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EPA / DALLAS , 1445 ROSS AVE., SUITE 1200
DALLAS, TX, 75202
P : (214) 665-6532 F :

February 28, 1994

NW
2230 G

David Shoemaker
Site Manager
Molycorp, Inc.
P.O. Box 469
Questa, NM 87556

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

Re: Draft Workplan for Molycorp Investigation

Mr. Shoemaker:

In order to better apprise you of the site investigation planned at Molycorp by the New Mexico Environment Department (NMED), Superfund Program, I have enclosed a draft workplan for your review. I encourage any comments you may have concerning the workplan; and as I anticipate fieldwork to begin in mid-April, I would appreciate any comments by the end of March. While your comments may be helpful in refining the workplan, any proposed changes to the workplan are subject to EPA and NMED approval.

I appreciate the cooperation which you have extended me and look forward to your continued assistance. If you have any comments or questions, please call me at 827-0037.

Sincerely,

Stuart Kent
NMED-Superfund Program

Bruce King
Governor

Judith M. Espinosa
Secretary

Ron Curry
Deputy Secretary

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DRUG FREE

DRAFT

Expanded Site Inspection Workplan

for the

Molycorp Site

Questa, NM

February 28, 1994

Stuart Kent
New Mexico Environment Department

DRAFT

TABLE OF CONTENTS

		PAGE
A.	INTRODUCTION	1
1.	EXPANDED SITE INSPECTION OBJECTIVES	1
2.	SITE LOCATION AND DESCRIPTION	1
3.	PREVIOUS STUDIES	2
B.	EXPANDED SITE INSPECTION	3
1.	WASTE CHARACTERIZATION	3
2.	SOIL EXPOSURE PATHWAY	5
3.	GROUNDWATER MIGRATION PATHWAY	7
4.	SURFACE WATER MIGRATION PATHWAY	12
5.	AIR MIGRATION PATHWAY	18
C.	PROJECT MANAGEMENT	19
	REFERENCES	21
	HEALTH & SAFETY PLAN	APPENDIX A

LIST OF TABLES

Table 1	Waste Source Metal Concentrations
Table 2	Waste Source Sampling Strategy
Table 3	Soil Exposure Sampling Strategy
Table 4	Summary of Groundwater Analysis by NMED of Private Wells and Monitoring Well Below (South) Molycorp Tailings Ponds (in ppm)
Table 5	Sampling Strategy for Groundwater Migration Pathway
Table 6	Surface Water Quality (in ppm) of Red River near Molycorp Mine
Table 7	Sampling Strategy for Surface Water Migration Pathway at Tailings Ponds: Phase I

Table 8 Sampling Strategy for Surface Water Migration Pathway at Mine Waste Location : Phase I

Table 9 Sampling Strategy for Air Migration Pathway at Tailings Ponds

LIST OF FIGURES

Figure 1 Index Map Showing the Location of the Questa (Molycorp) Molybdenum Mine

Figure 2 Extent of Mine Waste Rock

Figure 3 Waste Sample Locations (Approximate) at the Mine Site

Figure 4 Waste Sample Locations (Approximate) at the Tailings Ponds

Figure 5 Soil Sampling Locations near Tailings Ponds

Figure 6 Groundwater Sampling Locations at Tailings Ponds

Figure 7 Surface Water Migration Pathway: Environmental Targets and Target Distance Limit

Figure 8 Surface Water Migration Pathway: Sampling Strategy at Tailings Ponds

Figure 9 Surface Water Migration Pathway: Sampling Strategy at Mine Waste Site for Observed Release to Groundwater

Figure 10 Surface Water Migration Pathway: Sampling Strategy at Mine Waste Site for Observed Release to Surface Water

Figure 11 Air Sampling Strategy at Tailings Ponds

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Molycorp Site
Taos County, New Mexico

Expanded Site Inspection
Work Plan

New Mexico Environment Department
February 28, 1994

A. Introduction

The Molycorp site is a molybdenum mine and tailings disposal site in Northern New Mexico. It is currently under review by the New Mexico Environment Department (NMED), Superfund Program to determine whether the site is a potential candidate for inclusion on the National Priorities List (NPL) under the Comprehensive Environmental Recovery, Compensation and Liability Act (CERCLA). To further evaluate the site, an Expanded Site Inspection (ESI) will be conducted to obtain information critical for this assessment.

1. Expanded Site Inspection Objectives

This work plan identifies the tasks to be performed to obtain information relevant to the evaluation of the Molycorp Site using the Hazard Ranking System. The information collected will involve sampling various environmental media and review of records to more accurately determine the presence and distribution of CERCLA hazardous substances at Molycorp Site and to determine the extent and degree of contamination from the site along the air, soil, surface water and groundwater migration/exposure pathways. Environmental media to be sampled will include the following: 1) waste samples from the mining waste rock piles and tailings ponds; 2) soil samples near the tailings ponds to identify the area of contamination; 3) groundwater samples from wells and seeps/springs to determine if a release from the waste sources has occurred; 4) surface water and sediment samples from the Red River to identify a release of CERCLA hazardous substances and determine level of contamination; and 5) potential air sampling to identify airborne contaminants from the tailings ponds.

2. Site Location and Description

The Molycorp site is situated in Taos County near Questa, New Mexico (fig. 1). The mine, surrounded by Carson National Forest, occupies approximately three square miles on patented land owned by Molycorp, Inc. The mine is located at 36° 42' 30" N latitude and 105° 30' 30" W

longitude. The mine consists of both underground and open pit operations. The tailings ponds occupy approximately 1 square mile and are located 1 mile west of Questa, NM on land owned by Molycorp, Inc and consist of two large ponds and one smaller pond. The coordinates of the tailings ponds are 36° 42' 30" N latitude and 105° 37' 0" W longitude. A series of pipelines transports the tailings from the mill site to the ponds. The USGS 7½' quadrangle maps on which the Molycorp site and target distances are located are Sunshine, Cerro, Latir Peak, Guadalupe Mountain, Questa and Red River (ref. 1).

3. Previous Studies

Molycorp site in Questa has been the subject of several studies. In 1965, the US Department of Health conducted a survey of the Red River to assess the quality of the river prior to the commencement of open pit mining by Molycorp (ref. 2). While effects from numerous small mining sites adjacent to the Red River included periodic elevation of metal concentrations leached from sulphur-rich ores during storm events, the overall quality of the river, including the segment adjacent to the mine site, was determined to be of high quality (ref. 2).

Two studies conducted by the New Mexico Environment Department (formerly, NM Environmental Improvement Division) in 1986 and 1988 confirmed high metal loading of the Red River by periodic storm events but that metal concentrations in the river and sediment were not elevated to the point of causing aquatic toxicity (ref. 3, 4). The major elements which became elevated between the Red River Waste Water Treatment Plant and the Questa (USFS) Ranger Station were iron and aluminum. A portion of this segment abuts Molycorp property where mining operations have occurred.

A study conducted in 1985 by the NMED-Air Quality Program to evaluate air emissions from the tailings ponds, concluded that no ambient air quality standard had been exceeded (ref. 5). It also noted that the sampling protocol, which collected air samples every sixth day, is likely to miss recording additional periods of violations of the standard. In April of 1993, NMED-Air Quality Bureau installed a continuous monitoring device at the Questa Jr. High School. No violations of the federal PM 10 standard occurred during 1993 (ref. 6).

U.S. EPA conducted a Preliminary Assessment in May, 1980 and a Site Inspection in June, 1981. The conclusions of these reports, respectively, were for no further remedial action and placing the site at a lower priority (ref. 7).

However, EPA funded field investigation teams (FIT) to investigate Molycorp in 1983 and 1985. Part of the investigation was an assessment of the private (Molycorp) landfill located in Spring Gulch near the mining site. Because elevated levels of cadmium, copper, lead, nickel, zinc and several organic compounds were detected in Spring Gulch Creek below the Molycorp landfill (ref. 8, p. 3), conclusions from the second investigation included the apparent migration of contaminants off-site and the recommendation for further study of this landfill under RCRA authority (ref. 8). Molycorp currently has two landfills (in Spring and Goathill Gulches) which are exempted from NM Solid Waste Management Regulations since they now receive only demolition and construction debris (ref. 9).

B. Expanded Site Inspection

Sampling at the Molycorp Site will be conducted in two phases if necessary. During Phase I, the sampling strategy will be to confirm the presence of CERCLA hazardous substances in site waste sources and document a release of these substances to each of the pathway media, determine (partial) attribution of the release to Molycorp, Inc. and to determine targets exposed to these substances. The focus of Phase II will be to identify observed releases where they may be insufficiently established during Phase I and identify level of contamination at target locations.

1. Waste Characterization

1.1 Existing Data

Mine waste rock has been deposited in three main drainages: Capulin Creek, Goathill Gulch and Sulphur Gulch (fig. 2). While the waste rock occupies a surface area of approximately 40 million square feet (ref. 10, p. 5), the bulk of it is in Sulphur Gulch where the open pit is located. No underlying liner or other containment structure for the waste rock is present. The mine waste rock consists primarily of two rock types: hydrothermally altered volcanics (andesite and rhyolite) which is yellow in color and the aplitic granite (also called soda granite) which is gray. X-ray fluorescence (XRF) screening of two samples of mine waste rock indicated elevated levels of copper, zinc, lead and cadmium above background concentrations (Table 1). Background levels were taken as the higher value of a previously published report or results of XRF screening analysis of soil from a drainage above the mine waste rock (i.e. Hanson Creek). Concentrations ranged from 40 ppm for cadmium to 240 ppm for zinc (Table 1).

The tailings ponds, comprised of fine-grained tailings and waste water, occupy about 26 million square feet (ref. 10, p. 5) and are located behind three dams. Only one of these dams has an impermeable liner on its face (ref. 11). No other liner is present but transmission of waste water from the tailings slurry to groundwater is slowed by fine-grained sediment of the waste. This waste material was characterized from split sample analysis conducted by Molycorp and the Questa Board of Education (Table 1). Analytical results showed lead, copper and zinc at concentrations ranging from 90 ppm (lead) to 240 ppm (zinc). A subsequent analysis of the tailings by NMED reported lead and zinc but no copper (Table 1).

1.2 ESI Data Acquisition

A total of fourteen samples will be collected to characterize waste sources at Molycorp (Table 2). Sampling locations within a distinct waste location such as a specific tailings pond or drainage will be determined by screening each waste source for metals using a Spectrace 9000 portable XRF instrument. Samples for laboratory analysis will be collected at locations demonstrating the highest metal concentrations and analyzed for Target Analyte List metals.

Seven waste rock samples will be collected to characterize the mine waste rock piles with at least one sample from each rock type (fig. 3). Because most of the waste is piled in Sulphur Gulch, four samples will be collected from this drainage whereas three samples will be collected from Capulin Creek and Goathill Gulch. Waste rock is expected to be poorly sorted. Samples will be sieved with a #9 mesh (2.0 mm) prior to XRF screening and collection.

The characteristics of the tailings deposited at the tailings ponds may have changed over the course of disposal since 1965. This temporal variation in waste characteristics of the tailings is likely reflected in spacial variation associated with disposal in various areas of the tailings ponds. Thus, sampling at different locations near the surface of the tailings ponds will partially address variation of waste characteristics. Seven waste samples will be collected over the four ponds: five from Ponds 1 and 4 (the larger ponds) and one each from Ponds 2 and 5A (fig. 4). Since most of the tailings ponds are capped with approximately one foot of topsoil, samples will be collected at a depth of 6 inches below the cap.

2. Soil Exposure Pathway

2.1 Existing Data

Exposure to CERCLA hazardous substances in the soil which have resulted from waste sources is assessed by evaluating the population which resides and/or works on areas of contamination, the population residing within one mile who may pass through or recreate in these areas and terrestrial sensitive environments located on areas of contamination. The surface areas of the mining waste rock and the tailings ponds are estimated at 40 million square feet and 26 million square feet, respectively. Access to these areas are limited by the presence of either a fence (at the tailings ponds) or natural barriers such as steep side canyons (at the mining waste rock). It is likely that CERCLA hazardous substances, if present in the mine waste or tailings, extend beyond the waste sources due to the settling of airborne particulates generated from each waste source.

2.2 Targets

There are no people who reside within the currently identified area of soil contamination (site waste sources) and the number of workers in these areas is low as Molycorp presently employs only eleven people (ref. 10, p. 9). The population residing within a mile from the mine site is limited to two residents who own and operate a small seasonal lodge (called Fagerquist's Cottonwood Park). The population residing within a mile of the tailings ponds is presented below:

Waste Source	Distance (mi.)	Population (estimated)
Tailings Ponds	>0 - 1/4	0*
	>1/4 - 1/2	279+
	>1/2 - 1	1,007+

Total population within 1 mile of the tailings ponds = 1,286

* No residents within 1/4 mile from area of contamination (as determined by topographical maps)

\+ Determined during evaluation of the air migration pathway (see below)

The greatest number of people potentially affected by soil contamination near the tailings ponds are the 188 students

and staff at Questa Jr. High School (ref. 12) which is located 1/3 mile northeast of the tailings ponds (fig. 5). Residents who live 1/3 - 1/2 mile south or east from the tailings ponds could be equally affected by soil contamination.

Terrestrial sensitive environments are also to be assessed at areas of soil contamination. The habitat for the Small-headed Goldenweed (Hiplopappus microcephalus) has tentatively been identified near the mining site. This species is under review for its federally endangered or threatened status (ref. 13) and is considered sensitive to land use practices within the National Forest (ref. 14). This sensitive environment may be located within the delineated area of soil contamination at the mine waste piles. No other sensitive environments were noted for this exposure pathway.

