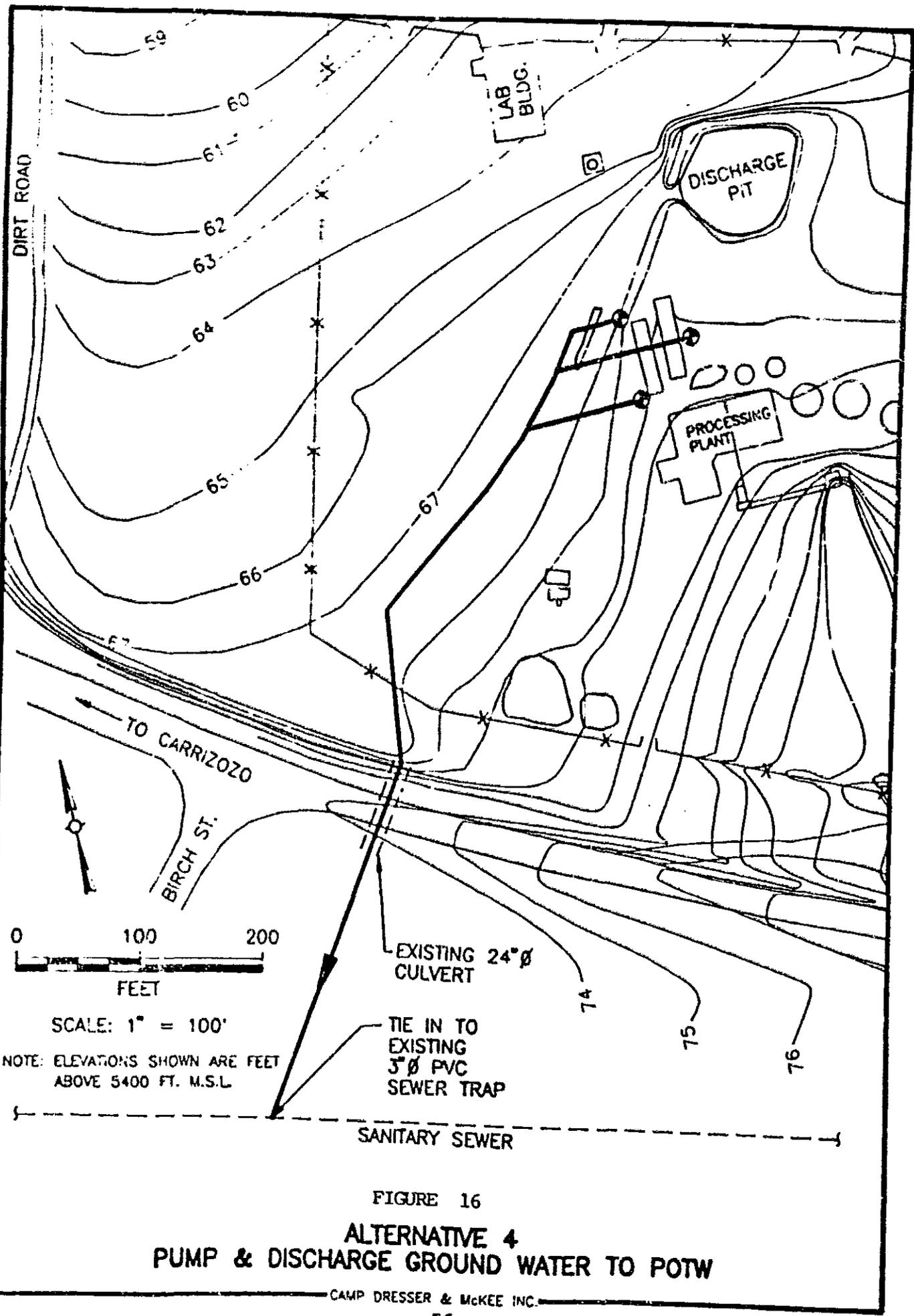
The sewer would convey Cimarron ground water several miles to the Carrizozo POTW. The estimated flow to the POTW is 180,000 gallons per day, according to Carrizozo plant personnel. The total cyanide concentration reaching the POTW is estimated to be 208 ug/L, assuming all of the pumped ground water is contaminated with 4,330 ug/L of total cyanide, which is a conservative estimate, considering that the average concentration detected was approximately 1500 ug/l of total cyanide. For comparative purposes, Federal and State drinking water standards for total cyanide are both 200 ug/L. All discharges to the POTW will comply with the pretreatment standard of 5 mg/l of cyanide as cited in 40 CFR 413.24 Subpart B and deemed relevant for this action.

Biological activity with the existing treatment lagoons, coupled with effluent chlorination and photodecomposition, would constitute treatment to further reduce the cyanide concentration.

Criteria Assessment

Alternative 4 would provide overall protection of human health and the environment by reducing the mobility and volume of cyanide in the shallow aquifer. The toxicity of cyanide would be reduced through treatment at the POTW.

The long-term risks associated with the Cimarron ground water contamination would be minimized. Short-term risks could be addressed by ensuring that the sewer hookup is inaccessible to the public. Alternative 4 could be readily implemented, since no special technologies would be required and the pretreatment regulations which exist regarding discharge to waters from CERCLA sites to POTWs would be met.



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Capital costs for Alternative 4 are estimated at \$43,700. System operating costs are estimated at \$18,800, based on 13 months of operating, as described for Alternative 3.

As presented for Alternative 3, present worth O&M costs associated with continued ground water monitoring would total \$32,025. Total present worth cost of Alternative 4 is \$95,000.

Alternative 5 - Pump, Treat and Discharge to POTW

Description

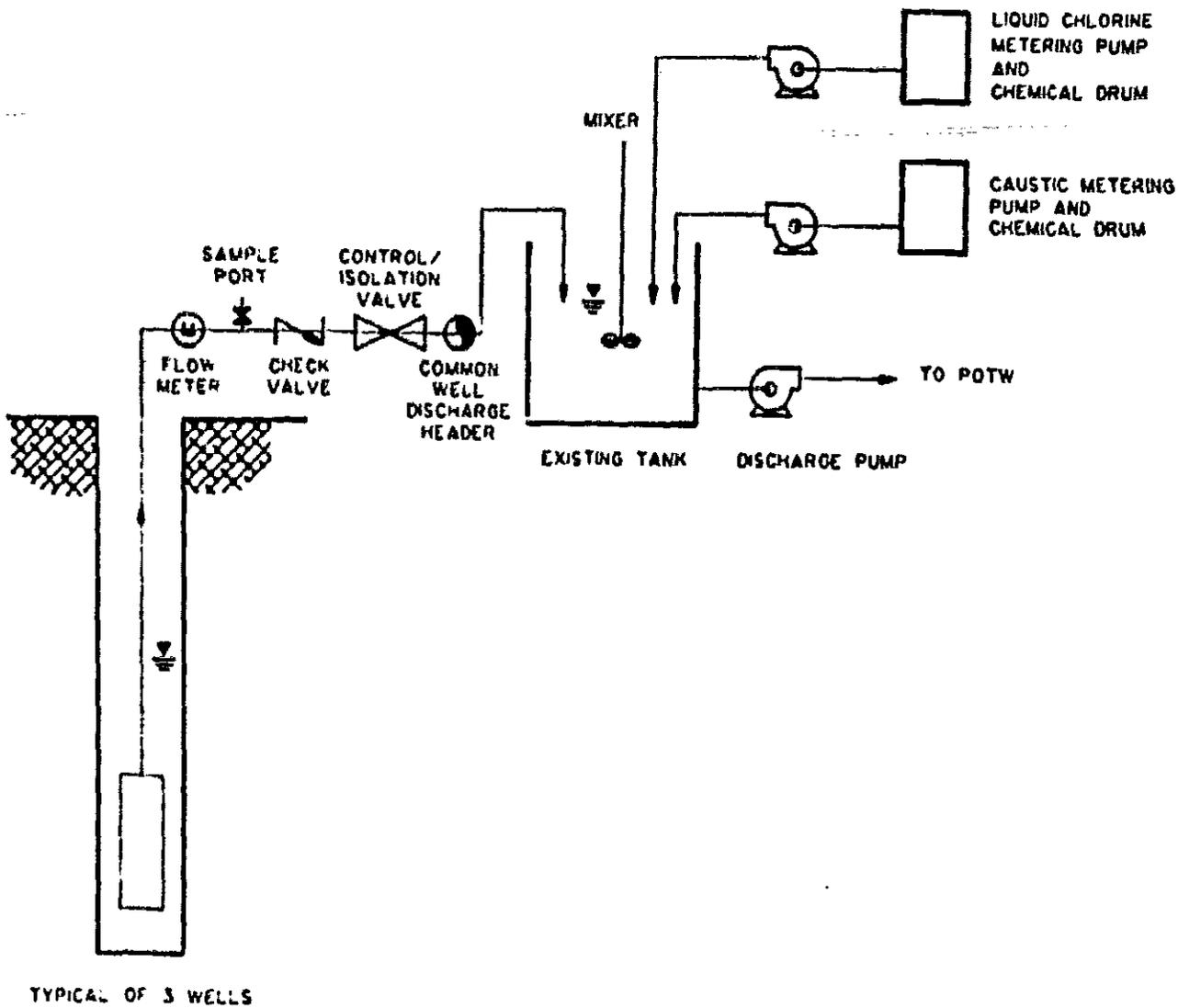
Alternative 5 consists of an extraction well system identical to Alternatives 3 and 4. Once above grade, all ground water would be treated prior to discharge to the POTW. The treatment system is illustrated in schematic form in Figure 17, and the site plan is presented as Figure 18. Treatment using the alkaline chlorination technology would occur in an existing 20-foot square by 10-foot deep solution tank. The tank would be fitted with a beam-mounted mechanical mixer designed to disperse chemical additions. Two relatively simple chemical feed systems would be required; one for liquid hypochlorite and one for a liquid caustic, such as sodium hydroxide. Chemical storage in drums would be sufficient.