2.3 ESI Data Acquisition

Soil sampling near the tailings ponds during Phase I will serve the dual purpose of further delineating the extent of soil contamination and identifying populations exposed to site contaminants. Sampling strategy will focus on nearest residential populations south of the tailings ponds, east of the tailings ponds and at Questa Jr. High School (fig. 5). Soil samples will be collected within 200 feet of residences where XRF screening shows the highest metal concentrations. Screening locations maybe influenced by approval of property access by homeowners. At least one soil sample will be collected at Questa Jr. High School and nearest residences regardless of the metal concentrations. Two background samples, collected south of the tailings ponds on the opposite side of the Red River (i.e. south), will be used for comparison. These sampling locations were chosen to represent the soil derived from alluvial strata of the Santa Fe Formation while remaining generally upwind from the tailings ponds. Samples will be collected from the top 2 inches of the soil surface to increase the proportion of the sample representing airborne particulates which have settled. A total of eight soil samples, including background samples, will be collected and analyzed for Target Analyte List metals.

During Phase I, the presence and delineation of the habitat for the Small-headed Goldenweed in the vicinity of the mine will be confirmed with the New Mexico Minerals and Natural Resources Department. Identification of other terrestrial sensitive environments will also occur.

If necessary, soil samples will be collected during Phase II within the range of this sensitive environment to determine if actual contamination of the soil exists. Background soil samples will be collected from soil weathered from areas of native rock and hydrothermal alterations where the lithology is similar to that of the mine waste rock. Proposed sample locations will be adjacent to Capulin Creek drainage and an altered area near Eagle Rock. All samples will be collected from 0 - 2 inches in depth. A summary of the soil sampling strategy is presented in Table 3.

3. Groundwater Migration Pathway

3.1 Existing data

The two waste sources of the Molycorp site are located in different physiographic areas which are separated by regional block-faulting. The Molycorp mine, and associated mining waste rock, is located in the Taos Range which is made up of intrusive igneous rock and metamorphic rock of Precambrian age which are overlain by Tertiary volcanics (ref. 15, p. 11). Subsequent fracturing and faulting occurred extensively in the vicinity of the mine (ref. 15).

Conversations with the Molycorp mine site manager (ref. 10, p. 12; ref. 16) regarding mine schematics revealed that new underground workings progress below the Red River. On-site precipitation and surface run-on drain through either the open pit in Sulphur Gulch or a 700-foot vertical bore hole in the adjacent Goathill Gulch. Water draining from both conveyances is filling the new mine workings. Since run-off is purposely directed to the groundwater, an observed release to groundwater exists due to the presence of CERCLA hazardous substances in the leachate from the mine waste dumps (ref. 17, p. 11). The elevation of the water level in the mine workings is approximately 400 feet below the Red River (ref. 16). However, the Red River is a gaining stream at this location. One survey (ref. 18) measured an increase in flow of 4 cubic feet per second between Columbine Creek (upstream from Goathill Gulch) and Bear Canyon (approx. 1 mile downstream from Goathill Gulch). This stretch of the Red River measures 2.8 miles and includes observed groundwater seeps along the northern streambed (ref. 10, p. 1). Because these seeps have perennial flow, the water

table is inferred to be the approximate elevation of the Red River which is 7,750 feet at Goathill Gulch.

The tailings ponds are situated in the Rio Grande Basin which resulted from Miocene uplifting of the Taos Range (ref. 19, p. 12). This downfaulted area has received alluvial sediment from the Taos Range. Intermittent extrusion of lava during late Pliocene and early Pleistocene has resulted in interbedding of the lava with alluvium. These lithologies together with occasional lake deposits comprise the Santa Fe group (ref. 19, p. 15).

The Santa Fe Group is the major water-bearing unit in the Rio Grande Basin of Taos County (ref. 19, p. 15) where depths to groundwater vary from 2-90 feet (ref. 19, p. 22; ref. 20, Tables 27, 37). Groundwater flow near the town of Questa and the tailings ponds is generally southwest away from the mountains and recharges the Red River and Rio Grande by numerous springs which generally emerge from the basalt layer. Those springs which recharge the Red River are located southwest of the tailings ponds toward the confluence of the Red River and Rio Grande. Some of these springs are hydrologically connected to the waste water leaching through the tailings ponds (ref. 21).

Groundwater and surface water monitoring data presented by Molycorp, Inc. in April 1987 revealed contamination in wells downgradient from the tailings ponds. Analyses of monitoring wells, surface water discharge points and one private well was used to characterize leachate from the tailings ponds (ref. 22). The mean concentration of lead in the aforementioned private well was approximately 0.056 ppm (N = 8). This level was greater than three times the reported background concentration of 0.016 ppm and above the New Mexico Groundwater standard of 0.05 ppm. The maximum and minimum concentrations reported were 0.12 ppm and 0.01 ppm, respectively. Comparing the results to the New Mexico State Groundwater standards, Molycorp concluded the violation of the standard for lead on four different occasions (ref. 22, p. 12). However, conversations with the site manager revealed that the numbers reported for lead reflect analytical detection limits and that lead (and cadmium) has never been detected in downgradient private wells (ref. 10, p. 27). Analytical results from seven private wells sampled in 1987 and 1988 by NMED, which included the well previously showing a violation, showed no detectable levels of either cadmium or lead (Table 4).

There may be sufficient information to clearly establish a release to groundwater. One problem from the 1987 data is that there is no clear background well. The report, acquiring data from 1985 and 1986, used analytical results

from numerous springs and two wells in the area as background conditions. These two wells, BLM Chiflo Campground Well and BLM Headquarters Well, are located three to four miles northwest of the tailings ponds and are screened in the deep basalt aquifer at depths of 415 feet and 546 feet, respectively (ref. 22). All springs used to characterize background conditions are located along the Red River where only basalt exists; the Santa Fe Group alluvium is not present (ref. 23). Subsurface hydrology is complex; characteristics of water from seeps located closely together can differ considerably (ref. 21). Use of analytical results from numerous springs, wells and seeps may not have accurately reflected background conditions, especially for the portion of the tailings ponds which overly the Santa Fe Group alluvium.

Groundwater analysis recently (Sept. 1993) submitted by Molycorp, Inc. used an off-gradient well to reflect background conditions. This well, labelled MW-CH, is screened in the middle to lower units of the Santa Fe Aquifer (ref. 22, p. 15). Results from this analysis show elevated levels above background of iron, manganese and zinc in several monitoring wells and detected levels of chromium and lead in one monitoring well (ref. 23, Table C-1).

3.2 Targets

The Fagerquist's Cottonwood Park is a small, 12 unit resort approximately 1/3 mile south of the Molycorp mine and 100 feet below the confluence of Columbine Creek and the Red River. The resort's well represents the nearest well supplying drinking water. With the facility on the south side of the Red River, the source for their groundwater supply is likely recharge from the Columbine Creek area. Although less likely, a portion of their water supply may come from groundwater which has drained from the north side of Red River. Recent field reconnaissance has determined that no other private wells exist between the mine and Questa Ranger Station on the north of the Red River (same side as the mine site).

Several wells located below the tailings ponds were used for drinking water purposes until Molycorp offered to switch drinking water supply to the community supply well system. The reason for this switch is currently unknown. Most wells, but not all, were switched. This switch occurred approximately in 1976 (ref. 10, p. 22). One family refused to have their water supply switched. Five members of this family used water from this well for drinking purposes, at least two of whom consistently used the well until 1986 (ref. 10, p. 21). While wells below the tailings pond are

not used for drinking water purposes or are currently being switched to the community water system (ref. 24), they still may be in use for agricultural purposes.

The total population served by groundwater within 4 miles of the tailings ponds is presented below (ref. 25):

Distance (mi.)	# Wells (*)	Population (**)
0-1/4	0	0
1/4-1/2	0	0
1/2-1.0	5 (3)	917 (911+)
1.0-2.0	22 (2)	911 (852+)
2.0-3.0	8 (3)	359 (345)
3.0-4.0	23 (1)	259 (198)
Total Population		2,446

* Number community wells in parentheses
** Population served by community wells in parentheses
\+ Includes ½ of Questa population (ref. 26)

3.3 ESI Data Acquisition

The groundwater migration pathway will not be extensively investigated at the mine site since few targets exist for this migration pathway. The nearest well supplying drinking water, at Fagerquist's Cottonwood Park, will be sampled and analyzed for Target Analyte List (TAL) metals and general chemistry. No other private well near the mine site will be sampled. Because of the multitude of seeps and springs below the mine site, groundwater will be also be evaluated at this waste source under the groundwater-to-surface water migration route.

A better understanding of the number of human targets below the tailings ponds is needed. Data acquisition during Phase I will include the identification of downgradient wells which had been used for drinking water prior to the switch of water supply to the community well. The year the wells were switched will be determined as well as the reason for the switch. Further review of past groundwater monitoring data could potentially confirm a release of CERCLA hazardous substances to groundwater.

Groundwater sampling will occur during Phase I to document or confirm a release of CERCLA hazardous substances to the aquifer underlying the tailings ponds and to determine the level of contamination. Sampling locations will consist of those monitoring wells recently sampled by both Molycorp and NMED-Groundwater Section which demonstrated elevated levels of CERCLA hazardous substances and/or TDS and sulfate (ref. 23, Table C-1). Prior analysis of monitoring wells 1-4 showed detectable levels of lead, zinc and copper in well # 3 and zinc in the other wells (ref. 27). All four of these monitoring wells will be sampled. One background sample will be collected from a monitoring well, labelled MW-CH, located east of Dam 1 tailings pond.

The Herrera well was the final private well directly downgradient from the tailings ponds to be switched to the community supply system. This switch occurred in 1988 (ref. 10, p. 21). Monitoring of this well in 1987 and 1988 (labelled P-1) by the NMED-Groundwater Section failed to identify the presence of any CERCLA hazardous substances (Table 4). Because five years have passed since the installation of an alternative water supply and the Herrera well has not been used for any purpose, the Herrera family is no longer considered potential targets for the groundwater exposure pathway. Therefore, the Herrera well is considered to be the equivalent of a monitoring well and will not be sampled since other monitoring wells are already included in the sampling plan. However, three private wells, owned by the Medina, Rael and Duran families, respectively, have until recently (November 1993) provided drinking water (ref. 24). Recent groundwater analyses from these wells showed measurable concentrations of iron, copper and zinc (ref. 28), but levels were far below New Mexico State Groundwater Standards (ref. 28). Although these analyses suggest little to no contamination from the tailings ponds, these wells will be sampled to possibly identify an observed release of CERCLA hazardous substances and the level of contamination. All samples will be analyzed for general chemistry and TAL metals. A total of 12 wells will be sampled to assess the tailings ponds (fig. 6). A summary of the groundwater sampling strategy is presented in Table 5.

4. Surface Water Migration Pathway

Molycorp mine and the tailings disposal ponds are located approximately eight miles apart in the Red River drainage. Five to six miles below the tailings ponds is the confluence of the Red River and Rio Grande (fig. 7). Evaluation of the surface water migration pathway from the Molycorp site to the Red River and Rio Grande entails the assessment of the overland flow and groundwater-to-surface water migration routes. Both routes exist at each of the waste source locations.

4.1 Existing Data.

The Molycorp site has been studied by several programs within NMED, predominantly by the Surface Water Bureau. Point source discharges from the tailings ponds have been monitored through a National Pollution Discharge Elimination System (NPDES) permit issued by U.S. Environmental Protection Agency. Renewal of the permit will include two additional discharge points from the mining site (NMED-Surface Water Bureau: personal communication). Several non-point discharge surveys have been conducted which have focused on the Red River (ref. 3, 4). One result drawn from these surface water surveys was that episodic run-off events erode oxidized sulphide-rich soils from naturally barren slopes and mining scars. This process generates acidic run-off which mobilizes and transports trace elements, including heavy metals, to the Red River. The acidic run-off temporarily reduces the pH of the river but the metals precipitate downstream as the pH becomes more neutral (ref. 4, p. 3). Another result from the survey was that biomonitoring in the Red River generally showed no chronic or acute toxicity but that biological indices were reduced below the Molycorp mine (ref. 4, p. 3).

During recent field reconnaissance, water from groundwater seeps was observed emerging and entering Red River approximately one and a half miles below (southwest) Molycorp mine (ref. 10, p. 1). Along this same stretch of the Red River, manganese concentrations were greater than three times the concentrations detected upstream (Table 6; ref. 4). The concentrations of zinc and total aluminum were two to three times greater than background. Other reports have determined that there is a general increase in the loading of sulfate, manganese, zinc and aluminum in the downstream direction with those seeps located below Capulin Canyon being the major contributors (ref. 29).

The increase in metal loading of the Red River in a downstream direction, noted in several studies, is at least partially attributable to the acid drainage from natural

hydrothermal scar areas (ref. 3, 4, 29). While some of this drainage reaches the Red River by overland flow (e.g. Hanson Creek), much infiltrates the river channel alluvium and discharges to the Red River through seeps/ springs. However, many of these seeps have perennial flow, even during dry seasons. Therefore, an undetermined proportion of the seep is likely attributable to groundwater which recharges the river. The segment of the Red River between Columbine Creek and the Questa Ranger Station (fig. 2) has been recorded as a gaining stream (ref. 18). While most of the leachate from the mine waste dumps and natural acidic run-on is purposely directed to groundwater below the Red River by Molycorp (ref. 10, p. 13, 27), the numerous fracture systems in the vicinity of the mine may provide an avenue for which the collected waste water can reach the Red River. Several statements from a recent hydrogeological report suggests this possibility. The past rate of dewatering the mine, 0.55 cubic feet per second (cfs), is less than 40 % of the estimated amount of water available to recharge (1.45 cfs; ref. 17, p. 8). Therefore, approximately 0.9 cfs is not collected by the mine. The report continues to state that fractures in the volcanics may provide an avenue for recharge to reach the Red River (ref. 17, p. 9). Whether the recharge to the Red River, via the seeps, contains any CERCLA hazardous substances from the leachate emanating from the mine waste rock is to be evaluated.

4.2 Targets.

No drinking water intakes have been identified along the target distance limit of 23 miles (ref. 30); however, fisheries and sensitive environments may both be present (ref. 13, p. 1; ref. 31; fig. 7). The Red River Fish Hatchery produces approximately 11,000 lbs. of fish per year which is used to stock the Red River above and below the Molycorp mine site and the Rio Grande (ref. 32).

One sensitive environment potentially affected by the surface water migration pathway is a federally designated wild & scenic river which begins approximately 2.5 miles below NPDES discharge outfall # 002 (fig. 7). The habitat for the Southwest Willow Flycatcher (<u>Empidomax trailii extimus</u>) which is under review for its federally endangered/threatened status, has been tentatively identified along the Red River (ref. 13, p. 1). Additional environmental targets may exist which have not yet been identified.

4.3 ESI Data Acquisition.

The surface water migration pathway at Molycorp will be evaluated for both the overland flow and groundwater-to-surface water routes. Each route is present at the tailings ponds as evidence of a National Pollution Discharge Elimination System (NPDES) permit and documented seeps attributed to the ponds (ref. 21). The mine site has overland flow as new NPDES discharge locations have been included into the current NPDES permit and the construction of a rock drain at the toe of the mining waste piles adjacent to Hwy 38 purposely conveys run-off to the Red River (ref. 10, p. 29). Whether CERCLA hazardous substances are present in these releases is to be evaluated. The Phase I sampling strategy for the surface water migration pathway at the mine site and tailings ponds is presented in Tables 7 and 8, respectively.

A release of CERCLA hazardous substances from the tailings ponds may be documented by the permit restrictions and monitoring requirements of the NPDES permit required of Molycorp. Releases of several of these substances including copper, manganese and zinc have been recorded but have not exceeded discharge limits (ref. 33). A more extensive review during Phase I of the monitoring reports by Molycorp for the discharge from the tailings ponds will be performed to determine if releases which exceed their NPDES permit have frequently occurred.

Numerous groundwater seeps and springs (approximately 25) have been identified along the Red River below the tailings ponds. Some of these have been used as an assessment of ambient groundwater quality (ref. 22) whereas others have been hydrologically influenced by the tailings ponds (ref. 21). A recent hydrogeological report identified five seeps with elevated sulfate concentrations which included seepage attributable to the tailings (ref. 21). Two of these seeps/springs provide a portion of the water supply for the Red River Fish Hatchery (ref. 21, 34). Sampling during Phase I will include the collection of water samples from four of these seeps/springs. Flow from the fifth seep is assumed to be too low (0.40 cfs, ref. 21) to affect much change in water chemistry of the Red River and therefore will not be sampled. The two springs supplying the Red River Fish Hatchery will be sampled at the hatchery to determine if a release of CERCLA hazardous substances has occurred. Surface water samples above and below the seep areas will also be collected. All samples will be analyzed for Target Analyte List (TAL) metals and general chemistry. Groundwater samples from an off-gradient well (ref. 23: CH-Well), representing the middle-to-lower units of the Santa Fe Group Aquifer, will be used as background

conditions to which analysis of downgradient seeps/springs will be compared. Three additional water samples will be collected: waste water from the NPDES discharge point # 002 and surface water above and below the outfall. Samples will be analyzed for TAL metals to identify the potential release of CERCLA hazardous substances not addressed in Molycorp's NPDES permit. Phase I sampling locations for the surface water migration pathway near the tailings ponds are shown on Figure 8 and overall sampling strategy is presented in Table 7.

A release to surface water from the mining site may result from both overland run-off and ground water seeps. While much of the run-off from the mining waste piles (and surface run-on) is directed to groundwater via the mine workings, a portion of the run-off drains to the Red River via overland flow. Some of this run-off will be collected and discharged to the Red River via Molycorp's renewed NPDES permit. Other, non-point discharge occurs where rock drains have been constructed at the toe of mining waste pile in Sulphur Gulch to convey water to the Red River (ref. 10, p. 29). Most of the overland flow not discharged under the NPDES permit is likely to infiltrate the alluvium of the river channel prior to reaching the Red River. Therefore, seeps/springs located downstream from the mining site will be evaluated under the groundwater-to-surface water migration route.

The evaluation of the potential impact of the Molycorp mining operation on the Red River will focus on effects above those which occur naturally. Background and downgradient groundwater samples will be used to determine any observed release of CERCLA hazardous substances. With variations in lithologies, geologic structures and mining operations over the entire mine site, background condition is not considered to be homogeneous. Therefore, several sampling locations will be used to evaluate background groundwater chemistry. These locations have been selected to represent groundwater which flows through either the fractures of the hard rock geology, the alluvium of the Red River channel or alluvium in the side channels which is impacted by natural scar drainage. Separation of the groundwater flow into three systems is useful in understanding general hydrogeology near the mine site and will assist in defining sources for the seeps near the Red River. It does not, however, necessarily preclude the communication among systems.

Potential background groundwater samples will be collected from seven separate sources to evaluate the groundwater-to-surface water migration route: the water which is currently filling the new underground workings; mine-

generated water higher in the workings; a groundwater sample from one of the two production wells at the mill site; a groundwater sample from the Red River Waste Water Treatment Plant; samples from wells at Elephant Rock and Fawn Lake Campgrounds; and a seep near the outfall of Hanson Creek (fig. 9). The water which is currently filling the mine is the groundwater which receives surface run-off and leachate from the mine waste dumps and is the receiving aquifer which defines an observed release by direct observation under the groundwater migration pathway. While this groundwater is presumably impacted (i.e. geochemically altered) by surface drainage, it may still be representative of background conditions for comparison to the seeps along the Red River. With few alternative sampling locations, use of the groundwater from the deep mine workings as background conditions seems appropriate. Exact sampling location for mine-generated water will be determined at time of field collection. Samples will be analyzed for TAL metals and general chemistry.

Downgradient groundwater samples will be collected from four of the seventeen seeps which have been identified along the Red River from the Molycorp milling site to Questa Ranger Station (ref. 29). Selection of specific seeps to be sampled was based upon field readings of conductivity and pH during a preliminary field reconnaissance (ref. 10, p. 15-20). During this reconnaissance, two reaches of the Red River where seeps are concentrated were noted. One of these reaches is located at the mouth of Capulin Canyon and the other is approximately a quarter-mile below Capulin Canyon (fig. 9).

Sampling will include water samples from both the seeps and receiving stream (i.e. Red River). Surface water samples to be collected during Phase I will occur above Molycorp property boundary, below Sulphur Gulch, above, within and below Columbine Creek (a major tributary) and above and below each of the two reaches where seeps are numerous (fig. 10). Samples of surface water and seepage will be analyzed for both TAL metals and general chemistry. Because neutralization of acidic run-off and seepage by Red River causes precipitation of much of the metals, sediment samples will also be collected. These samples will be collected at all surface water sampling locations and analyzed for TAL metals.

Molycorp landfills, located in Spring Gulch (a tributary to Sulphur Gulch) and Goathill Gulch, currently receive construction/demolition debris which may impact the Red River. To preliminarily evaluate this potential impact, water samples will be collected immediately above and below the confluences of Sulphur and Goathill drainages with the

Red River. These samples will be analyzed for Target Compound List organics.

Determining partial attribution of CERCLA hazardous substances to Molycorp Mine will require the characterization of leachate emanating from the mining waste rock and comparison to water chemistry of the seeps. Water chemistry will be evaluated at all water sampling locations to determine whether a chemical similarity exists between the leachate from the mine waste piles and the downgradient seeps. Leachate samples (2) will be collected from the toe of the mining waste rock piles at the head of Capulin Canyon and Goathill Gulch (fig. 9). Two leachate samples will also be collected from hydrothermal scar areas. The overall sampling strategy during Phase I for the surface water migration pathway at the mine site is presented in Table 8.

Dilution of groundwater from river water flowing through the alluvium is expected. If a release to surface water cannot be documented from sampling the seeps during Phase I, additional sampling will occur during Phase II. Sampling will involve the collection of groundwater samples from ports dug into the river alluvium. Sampling ports will be dug either by a hand auger or a drive point bar. Sampling will be located closer to the mouths of the side canyons so as to minimize the dilution of river water within the channel alluvium. To minimize the number of sampling ports, selection of port locations will be directed toward those seeps containing higher concentrations and/or toxicities of CERCLA hazardous substances determined during Phase I analysis. Samples will be analyzed for general chemistry and TAL metals.

Targets for the surface water migration pathway need to be identified more accurately. Specifically, a fishery along the lower Red River has been identified, the upper boundary of which is currently unknown. Research will be conducted during Phase I which will more accurately determine the boundary of the fishery and its production. If sufficient information does not exist, a biological stream survey will be conducted during Phase II to determine productivity of the Red River. The identified fishery extends below the NPDES discharge outfall (or the probable point of entry) from the tailings ponds.

A potential habitat for one species (i.e. Southwestern Willow Flycatcher) under consideration for federal endangered or threatened status was previously identified. Additional information delineating the range of this species and the identification of other sensitive environments such as wetlands will be collected during Phase I.

5. AIR MIGRATION PATHWAY

5.1 Existing Data.

Several incidents of exposure to tailings dust at Questa High School (currently the Jr. High School), located 0.3 mile NE of the northern edge of the tailings ponds, have been recorded with the New Mexico Environment Department (ref. 5, p. 1, 5). During the spring months, the school is predominantly downwind from the tailings ponds. Since the installation of a sampling device at Questa High School in 1979 (ref. 5, p. 4), NMED has conducted ambient air measurements of total suspended particulates. While abundant information is not available concerning the heavy metal concentrations in these particulate samples, several sampling events had measurable concentrations of Pb (average of 0.09 ug/m^3). Although detected, Pb concentrations were below the National Ambient Air Quality Standard of 1.5 ug/m^3 (ref. 5, Table II). An automated continuous air monitoring device which has recorded total particulates at the school since June 1993, has shown no violation of air quality standards at Questa Jr. High School (ref. 6).

5.2 Targets

With enrollment and faculty at Questa Jr. High School at 188 (ref. 12), the total number of targets at the school or closer to the tailings ponds is 238. The population beyond the distance to the junior high school and up to 4 miles is 2,022:

Distance (mi.)	Population (estim.)
>0.3* - 1/2	41**
>1/2 - 1	1,007+
>1 - 2	413**
>2 - 3	396++
>3 - 4	165**

* 0.3 mile is location of Questa Jr. High School

** Determined by multiplying # houses on topographical map by # people/household (ref. 26).

\+ Determined by subtracting population numbers of other distance rings from census population (ref. 26). The number of students and faculty at the Jr. High School were excluded from this calculation.

++ Town of Cerro comprises bulk of the population for this distance; Cerro population calculated as # of mailboxes (ref. 35) X # people/ household (ref. 26).

Three sensitive environments have been identified for the air migration pathway: a federally designated wild and scenic river (fig. 7) and two potential habitats for species under consideration for their federally endangered or threatened status (Southwestern Willow Flycatcher and Small-headed Goldenweed, refs. 13, 14).

5.3 ESI Data Acquisition

Analysis of the tailings during the ESI and existing video photography showing a release at Questa Jr. High School may provide evidence of an observed release of CERCLA hazardous substances. The video tape will be carefully reviewed to confirm a release to the air pathway from the tailings ponds. Additionally, analysis of the tailings will be conducted to determine constituents (see waste characteristics above).

While releases of particulates have reportedly been documented, no comparison of air samples to background conditions has been made. Complicating the issue is the potential air release from a gravel mining operation located between the tailing ponds and the junior high school. If the video tape is not adequate in determining an observed release by direct observation, an alternative air sampling strategy will be conducted during Phase II. This strategy is to place a total suspended particulate air monitor at the Red River Fish Hatchery (southwest of the tailings ponds), the Jr. High School (northeast of the ponds) and between the tailings ponds and gravel mining operation (fig. 11). A temporary meteorological station will be installed to determine whether samples collected on each sampler adequately reflect background and down-wind conditions. Previous air monitoring data have shown higher levels of particulates during the spring months. If necessary, air sampling will occur at that time (Phase II). Samples will be analyzed for Target Analyte List metals. The air sampling strategy is presented in Table 9.

C. Project Management

Personnel.

Stuart Kent of the New Mexico Environment Department-Superfund Program will be the primary investigator of the

Molycorp Site. ESI workplan and subsequent reports will be reviewed by Mary Ann Menetrey and Kerrie Neet of NMED-Superfund Program. All laboratory analysis during the investigation will be conducted by EPA Contract Laboratory Program.

Personnel Safety.

A site specific Health & Safety Plan is presented in Appendix A.

Schedule.

This investigation will be conducted in two phases, if necessary. Phase I will occur in April, 1994. Collection of waste samples may not be practical since access will be difficult and the ground maybe frozen and/or saturated, thus reducing the dependability of the x-ray fluorescence instrument. Should this situation occur, waste source sampling will occur during Phase II which is scheduled for later in the spring of 1994.

References

1. U.S. Geological Survey 7 1/2 minute quadrangle maps: Latir Peak, NM 1963; Guadalupe Mountain, NM 1963; Red River, NM 1963; Sunshine, NM 1963; Cerro, NM 1963; Questa, NM 1963.