Automatic system control would be accomplished using a programmable logic controller. This would minimize the labor cost for treatment operations. Additionally, an alarm tank level sensor would automatically shut off the extraction well pumps if the water level approached overflow conditions.

A large portion of the cyanide is expected to be amenable to chlorination; however, further analysis would be required as part of a design investigation or preliminary design investigation prior to implementation of an alkaline chlorination treatment system. Influence of the treatment system on suspended solids contamination would also be evaluated.

Discharge of treated ground water to the POTW in the same manner described for Alternative 4 is illustrated in Figure 19.

Alternative 5 is evaluated so as to provide a POTW discharge option which includes prior treatment. This alternative provides overall protection of human health and the environment by reducing the toxicity and volume of cyanide in the shallow aquifer.



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FIGURE 17
 PROCESS SCHEMATIC
 ALKALINE CHLORINATION PROCESS

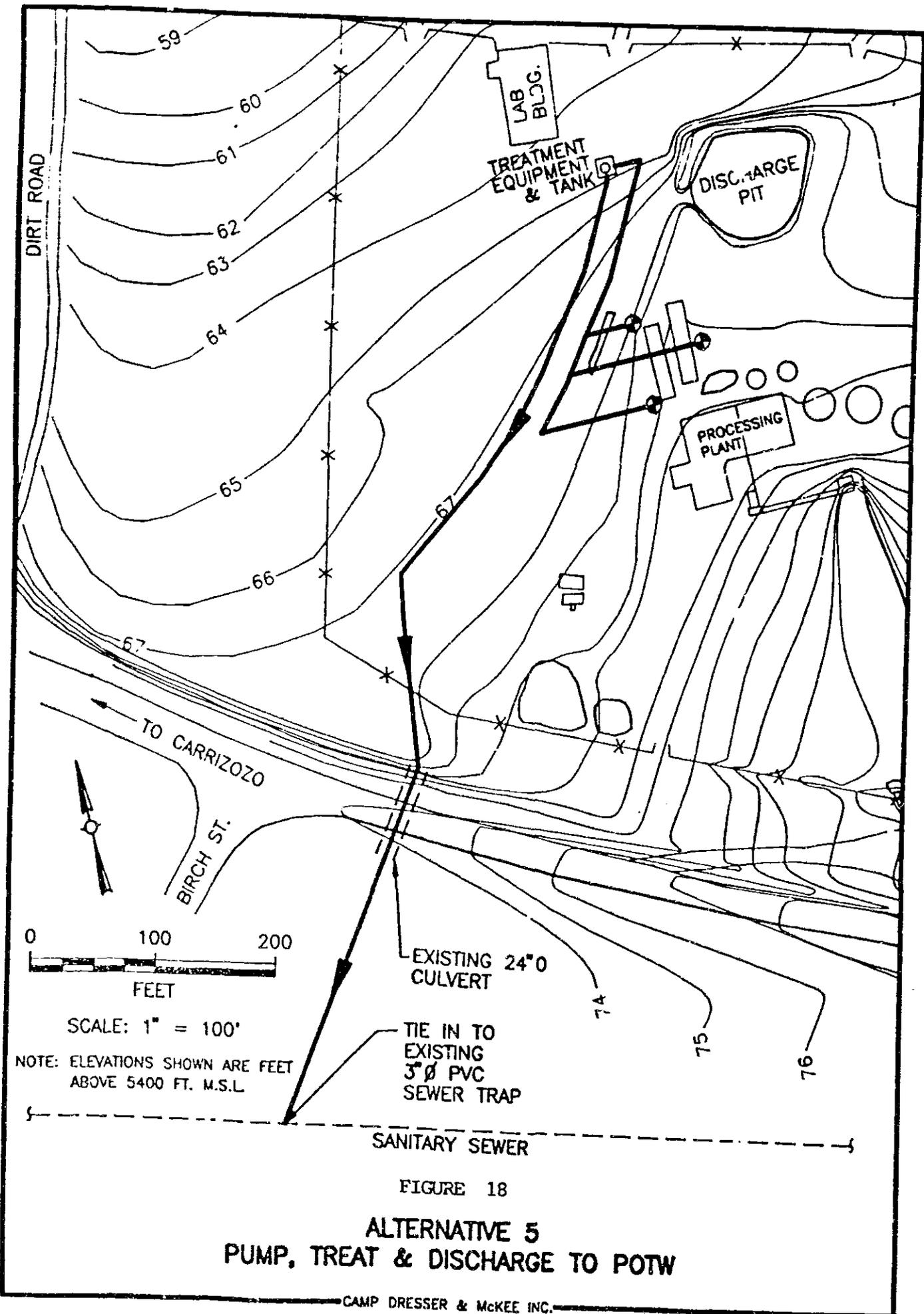


FIGURE 18

**ALTERNATIVE 5
PUMP, TREAT & DISCHARGE TO POTW**

CAMP DRESSER & MCKEE INC.

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The long-term risks associated with the Cimarron ground water contamination would be minimized, as significant cyanide destruction using alkaline chlorination would be accomplished, and further natural degradation processes could occur in the POTW. Short-term risks could be addressed by ensuring that the sewer tap discharge point is inaccessible to the public. Alternative 5 would be technically implementable, however, more specialized skills would be required for design and operation when compared with Alternatives 1 through 4.

Capital costs for Alternative 5 are estimated at \$85,700. System operating costs are \$18,800 based on 13 months of operation, as described for Alternative 3.

As presented for Alternative 3, present worth O&M costs associated with continued ground water monitoring would total \$32,025. Total present worth cost of Alternative 5 is \$136,000.

Alternative 6 - Pump, Treat and Recharge Ground water

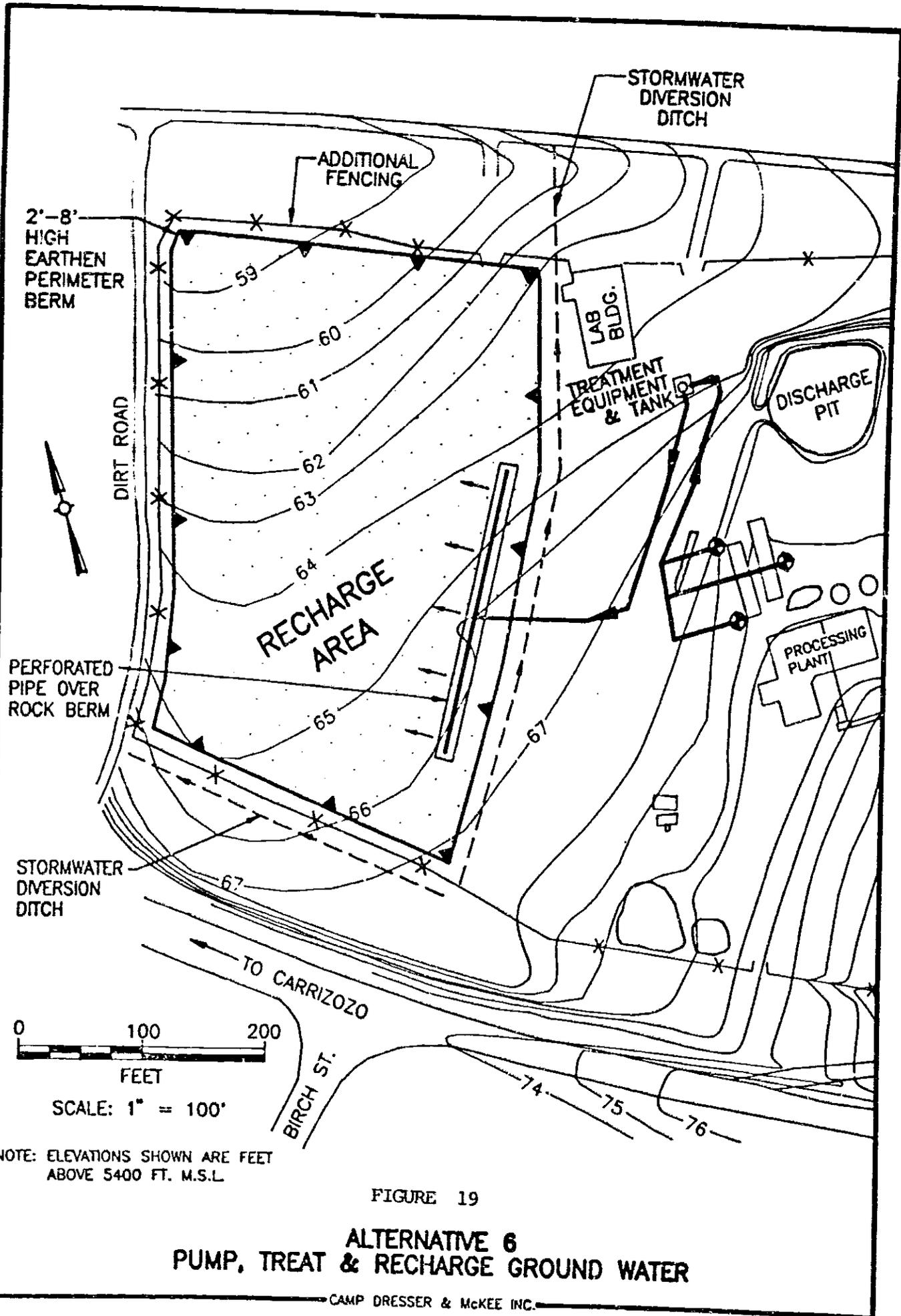
Description

Alternative 6 consists of an extraction well and treatment system identical to Alternative 5, but a different treated water disposal system. In Alternative 6, treated ground water would be recharged on-site (Figure 19). A combination of evaporation and infiltration would result. The recharge area could be bermed as described in Alternative 3 to isolate the recharge area from storm water additions and possible subsequent overflow.

Long-term risks associated with the Cimarron ground water contamination would be minimized as significant cyanide destruction using alkaline chlorination would be accomplished. Short-term risks could be addressed by ensuring that the on-site recharge area is inaccessible to the public. Alternative 6 would be technically implementable, however, as for Alternative 5, more specialized skills would be required for design and operation when compared to Alternatives 1 through 4. Alternative 6 would also be more expensive than Alternative 5 due to recharge area construction costs, and might require more stringent monitoring to ensure effective treatment is occurring, so as to prevent recharge of contaminated water.

Capital costs for Alternative 6, are estimated at 132,700. System costs are estimated at \$18,900 based on 13 months of operation, as described for Alternative 3.

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As presented for Alternative 3, present worth O&M costs associated with continued ground water monitoring would total \$32,025. Total present worth cost of Alternative 6 is \$184,000.

VIII. Summary of Comparative Analysis of Alternatives

Comparison of Alternatives

o Overall Protection of Human Health and the Environment