2. A Water Quality Survey - Red River of the Rio Grande, New Mexico. U.S. Department of Health, Education and Welfare. Robert S. Kerr Water Research Center Jan. 1966.

3. Intensive Water Quality Survey of the Red River: August 18-21, 1986. Smolka, L. R., Tague, D. F. Oct. 1987.

4. Intensive Water Quality Survey of the Middle Red River: Sept. 12 - Oct. 25, 1988. Smolka, L. R., Tague, D. F. May 1989.

5. Ambient Air Quality Data and Associated Data Collected in the Questa, New Mexico Area (1979-1983), Summary Report. Williams, C. New Mexico Environmental Improvement Division, Air Quality Bureau. 4/11/85.

6. PM-10 Graph at Questa Jr. High School. NMED - Air Quality Bureau.

7. CERCLIST by U.S. Environmental Protection Agency Superfund Program.

8. Preliminary Report by Ecology and Environment on Sampling Inspection at Molycorp, Inc., Questa, NM. June 4, 1986. For U.S. EPA Region VI.

9. NMED-Solid Waste Bureau correspondence to David Shoemaker, Molycorp Site Manager accepting exempted status for landfill permit requirements. June 1, 1993. Also included is Exemption request letter from David Shoemaker, Molycorp, Inc. Jan. 27, 1993.

10. Molycorp Field Notes and Computations. NMED-Superfund Program.

11. Molycorp Plan of Operation at Tailings Disposal Site. Date unknown.

12. Record of Telephone Conversation: Superintendent's Office-Questa School Distr. Date: 7/12/93.

References (cont.)

13. US Fish & Wildlife Federally Listed and Candidate Species of Endangered or Threatened Status (Draft 1992).

14. Inventory of Rare and Endangered Plants of New Mexico. New Mexico Forestry and Resources Conservation Division. March 1992.

15. Geology of the Questa Molybdenum (Moly) Mine Area, Taos County, New Mexico. Schilling, J. H. 1956. New Mexico Bureau of Mine and Mineral Resources, Bulletin 51.

16. Record of Telephone Conversation: David Shoemaker, Site Manager Molycorp, Inc. Date: 5/11/93.

17. Preliminary Investigation of the Potential Impact of the Rewatering of Molycorp's Deeper Underground Mine on the Red River near Questa, New Mexico. South Pass Resources, Inc. July 14, 1993.

18. Seepage Investigation-Rio Grande Basin, Red River. Oct. 25, 1988. USGS-Water Resources Division.

19. Ground-water Conditions and Geology of Sunshine Valley and Western Taos County, New Mexico. Winograd, I. J. New Mexico State Engineer Office. Technical Report No. 12. 1959.

20. Water Availability and Water Quality , Taos County, New Mexico. Lee Wilson and Associates, Inc. Sept. 13, 1978.

21. Analysis of Tailings Pond Seepage Flow to Red River at UNOCAL 76 Molycorp, Inc. - Questa Division. Vail Engineering, Inc. Sept. 24, 1993.

22. Compilation of groundwater data submitted by Molycorp, Inc. to New Mexico Environment Department, Groundwater Bureau. March 12, 1987.

23. Hydrogeologic Evaluation of Tailings Ponds: Molycorp, Questa Division - Questa, New Mexico. South Pass Resources, Inc. Sept. 23,

24. Record of Telephone Conversation: David Shoemaker, Site Manager Molycorp, Inc. Date: 11-19-93.

25. Record of Telephone Conversation: Ben Herrera, Village of Questa Superintendent. Date: 4/30/90 and Questa Water Supply System.

References (cont.)

26. 1990 Census of Population and Housing: Summary of population and Housing Characteristics-New Mexico. U.S. Dept. of Commerce. 1990 CPH-1-33.

27. Groundwater Analytical Data of Monitoring Wells (MW) # 1-4 at Tailings Ponds. Wells Sampled May 13, 1992. Submitted by Molycorp, Inc.

28. Groundwater Analytical Data of Private Wells # 4b, 5 and 9 near the Tailings Ponds. Submitted by Molycorp, Inc. on Nov. 2, 1993.

29. Interim Study of the Acidic Drainage to the Middle Red River, Taos County, New Mexico. Vail Engineering, Inc. July 9, 1993.

30. Record of Telephone Conversation: Ken McCallum, New Mexico Environment Dept.-Taos Office. Date: 7/9/93.

31. Record of Telephone Conversation: George Lopez, Assistant Chief of Fisheries, New Mexico Game & Fish Dept. Date: 7/9/93.

32. Record of Telephone Conversation: Gene Santistevin, Wildlife Culturist, Red River Fish Hatchery. Date: 7/10/93.

33. NPDES Discharge Monitoring Report (partial) for Molycorp, Inc. 1/1/93 - 5/31/93.

34. Record of Telephone Conversation: Victor Trujillo, Red River Fish Hatchery Manager. Date: 2/1/94.

35. Record of Telephone Conversation: Mrs. Parry, former US Postal worker in Cerro, NM. Date: 6/16/93.

36. Element Concentrations in Soils and Other Surficial Materials of the Coterminous United states. Shacklette, H. T. and Boerngen, J. G. U.S. Geological Survey Professional Paper 1270. 1984.

37. X-ray Fluorescence (XRF) analysis of soil samples on and near the Molycorp Mine. Samples collected 7/11/92; Samples screened 3/2/93.

38. Molycorp, Inc. Response to "Summary Statement" Presented by Questa Board of Education. March 1982.

References (cont.)

39. Groundwater Analytical Data of Private Wells and Monitoring Wells near the Molycorp Tailings Ponds. Samples collected by NMED - Groundwater Program between Feb 4, 1987 and April 19, 1988.

Table 1. Waste Source Metal Concentrations (ppm)

Sample Location	Mn	Ni	Cu	Zn	As	Mo	Hg	Pb	Cd
USGS 1270*	380	15	21	55	5.5	–	0.04	17	1
Erosional Scar**	340	90	10	20	10	0	0	20	0
Mine Waste Rock+									
Mine Waste 1	590	60	140	30	0	200	0	80	90
Mine Waste 2	1000	0	140	240	0	340	0	90	40
Tailings++									
Molycorp (split)	490	5.6	94	98	2.7	130	–	180	0.28
Education (split)	620	40	140	240	8	290	–	90	–
NMED+++	–	–	–	166	5.7	292	0.01	77	0.6

* Background Data, ref. 36
** Background Data by X-ray Fluorescence, ref. 37
\+ X-ray Fluorescence Data, ref. 37
++ Ref. 38, Table 1; Samples split between Molycorp and Questa Board of Education
+++ Ref. 5, Table V.
Shaded data are 3 X background

Table 2. Waste Source Sampling Strategy

Phase I

Sample Type	Source	Location	# Samples	Purpose	Analysis
Waste (soil)	Tailings Ponds	Dam Ponds 1,2,4,5-A	7	Establish presence of CERCLA hazardous substances	Target Analyte List (TAL) Metals
Waste (soil)	Mine Waste Piles	Capulin Canyon Goathill Gulch Sulphur Gulch	7	Establish presence of CERCLA hazardous substances	TAL Metals
Total Number of Samples			14		

Table 3. Soil Exposure Sampling Strategy

Phase I

Sample Type	Source	Location	# Samples	Purpose	Analysis
Soil	Tailings Ponds	Across Red River In Santa Fe Alluvium	2	Establish Background Soil Characteristics near Tailings Ponds	Target Analyte List (TAL) Metals
Soil	Tailings Ponds	Questa Jr. High School Residences East and South of Tailings Ponds	6	Determine Area and Level of Soil Contamination	TAL Metals
Total Number of Samples			8		

Phase II (if necessary)

Soil	Mine Waste Piles	Capulin Canyon Eagle Rock	2	Establish Background Soil Characteristics near Mine Site	TAL Metals
Soil	Mine Waste Piles	Terrestrial Sensitive Environment	2	Determine Area and Level of Soil Contamination	TAL Metals
Total Number of Samples			4		

Table 4. Summary of Groundwater Analysis by NMED of Private Wells and Monitoring Wells Below (South) Molycorp Tailings Ponds (in ppm)*

Well Location	Ownership	Date Sampled	TDS	SO4	Cd	Cr	Cu	Mn	Pb	Zn
P-1	Herrera	2-4-87	1406	325	<0.001	<0.005	<0.1	<0.05	<0.01	0.2
		5-26-87	1316	837	"	"	"	"	"	<0.1
		3-28-88	1652	875	<0.1	<0.1	"	"	<0.1	"
P-4a	Rael	2-4-87	792	<10	<0.001	<0.005	"	"	<0.01	"
		5-26-87	-	-	"	"	"	"	"	"
P-4b	Rael	2-4-87	356	93	"	"	"	"	"	0.2
		5-26-87	270	88	"	"	"	"	"	0.1
P-5	T. Durane	-	982	504	-	-	-	-	-	-
P-7	S. Durane	2-4-87	274	78	<0.001	<0.005	<0.1	<0.05	<0.01	0.3
		5-26-87	260	79	"	"	"	"	"	0.2
P-8	J. Durane	5-26-87	186	32	"	"	"	"	"	<0.1
MW-1		4-19-88	1360	750	"	"	"	"	"	"
MW-2		"	1446	815	"	"	"	"	"	"
MW-3		"	928	465	"	0.006	"	"	"	"
MW-4		"	1114	545	"	<0.005	"	"	"	"
MW-A		"	844	425	"	"	"	"	"	"
MW-C		"	1224	645	"	"	"	1.2	"	"

* ref. 39

Table 5. Sampling Strategy for Groundwater Migration Pathway

Sample Type	Source	Location	# Samples	Purpose	Analytes
Ground Water	Tailings Ponds	MW-CH	3	Establish Background Characteristics at Tailings Disposal Site	Target Analyte List (TAL) Metals (filtered/unfiltered) Wet Chemistry*
Ground Water	Tailings Ponds	MW-1, 2, 3, 4 MW-C MW-7a,b,c Private Wells: P-4b, P-5, P-9	33	Establish release of CERCLA hazardous substances & level of contamination P-4b = nearest well which has most recently been used	TAL Metals (filtered/unfiltered) Wet Chemistry
Ground Water	Mine Waste Site	Fagerquist Well	3	Nearest Drinking Water Well**	TAL Metals (filtered/unfiltered) Wet Chemistry
Total Number of Samples			39		

* Wet chemistry to include carbonate, bicarbonate

** Background condition for comparison is same as in the groundwater-to-surface water migration route

Table 6. Surface Water Quality (ppm) in Red River near Molycorp Mine

Constituent	Above Molycorp Boundary	Red River above Columbine Crk.	Columbine Creek	Red River at Goathill Campground	Red River at USFS Station
Al					
total	792	757	90	1050	1800
dissolved	120	110	-	-	67
Mn					
total	117	123	50	270	673
dissolved	100	90	-	-	635
Zn					
total	50	50	50	50	117
dissolved	50	50	-	-	110

Note: Data are mean concentrations during low flow conditions
Total metal concentrations are mean of three sampling events:
9/20/88; 9/26/88; 10/25/88
Dissolved metal concentrations are mean of two sampling events:
9/20/88; 9/26/88
Data taken from ref. 4, p. 43–51.
Shaded area is 3 x background concentrations

Table 7. Sampling Strategy for Surface Water Migration Pathway at Tailings Ponds: Phase I

Sample Type	Location	# Samples	Purpose	Analytes
GW Seeps/ Springs	Fish hatchery collection springs (sampled at hatchery) Seeps adjacent to hatchery springs/seeps	12	Establish release of CERCLA Hazardous Substances to Groundwater*; Establish Attribution to Tailings Ponds	TAL Metals (filtered/unfiltered) Wet Chemistry**
Surface Water	Above/below NPDES pts. Above/below seep areas	15	Establish release of CERCLA hazardous substances	TAL Metals (filtered/unfiltered) Wet Chemistry
Waste Water	NPDES Discharge to Red River (outfall # 002)	3	Determine Leachate Chemistry	TAL Metals (unfiltered) Wet Chemistry
Total Number of Samples		30		

* Evaluation of GW-to-SW migration route requires the release of CERCLA hazardous sustances to GW

** Wet Chemistry to included carbonate, bicarbonate

Table 8. Sampling Strategy for Surface Water Migration Pathway at Mine Waste Location: Phase I

Sample Type	Location	# Samples	Purpose	Analytes
Groundwater (GW)	Mill site Bottom of mine Mine generated water Red River POTW Hanson Crk. seep Fawn Lakes CG. Elephant Rock CG.	21	Establish Background Characteristics in Groundwater at Molycorp Mining Site	Target Analyte List (TAL) Metals (filtered/unfiltered) Wet Chemistry*
GW Seeps	1/4 mi. below Capulin Canyon Capulin Canyon 1/4 mi. above Capulin Canyon Goathill Gulch	12	Establish Release of CERCLA Hazardous Substances to Groundwater**; Establish Partial Attribution of Release	TAL Metals (filtered/unfiltered) Wet Chemistry
Surface Water (SW)	Above/below seep reaches Above/below/within Columbine Creek Above/below Hanson Crk. Above/below Sulphur Gulch Above/below Goathill Gulch	22	Establish release of CERCLA Hazardous Substances to Surface Water	TAL Metals (unfiltered) Wet Chemistry
	Above/below Sulphur Gulch Above/below Goathill Gulch	4	same as above	Target Compound List Organics

(Continued on next page)

Table 8 (cont.). Sampling Strategy for Surface Water Migration Pathway at Mine Waste Location: Phase I

Sample Type	Location	# Samples	Purpose	Analytes
Sediment	Same as Surface Water Locations	11	Establish release of CERCLA Hazardous Substances to Surface Water	TAL Metals
Soil	Hydrothermal Scars	2	Determine Metal Concentrations at Natural Hydrothermal Scar Areas	TAL Metals
Leachate from Waste Piles/ Hydrothermal Scars	Capulin Canyon Goathill Gulch Hydrothermal Scars	12	Determine Metal Concentrations at Natural Hydrothermal Scar Areas; Assist in Establishing Partial Attribution of Release	TAL Metals (filtered/unfiltered) Wet Chemistry

* Wet Chemistry to included carbonate, bicarbonate

** Evaluation of GW-to-SW migration route requires the release of CERCLA hazardous sustances to GW

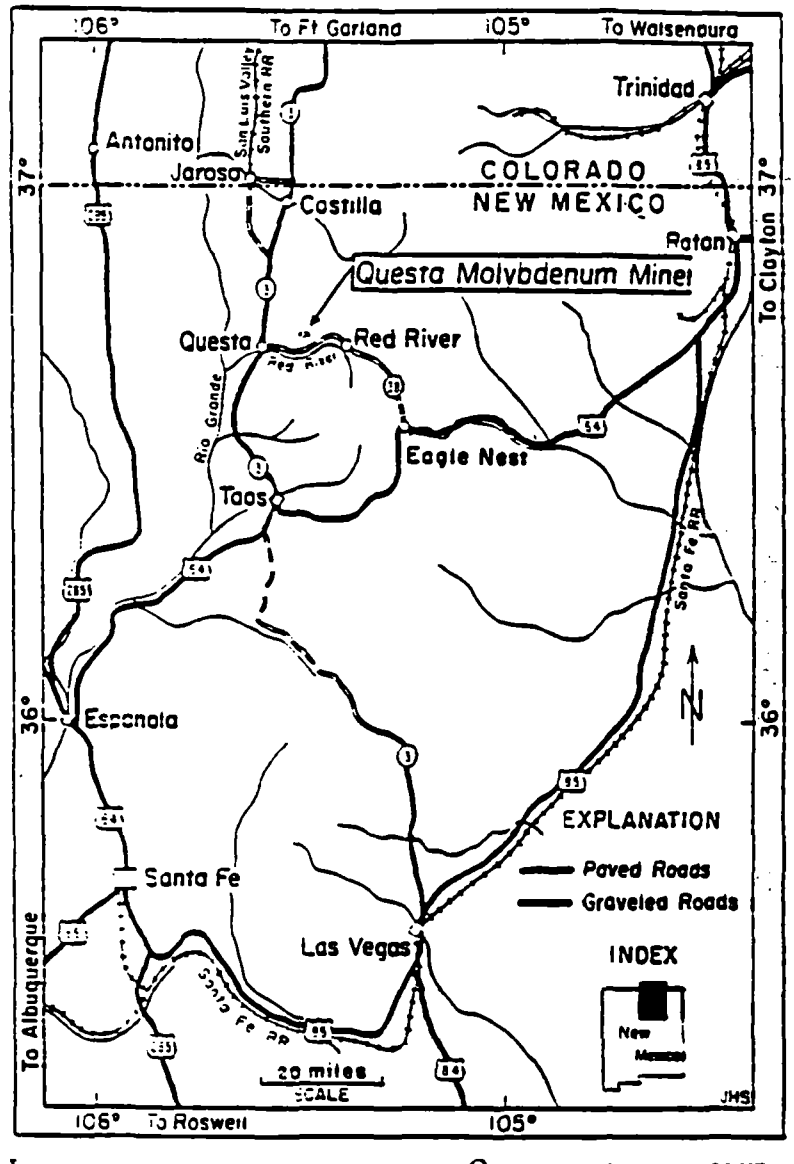
Table 9. Sampling Strategy for Air Migration Pathway at Tailings Ponds

Phase I NONE

Phase II

Sample Type	Location	# Samples	Purpose	Analytes
Air	Up-gradient monitor at fish hatchery Questa Jr. High School Between tailings ponds and gravel pit operation	3	Establish release of CERCLA hazardous substances & level of contamination	Target Analyte List (TAL) Metals
Total Number of Samples		3		

DRAFT



INDEX MAP SHOWING THE LOCATION OF THE QUESTA MOLYBDENUM MINE.

Figure 1 (from Ref. 15)

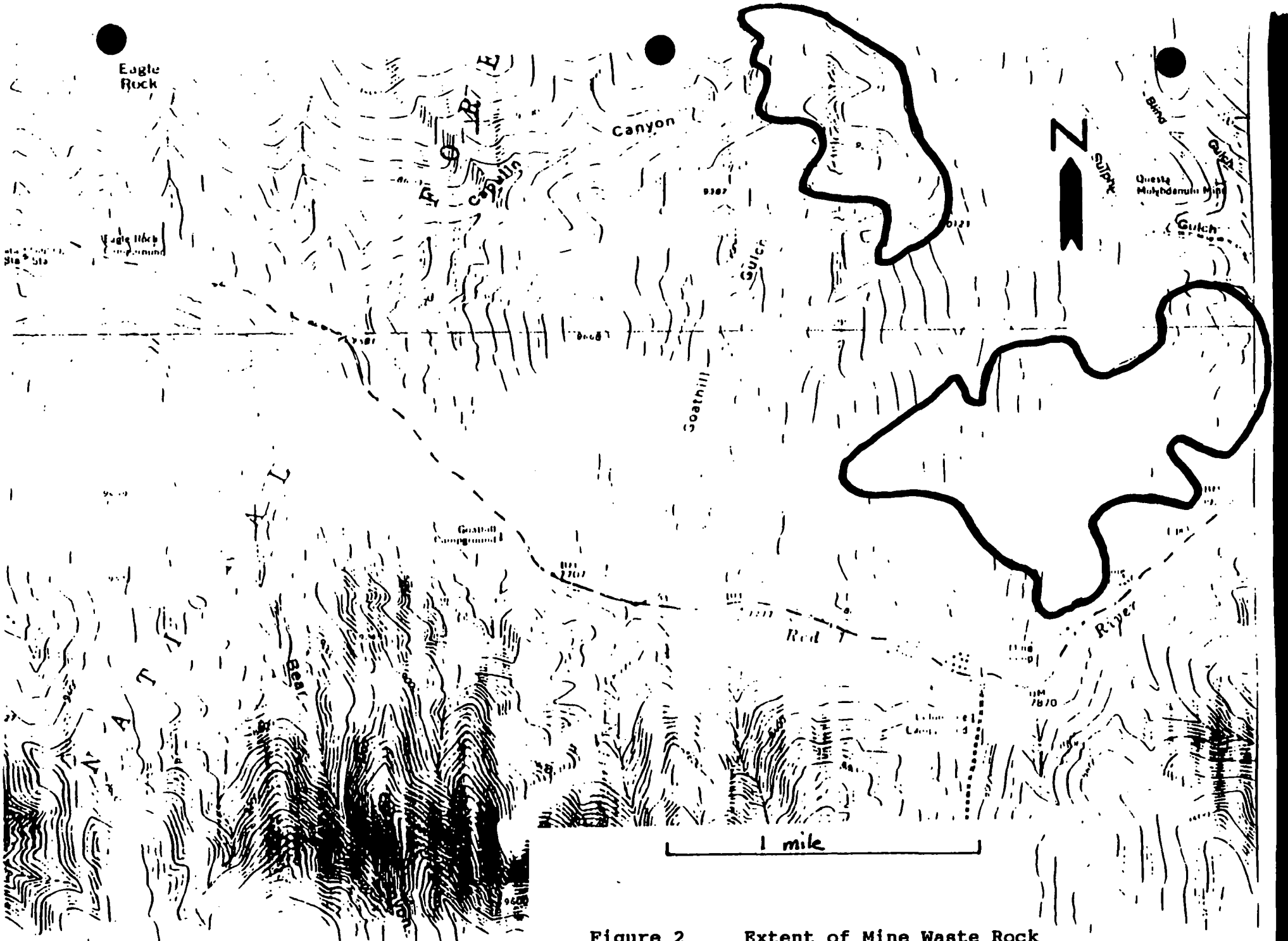


Figure 2 Extent of Mine Waste Rock
(Ref. 29, Drawing A)