With respect to overall protection of human health and the environment, Alternative 1 provides none other than the already existing fence at the site. Alternative 2 provides some protection by limiting future site uses. Alternatives 3 through 6 provide the most protection by reducing the concentration of cyanide in the site shallow ground water which could potentially migrate to lower drinking water zones.

o Compliance With ARARs

Compliance with drinking water and water quality criteria is met by all of the treatment alternatives. The No-Action and Institutional Controls alternative would not meet the New Mexico Water Quality Control Commission Regulation which requires protection of all ground water of less than 10,000 mg/l of total dissolved solids for potential future beneficial use as a source of drinking water.

o Long-Term Effectiveness and Performance

Longer-term effectiveness and performance would be nonexistent for Alternative 1 and difficult to ensure for Alternative 2 because of enforcement requirements. Long term effectiveness and performance of Alternatives 3 through 6 however, would be considerably higher because of associated reduction of contamination in the shallow aquifer.

o Reduction of Toxicity, Mobility or Volume Through Treatment

Reduction of toxicity, mobility or volume through treatment would be achieved in Alternatives 3 through 6. Alternatives 3, 5 and 6 would provide treatment by site processes. Alternative 4 would rely on treatment through chlorination and natural degradation processes within the POTW.

- o Short Term Effectiveness - (How well the alternative protects human health and the environment during construction and implementation of a remedy) Short term effectiveness is zero for Alternative 1 since no actions would be taken. Alternative 2 short term effectiveness is relative to the speed at which institutional controls are implemented. Alternatives' 3 and 6 short term effectiveness could be addressed by ensuring that the evaporation pond or recharge area are inaccessible to the public. Alternatives' 4 and 5 short term effectiveness could be addressed by ensuring that the sewer tap discharge point is inaccessible to the public.