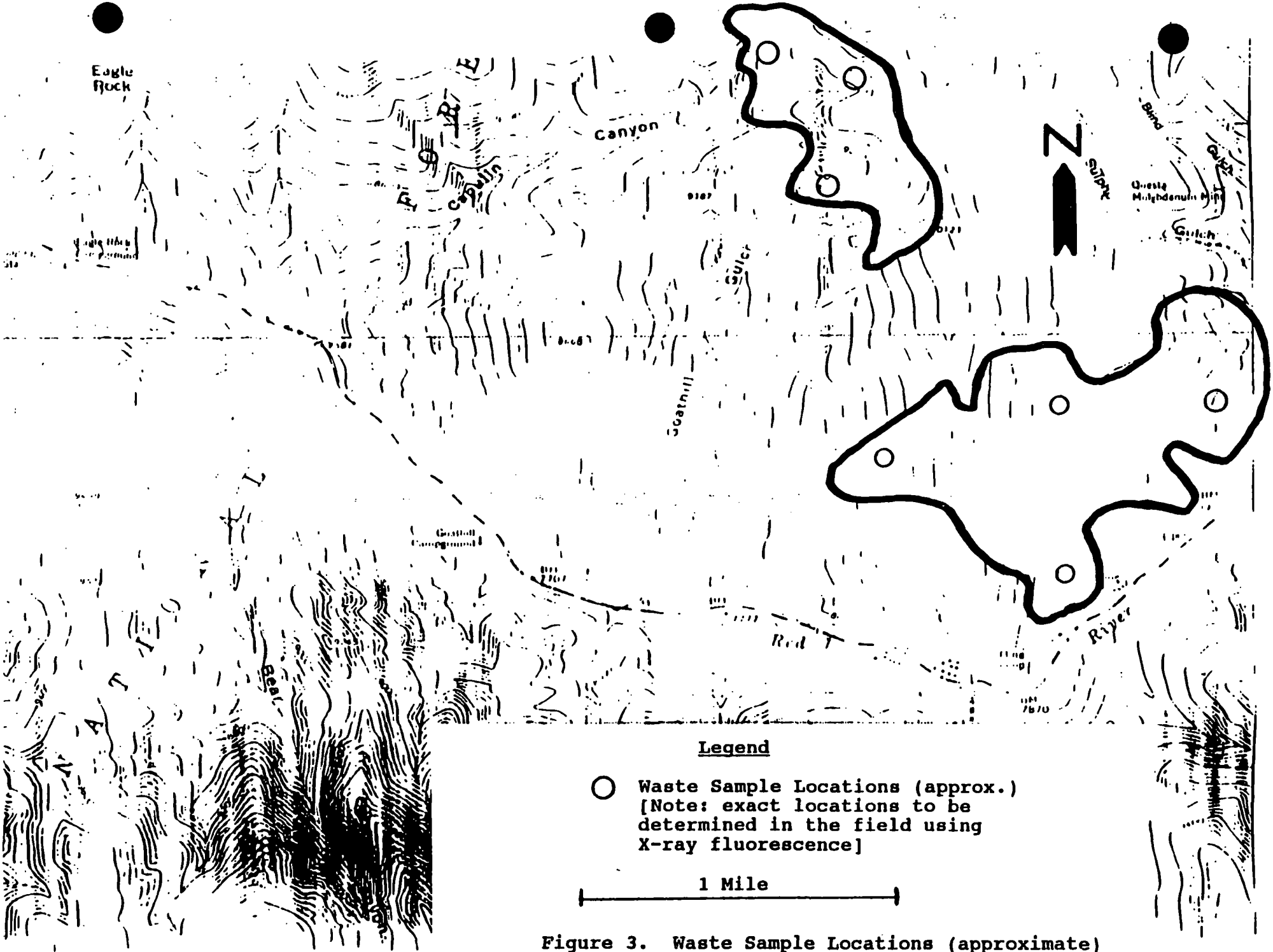


Figure 3. Waste Sample Locations (approximate) at the Mine Site

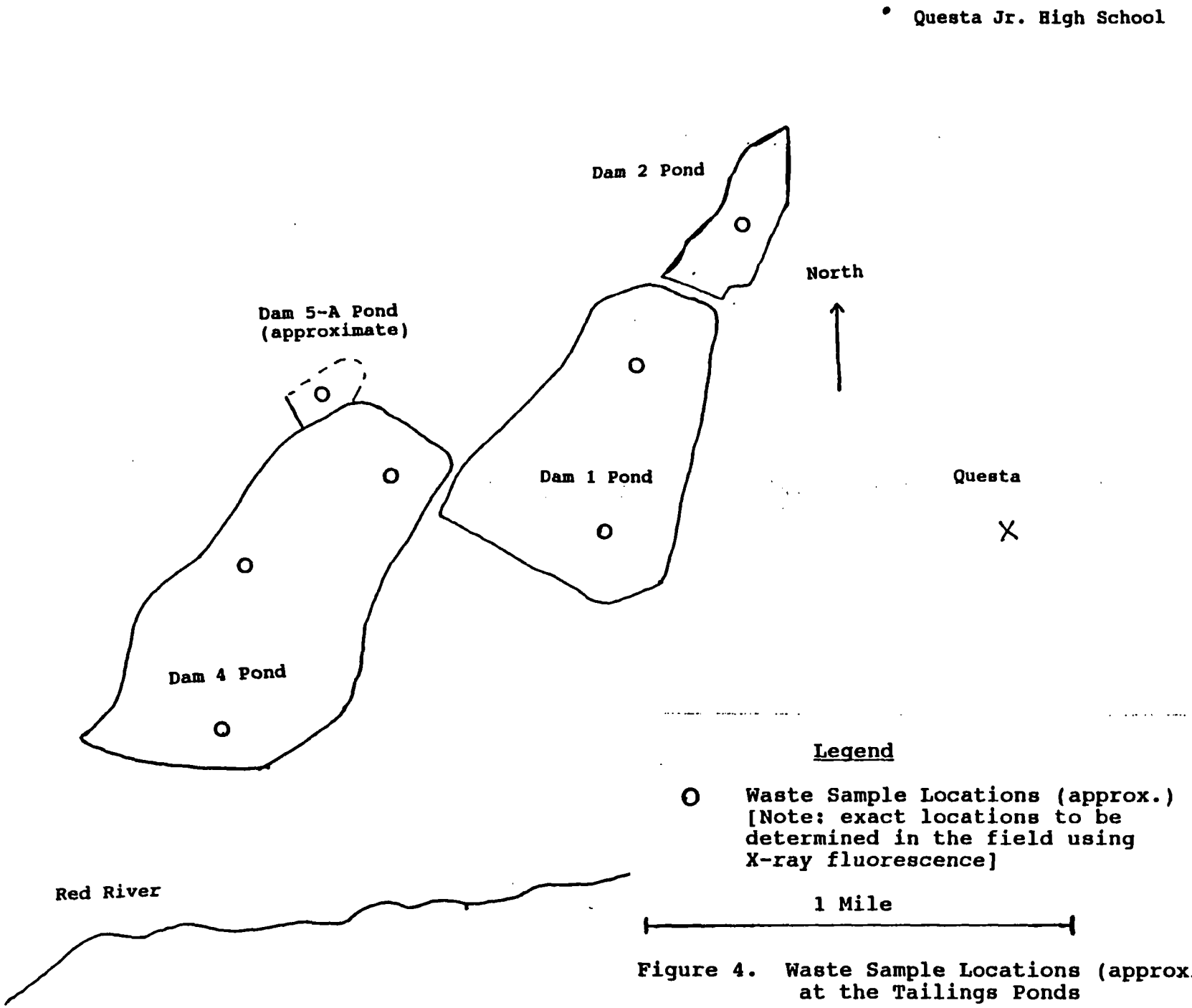


Figure 4. Waste Sample Locations (approximate) at the Tailings Ponds

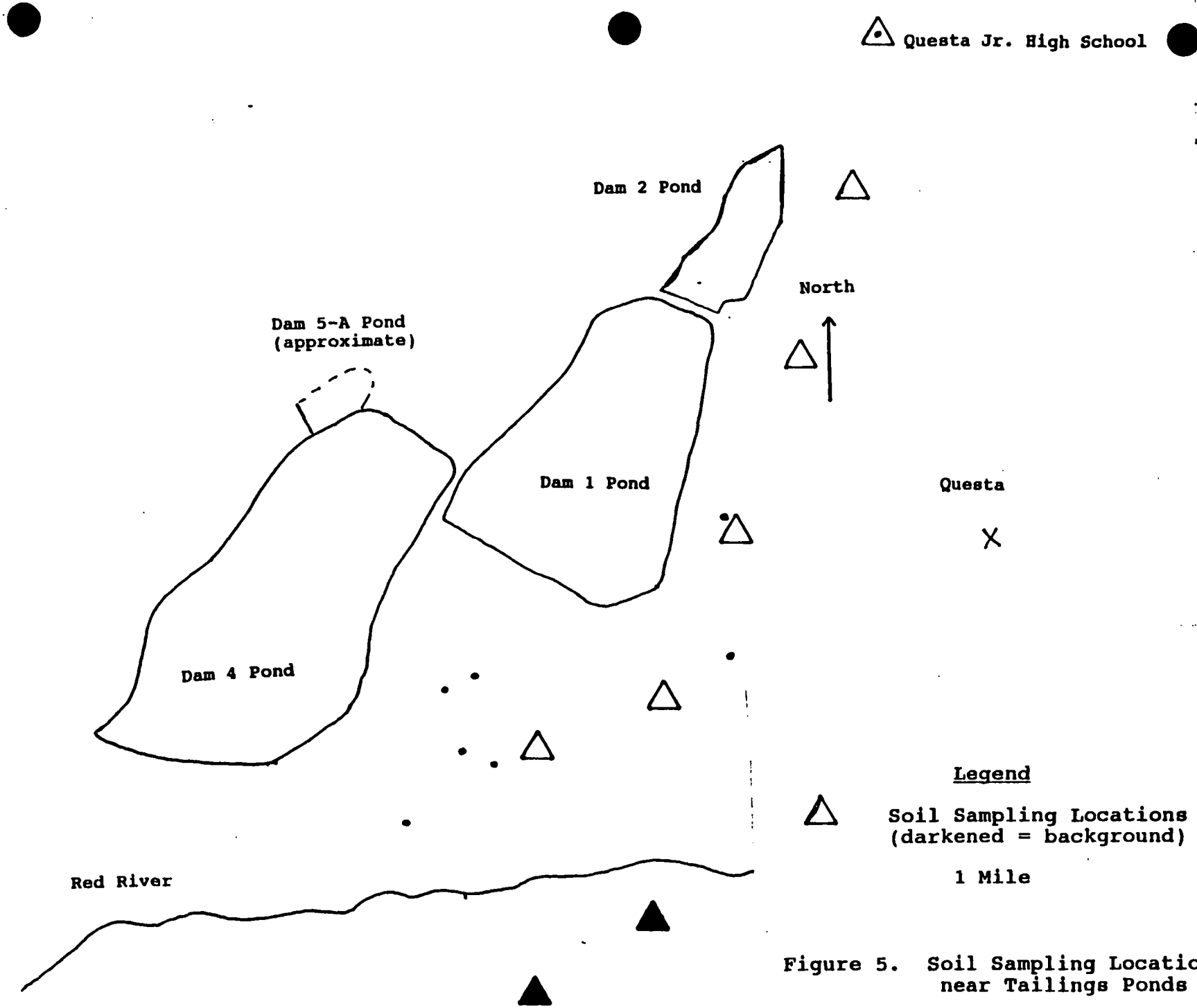


Figure 5. Soil Sampling Locations near Tailings Ponds

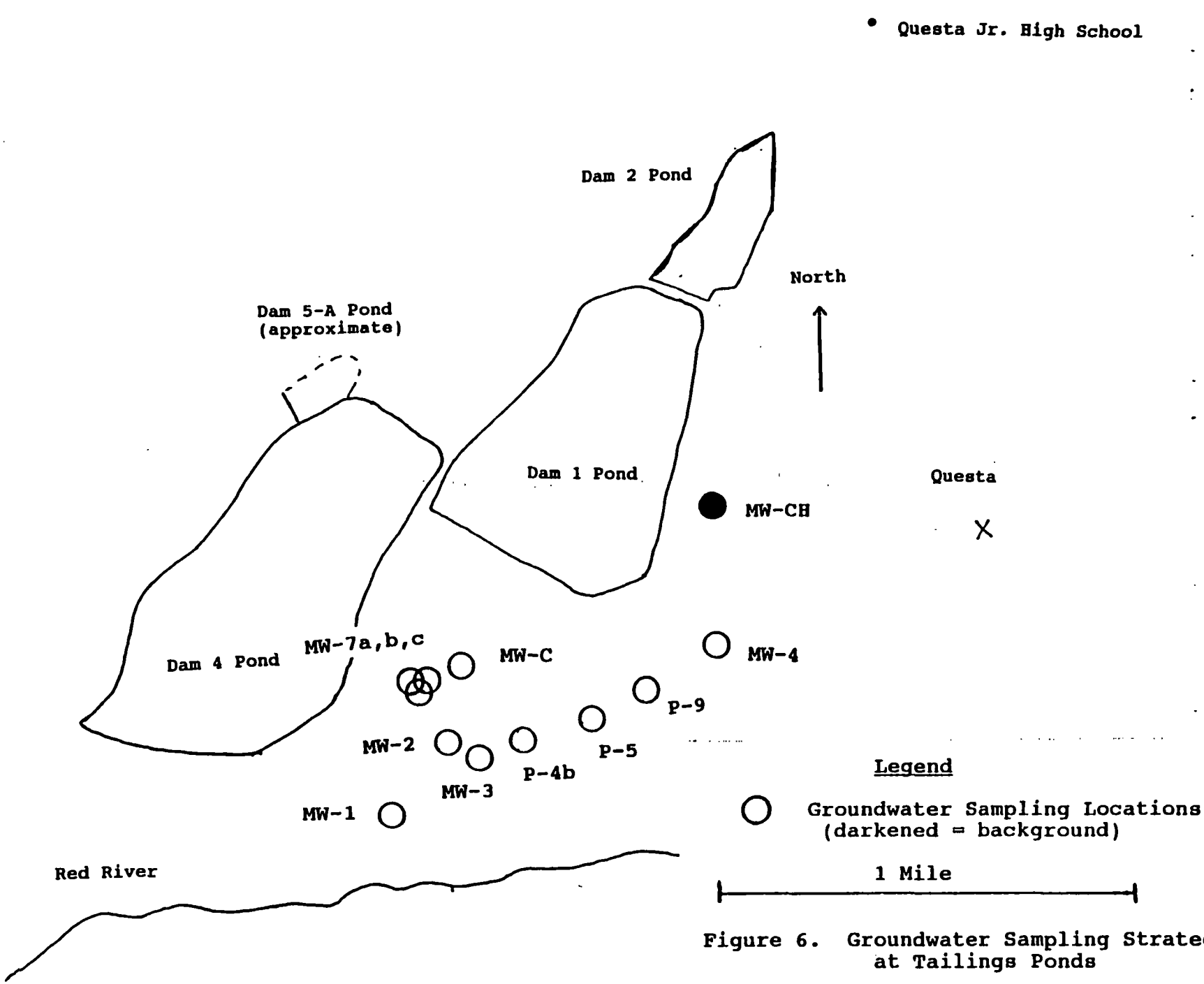


Figure 6. Groundwater Sampling Strategy at Tailings Ponds

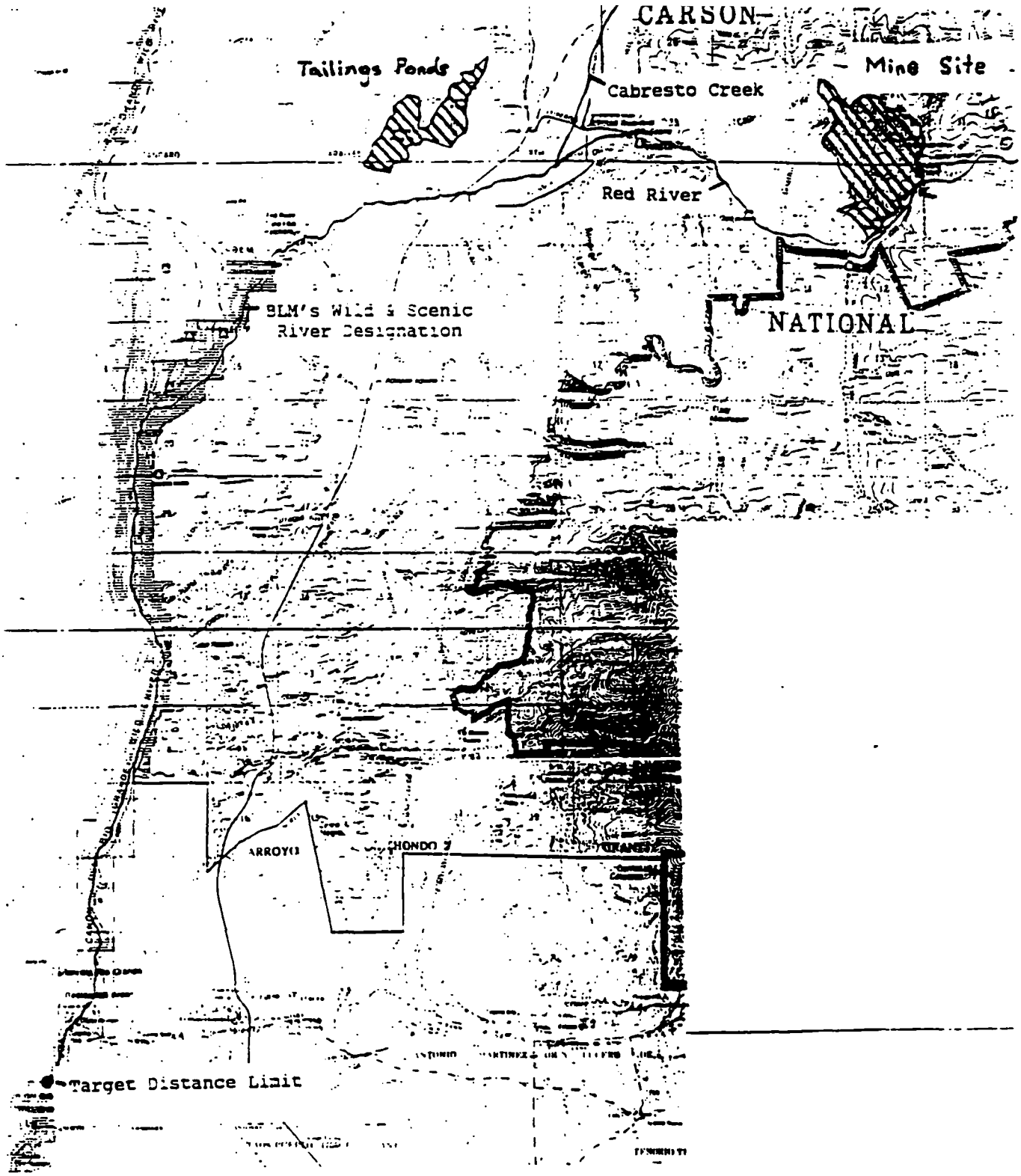


Fig. 7. Surface Water Migration Pathway: Environmental Targets and Target Distance Limit