- o State Acceptance

The New Mexico Environmental Improvement Division (NMEID) has concurred on the selected remedy. (Letter from Dr. Kirkland Jones dated 6/22/90 and official statement at public meeting 7/30/90).

- o Community Acceptance

The City of Carrizozo, the New Mexico Bureau of Mines and the citizens of Carrizozo support the selected remedy.

- o Implementability

All of the alternatives are technically and administratively implementable. Alternative 1 is most easily implemented. Alternative 2 requires long term management of the institutional controls. Alternative 3 is easily implementable due to the technical simplicity of installing and maintaining an extraction well system and an evaporation basin. Alternative 4 is easily implemented from a construction standpoint, however, coordination and agreement with the City of Carrizozo regarding use of the POTW would require some legal and administrative effort. Alternative 5's implementability is the same as Alternative 4 except that an on-site treatment system would be constructed. This would increase construction and maintenance effort, but could reduce the administrative, legal and analytical effort required under Alternative 4. Alternative 6 implementability is similar to that of Alternative 4, except that a chemical treatment system would have to be constructed and maintained. Additionally, more stringent monitoring of effluent contaminant levels would be required under Alternative 6 than for Alternative 3.

d Cost

Present worth costs of the six alternatives are as follows:

Alternative 1:	\$32,000
Alternative 2:	145,000
Alternative 3:	212,000
Alternative 4:	95,000
Alternative 5:	136,000
Alternative 6:	184,000

None of these costs consider the additional preventative remedial option of filling in the cinder block trenches and the discharge pit to ensure that on-site precipitation runoff will not collect and infiltrate to ground water. Estimated additional cost is \$10,000. Additionally, Alternative 4 and 5 might require on-site sedimentation prior to discharge to the POTW. This would increase costs of these alternatives by approximately \$10,000.

Alternative 4:

IX. Selected Remedy - Pump and Discharge Shallow Ground Water to POTW

As stated in the risk assessment, soil contamination at the Cimarron site is below action levels, and the ground water contaminant of concern is cyanide.

A proposed site plan for the selected remedy is presented in Figure 17. Extraction well pumps would transport an estimated maximum 6 gpm flow of ground water to a sewer tap located approximately 200 feet south of the site.

The sewer would convey Cimarron ground water several miles to the Carrizozo POTW. The estimated flow to the POTW is 180,000 gallons per day, according to Carrizozo plant personnel. Total cyanide concentration reaching the POTW is estimated to be 208 ug/l, assuming all of the pumped ground water is contaminated with 4,330 ug/l of total cyanide, which was the highest detected cyanide concentration. This is a conservative estimate, considering the average concentration of cyanide detected was approximately 1500 ug/l. For comparative purposes, Federal and State drinking water standards for total cyanide are both 200 ug/l. The discharge to the POTW will comply with the pretreatment standard of 5 mg/l of cyanide as cited in 40 CFR 413.24 Subpart B and deemed relevant for this action. Biological activity with the existing treatment lagoons at the POTW, coupled with effluent chlorination and photodecomposition, will constitute treatment to further reduce the cyanide concentration.

This remedy also includes filling in the cinder block trenches and discharge pit, plugging the abandoned water supply well and inspection and maintenance of the existing fence.

Based on calculations, an estimated 133,242 lbs of suspended solids could be introduced to the POTW. Potential impacts of contaminated solids have not been quantified. If, however, the solids are found to be a problem during the Design Investigation, they will be removed at the Cimarron site, by sedimentation, prior to discharge of the ground water to the POTW.

The goal of this remedial action is to restore the ground water to its potential future beneficial use as a drinking water aquifer, as required by the New Mexico Water Quality Control Commission Regulations. A remediation goal of 200 ug/l of cyanide will be utilized, if possible, for the shallow ground water. Based on information obtained during the remedial investigation, and the analysis of all remedial alternatives, EPA and the New Mexico Environmental Improvement Division believe that the selected remedy will achieve this goal. Ground water contamination may be especially persistent in the immediate vicinity of the contaminants' source, where concentrations are relatively high. The ability to achieve cleanup goals at all points throughout the area of attainment, or plume, cannot be determined until the extraction system has been implemented, modified as necessary based on engineering design changes and plume response monitored over time. If the selected remedy cannot meet the health-based remediation goals, at any or all of the monitoring points during implementation, contingency measures and goals as discussed below may replace the selected remedy and goals. Such contingency measures may also include ground water extraction and onsite treatment. These measures are still considered to be protective of human health and the environment, and are technically practicable under the corresponding circumstances.