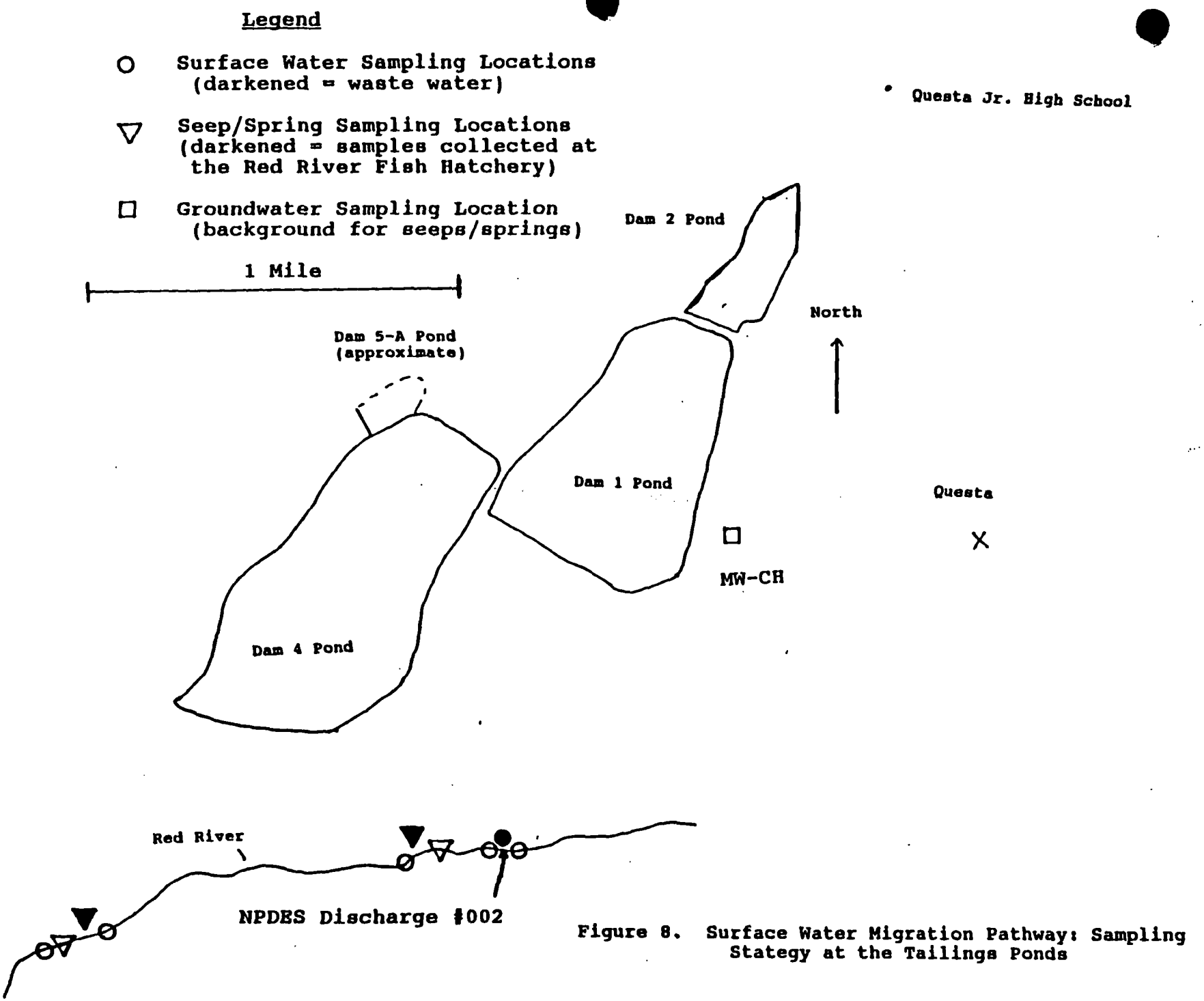


Figure 8. Surface Water Migration Pathway: Sampling Stategy at the Tailings Ponds

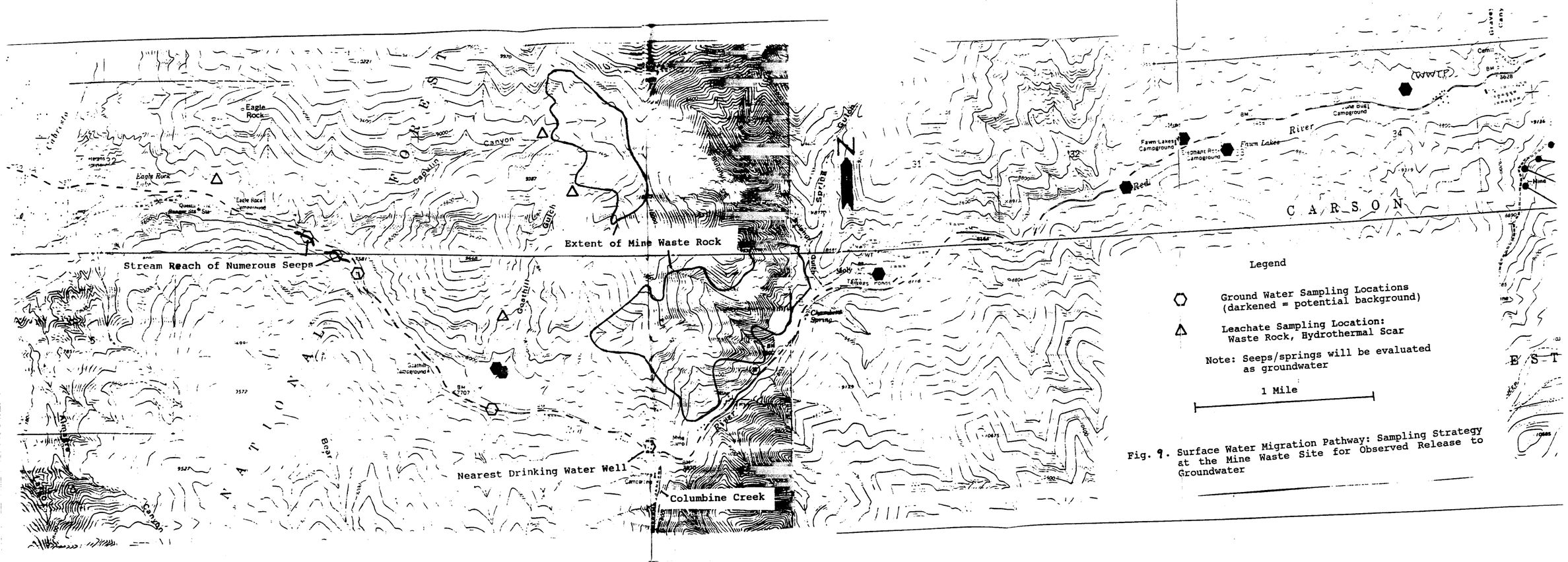


Fig. 9. Surface Water Migration Pathway: Sampling Strategy at the Mine Waste Site for Observed Release to Groundwater

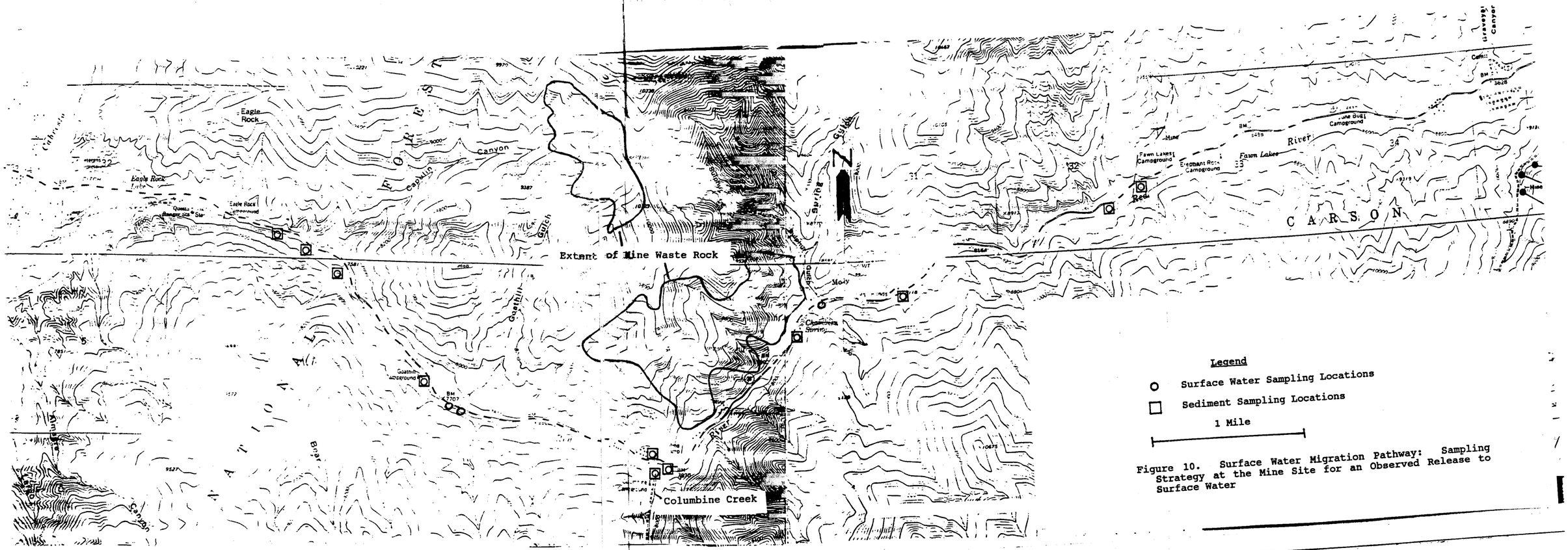


Figure 10. Surface Water Migration Pathway: Sampling Strategy at the Mine Site for an Observed Release to Surface Water

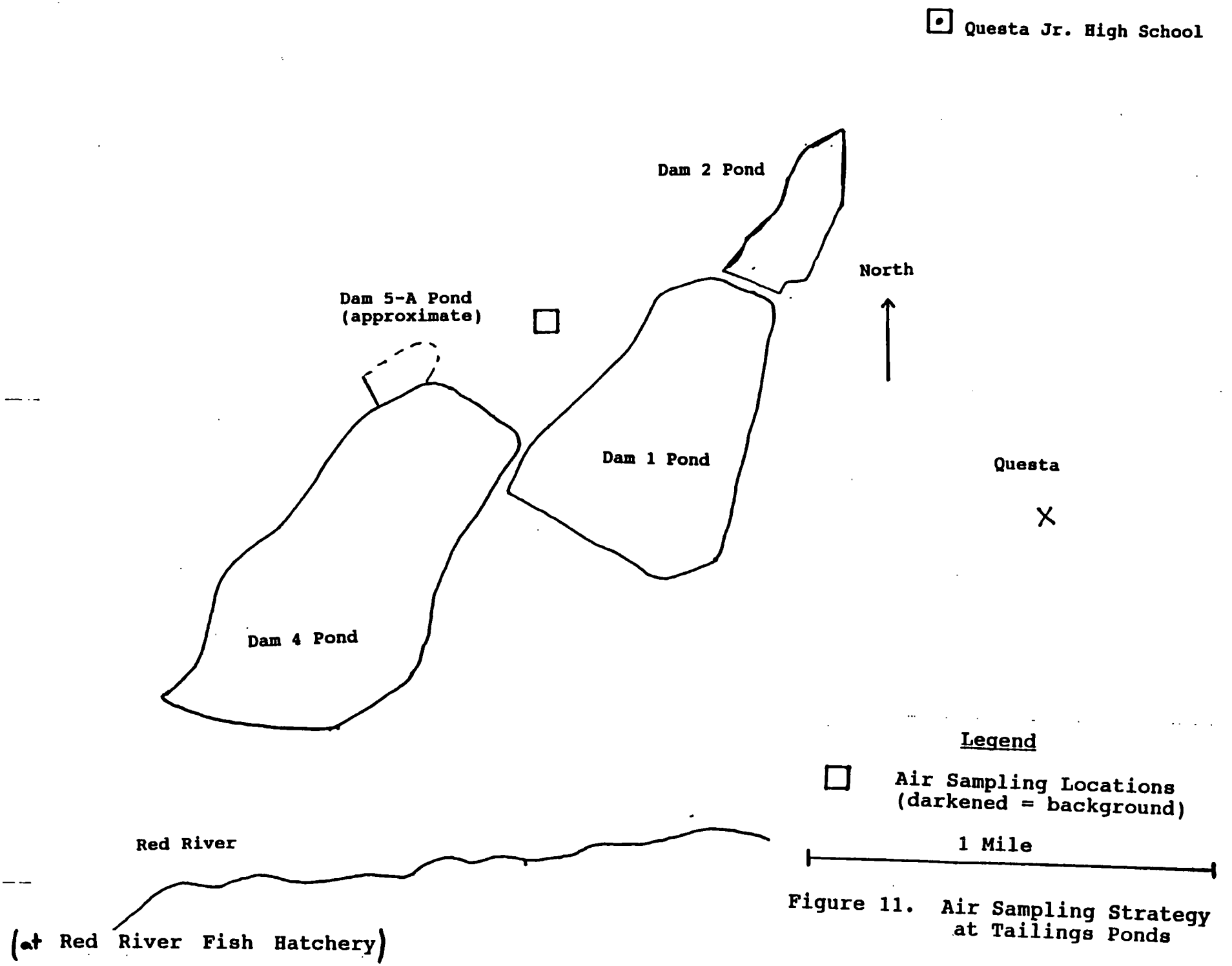


Figure 11. Air Sampling Strategy at Tailings Ponds

Reference 1

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETRE

L 40 FEET
AL DATUM OF 1929

MAP ACCURACY STANDARDS
ILORADO 80225, OR RESTON, VIRGINIA 22092
D SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

State Route

(EAGLE NEST)
4957 III SE

RED RIVER, N. MEX.