The selected remedy will include ground water extraction for the estimated period of 13 months, during which time the system's performance will be carefully monitored on a regular basis and adjusted as warranted by the performance data collected during operation. The operating system may include:

- a) discontinuing operation of extraction wells in the area where cleanup goals have been attained;
- b) alternating pumping at wells to eliminate stagnation points; and
- c) pulse pumping to allow aquifer equilibration and encourage adsorbed contaminants to partition into ground water.

If, in EPA's judgement, implementation of the selected remedy clearly demonstrates, in corroboration with strong hydrogeological and chemical evidence, that it will be technically impracticable to achieve and maintain remediation goals throughout the area of attainment, the contingency plan will be implemented. At a minimum, and as a necessary condition for invoking the contingency plan, it must be demonstrated that contaminant levels have ceased to decline over time and are remaining constant at some statistically significant level above remediation goals, in a discrete portion of the area of attainment, as verified by multiple monitoring wells.

Where such a contingency situation arises, ground water extraction and treatment would typically continue as necessary to achieve mass reduction and remediation goals throughout the rest of the area of attainment.

If it is determined, on the basis of the preceding criteria and the system performance data, that certain portions of the aquifer cannot be restored to their beneficial use, all of the following measures involving long-term management may occur, for an indefinite period of time, as a modification of the existing system:

- a) low level pumping will be implemented as a long-term gradient control, or containment, measure;
- b) chemical-specific ARARs will be waived for the cleanup of those portions of the aquifer based on the technical impracticability of achieving further contaminant reduction; and/or
- c) institutional controls will be implemented to restrict access to those portions of the aquifer which remain above health-based goals, should this aquifer be proposed for use as a drinking water source.

The decision to invoke any or all of these measures may be made during periodic reviews of the remedial action.

An Explanation of Significant Differences will be issued to inform the public of the details of these actions when they occur.

Capital costs for the selected remedy are estimated at \$43,700. System operating costs are estimated at \$18,800, based on 13 months of operation.

Present worth O&M costs associated with continued ground water monitoring would total \$32,025. Total present worth cost is \$95,000.

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If on-site sedimentation were to be included, based on the Remedial Design Investigation, capital costs would increase by an estimated \$10,000 for on-site tank retrofitting and pumping equipment. As previously stated, an agreement with the bankruptcy trustee has been reached regarding the removal of the process chemical drums on site.

X. Statutory Determination

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Pumping and discharge to the POTW would provide protection of human health and the environment by reducing the mobility and volume of cyanide in the shallow aquifer. The toxicity of cyanide would be reduced through treatment at the POTW. Hazard Indices for noncarcinogens at the site will be less than 1 upon completion of remedial activities. Additionally, implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts. The selected remedy also meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable.

The long-term risks associated with the Cimarron ground water contamination would be minimized. Short-term risks could be addressed by ensuring that the sewer hookup is inaccessible to the public. The selected remedy could be readily implemented, since no special technologies would be required; and, pretreatment regulations which exist regarding discharge to waters from CERCLA sites to POTWs will be met.

All Federal and State requirements for this remedy that are Applicable or Relevant and Appropriate (ARARs) can be met through adequate design and planning.

Long-term effectiveness is achieved through removal and ultimate destruction of the contaminants of concern. In addition, treatment is utilized to the maximum extent practicable in this alternative.

This remedy is cost effective in comparison to other alternatives. The total cost of the selected remedy is estimated to be \$95,000 net present worth dollars (+50% or -30%). Five-year facility reviews will not be necessary for the soils since

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contaminants are not above health based levels. Ground water monitoring will continue for 30 years if sample analysis deems it necessary.

The selected remedy provides the best balance of tradeoffs among the selection criteria used to evaluate the six proposed alternatives for the site, as discussed in Section VIII of this Record of Decision.

Community and state acceptance is favorable to this remedy in comparison to other alternatives presented during public comment.

XI. Documentation of No Significant Changes

The Proposed Plan for the Cimarron Mining Corporation site was released for public comment in July 1990. The Proposed Plan identified Alternative 4, pump and discharge shallow ground water to the POTW, as the preferred alternative. EPA reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the remedy, as it was originally identified in the Proposed Plan, were necessary.

XII. Responsiveness Summary

Community Preferences

The citizens of Carrizozo, town officials and the New Mexico Bureau of Mines expressed preference for the selected remedy of pump and discharge ground water to the POTW for treatment at the public meeting conducted on July 30, 1990. Local preference was also indicated in the August 16, 1990, article in the Lincoln County News, page 1, entitled "EPA, Town concurs with cleanup option". The New Mexico Environmental Improvement Division has also provided formal concurrence with the proposed remedy.

Integration of Comments

- i. Comment: The Hispanic Community is not aware of the problem at the Cimarron site. There are some people that live near the Cimarron mill who speak only Spanish.

Response: In April 1989, prior to the initiation of the Remedial Investigation at the site, a fact sheet containing a request form for addition to the EPA mailing list was produced in Spanish and distributed in Carrizozo. None of the Spanish-language request forms were returned. In addition, no indication of a need for Spanish translation has been expressed at any of the "open house" or formal public meetings.

Due to the lack of response to the initial Spanish-language fact sheet and the apparent lack of interest in Spanish-translation at the public meetings, the Spanish-language fact sheets were discontinued. Spanish-language translation will however, be reconsidered for future fact sheets and meeting announcements.

2. Comment: The remedial work at the Cimarron site should be conducted by local residents as much as possible.

Response: Following the Remedial Design EPA will formally advertise for bids and Federal procurement regulations will be followed. The contract will be awarded to the lowest responsive, responsible bidder. The potential for utilizing local labor would be through either the contractor that is awarded the contract or any possible subcontractors.

3. Comment: EPA should take advantage of local expertise in reviewing technical documents, inspection reports, feasibility studies, etc.

Response: EPA agrees and has taken steps to involve the local community. Beginning in January 1989, EPA has continued to announce the availability of a Technical Assistance Grant for use by local residents to obtain technical expertise to assist in conducting reviews of documents and gain assistance in interpreting reports. No requests to obtain a Technical Assistance Grant have been submitted to date.

EPA has attempted to utilize local expertise by way of interviews and discussions with previous employees of the Cimarron mill and those familiar with local mining and mill practices. This has proven to be very valuable in identifying the mill processes utilized at the Cimarron site and the location of potential contaminant sources. In addition, all Remedial Investigation and Feasibility Study reports have been made available for review and comment through the public comment process.

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4. Comment: How many gallons of the contaminated ground water from the Cimarron site would you have to drink to be a fatal dose? How toxic is the 4330 ug/l of cyanide which was the highest level detected in the ground water? What are the effects to the body?

Response: The State and Federal Drinking Water Standards for cyanide have been established at 200 ug/l. Based on the highest concentration of 4330 ug/l of cyanide detected at this site, a fatal adult dose would be approximately 3.2 gallons. A fatal dose for a child would be approximately 1/2 gallon. Cyanide primarily attacks the nervous system with death resulting from respiratory paralysis. An adult could begin to experience nervous system disorders after consuming 1/10 of a gallon and a child after consuming 1/100 of a gallon.

5. Comment: How much money has been spent on the project so far? (As of July 30, 1990).

Response: The most recent financial report (expenditures through June 1990) indicates approximately \$551,000 has been spent on the Cimarron Remedial Investigation and Feasibility Study.

6. Comment: Can the contaminated monitoring wells be used to treat the ground water in-place by putting bleach in the well to break down the cyanide by chlorination?

Response: The extremely low permeabilities of the underlying soils would not allow for adequate diffusion and mixing to treat the area of contamination through chlorination. Removal of the contaminated ground water for treatment is the most viable approach.

7. Comment: How many gallons of contaminated ground water will need to be treated?

Response: Based on the area of contamination and the permeability of the soils, approximately 3,000,000 gallons.

8. Comment: It seems like an awful lot of money has been spent on the site.

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Response: The studies required by Superfund regulation and statute are very costly due to the extensive sampling, analysis, and expert consultations required. For this reason potential Superfund sites are screened before these studies are begun. For example, of 3,000 possible hazardous waste sites EPA Region 6 has examined, only 73 were found to present enough risk to be eligible for study. The average cost of these studies is \$750,000 compared to \$551,000 at Cimarron. Although by no means "cheap", the cost of studies at Cimarron was, in EPA's judgment, the minimum expenditure needed to characterize what is an environmental problem as well as what is not a problem (e.g. toxic metals in surface soils).

9. Comment: How can we be assured that the POTW can adequately treat the contaminated ground water?

Response: Water entering the collection system and POTW effluent and sludges will be sampled to ensure no adverse impacts to the POTW. The POTW has adequate capacity and the capability through the chlorination, aeration and photodecomposition within the treatment plant to effectively treat the contaminated ground water from the Cimarron site.

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