N3637.5—W10522.5/7.5

1963

AMS 4957 III NW—SERIES V881

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

40 FEET
FOOT CONTOURS
LEVEL

AP ACCURACY STANDARDS
ORADO 80225, OR WASHINGTON, D. C. 20242
SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

State Route

(ARROYO SECO)
4957 II SE

GUADALUPE MOUNTAIN, N. MEX.

N3637.5-W10537.5/7.5

1963

AMS 4957 II NW-SERIES V881

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

40 FEET
DATUM OF 1929

AP ACCURACY STANDARDS
ORADO 80225, OR RESTON, VIRGINIA 22092
SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Unimproved dirt

(RED RIVER PASS)
4957 III NE

LATIR PEAK, N. MEX.

36105-G4-TF-024

1963

DMA 4957 IV SW-SERIES V881

00

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

10 FEET
FOOT CONTOURS
LEVEL

IAP ACCURACY STANDARDS
.ORADO 80225, OR WASHINGTON, D. C. 20242
SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium duty — — — Light duty

Unimproved dirt

State Route

(RED RIVER)
4857 I II NW

CERRO, N. MEX.
N3645 - W10530/7.5

1963

AMS 4857 I SE-SERIES V881

0

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

10 FEET
FOOT CONTOURS
LEVEL

AP ACCURACY STANDARDS
ORADO 80225, OR WASHINGTON, D. C. 20242
YMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium-duty Light-duty

Unimproved dirt

( ) State Route

(WHEELER PEAK)
4857 I II SW

QUESTA, N. MEX.
N3637.5-W10530/7.5

1963

AMS 4857 II NE-SERIES V881

00

1 MILE

4000 5000 6000 7000 FEET

1 KILOMETER

20 FEET
FOOT CONTOURS
DATUM OF 1929

AP ACCURACY STANDARDS
ORADO 80225, OR RESTON, VIRGINIA 22092
SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Medium-duty — — — Light duty

Unimproved dirt

State Route

(QUESTA)
4857 II NE

SUNSHINE, N. MEX.
N3645 - W10537.5/7.5

1963

DMA 4857 I SW SERIES V881

Reference 2

A
WATER QUALITY SURVEY
RED RIVER OF THE RIO GRANDE
NEW MEXICO

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Federal Water Pollution Control Administration
Robert S. Kerr Water Research Center
Ada, Oklahoma

JANUARY 1966

A WATER QUALITY SURVEY

RED RIVER OF THE RIO GRANDE

NEW MEXICO

Prepared for

NEW MEXICO DEPARTMENT OF PUBLIC HEALTH

Santa Fe, New Mexico

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
ROBERT S. KERR WATER RESEARCH CENTER
ADA, OKLAHOMA

JANUARY 1966

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES	iv
I. INTRODUCTION	
Authority	I-1
Purpose and Scope	I-1
Acknowledgments	I-1
II. SUMMARY AND CONCLUSIONS	
Summary	II-1
Conclusions	II-1
III. DESCRIPTION OF THE PROJECT	
Location	III-1
Characteristics of the Drainage Area	III-1
Geological Factors	III-2
Streamflow Characteristics	III-3
IV. DESCRIPTION OF ANALYTICAL METHODS	
Chemical Methods - Laboratory	IV-1
Chemical Methods - Field	IV-2
Microbiological Methods	IV-3
Biological Methods	IV-4
V. PRESENTATION OF DATA	
Chemical Quality	V-1
Microbiological Quality	V-10
Biological Quality	V-12

TABLE OF CONTENTS (Continued)

Page

Groundwater Characteristics V-23

U. S. Geological Survey Flow Data V-26

Water Quality V-28

VI. BIBLIOGRAPHY

LIST OF TABLES

			Page
Table	V-1.	Water Quality Summary Sheet	V-2
	V-2.	Chemical Quality - Station 2	V-3
	V-3.	Chemical Quality - Station 3	V-4
	V-4.	Chemical Quality - Station 4	V-5
	V-5.	Chemical Quality - Station 5	V-6
	V-6.	Chemical Quality - Station 6	V-7
	V-7.	Chemical Quality - Station 7	V-8
	V-8.	Chemical Quality - Station 8	V-9
	V-9.	Bacteriological Results	V-11
	V-10.	Biological Summary	V-13
	V-11.	Biological Data, Station T	V-14
	V-12.	Biological Data, Station 2	V-15
	V-13.	Biological Data, Station 2-A	V-16
	V-14.	Biological Data, Station 3	V-17
	V-15.	Biological Data, Station 4	V-18
	V-16.	Biological Data, Station 5	V-19
	V-17.	Biological Data, Station 6	V-20
	V-18.	Biological Data, Station 7	V-21
	V-19.	Biological Data, Station 8	V-22
	V-20.	Description of Groundwater Sampling Points	V-24
	V-21.	Groundwater Analysis	V-25
	V-22.	Red River Flow Data	V-27

LIST OF FIGURES

		Following Page
Figure III-1.	Location Map	VI-1
III-2.	Flow Frequency Analysis of Red River . . .	III-3
V-1.	Chemical Analysis Versus River Stations . . .	V-1

I. INTRODUCTION

Authority

In a letter dated September 24, 1965, the New Mexico Department of Public Health requested that the Robert S. Kerr Water Research Center ". . . perform a stream survey on the Red River of the Rio Grande to determine the present quality of the stream."

This study was made under the provisions of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.).

Purpose and Scope

The results of this stream survey will serve as water quality background information for the purpose of determining the extent of any water quality degradation that might come as a result of increased activity along the watershed of the Red River.

Historically, the drainage basin for the Red River has been a lightly populated, mountain resort area. Heavy industry has been absent from the basin. At present the most significant water users are an exploratory molybdenum mine and mill, a State fish hatchery, and a small amount of irrigation (800 acres).

In the near future Red River Basin activities are expected to intensify. Presently, a molybdenum mine, mill, and tailings pond are under construction. These operations, together with the people employed by the construction contractor and mining company, have the potential to incur a significant pollutional problem to the water resources of the basin.

Realizing that Red River Basin activities will intensify, the State of New Mexico desires to initiate a surveillance program for the area. This water quality survey will provide the necessary background for that program.

Acknowledgments

The cooperation of many people and several agencies was necessary in this study. The efforts of the following are especially appreciated:

New Mexico Department of Public Health
New Mexico Fish and Wildlife Department
United States Geological Survey

II. SUMMARY AND CONCLUSIONS

Summary

The New Mexico Department of Public Health requested the U. S. Public Health Service to conduct a water quality study on the Red River near Questa, New Mexico.

In accordance with this request, personnel from the Robert S. Kerr Water Research Center, assisted by State personnel, investigated seven major sampling stations and seven minor spring and well stations along the main stem of the Red River from above the town of Red River to below the State fish hatchery near Questa.

The facilities of the New Mexico State Public Health Laboratory in Albuquerque were used during the study where some 80 water samples were analyzed.

A field biological and bacteriological laboratory was set up at the State fish hatchery near Questa, New Mexico, where the samples from all major stations were assayed.

Basic water quality measurements were made at each sampling station on two-hour intervals for three 8-hour sample days and one 24-hour sample day. Measurements were made using portable instruments.

The river flow was gauged near each of the seven main stem stations by the U. S. Geological Survey during the period of investigation.

Conclusions

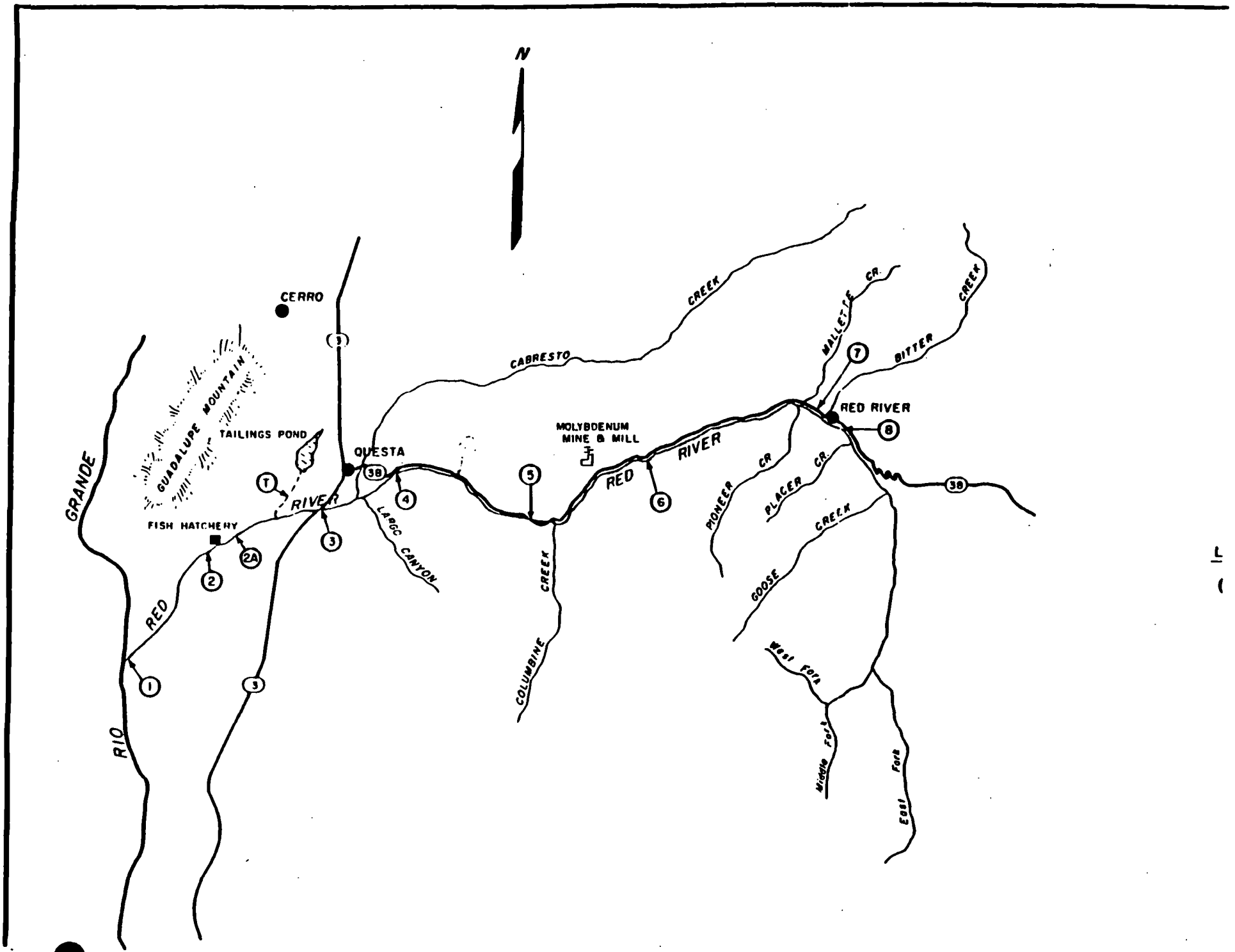
1. The chemical quality of the Red River water is exceptional. The water is suitable for a wide range of beneficial uses--domestic, industrial, and recreational, including the propagation of trout.

2. Microbiological quality of the river is generally good. Marginal fecal coliform pollution is indicated at Stations 2 and 7.

3. Biological conditions in the river are good. A biotic index of 11 or greater is indicated at all stations. A clean stream is described as a stream with a biotic index of 10 or greater.

4. Groundwater resources of the area are of high quality. Groundwater quality is comparable with the surface water, with the exception that total solids and chlorides are slightly higher.

5. The effect of even a small amount of untreated or inadequately treated waste would seriously degrade the water quality of the Red River due to its low average annual flow rate. Waste treatment must become a part of basin growth in order to preserve its high quality water. Surveillance of basic parameters at stations near the tailings pond and near Questa and Red River are desirable to detect water quality degradation as basin activities intensify.


N
CERRO
GUADALUPE MOUNTAIN
TAILINGS POND
FISH HATCHERY
QUESTA
RIO GRANDE
RED RIVER
LARGO CANYON
CABRESTO CREEK
COLUMBINE CREEK
MOLYBDENUM MINE & MILL
RED RIVER
PIONEER CR
PLACER CR
GOOSE CREEK
West Fork
Middle Fork
East Fork
WALLETTE CR.
BITTER CREEK
RED RIVER
38
1
2
2A
3
4
5
6
7
8
T

Reference 3

EID/SWQ-86/22

INTENSIVE SURVEY OF THE RED RIVER, TAOS COUNTY, NEW MEXICO

AUGUST 18-21, 1986

Larry R. Smolka and David F. Tague

Surveillance and Standards Section
Surface Water Quality Bureau
New Mexico Environmental Improvement Division
P.O. Box 968, Harold Runnels Building
1190 St. Francis Drive
Santa Fe, New Mexico 87504-0968

October 1987

EID-SWQ-86/22

INTENSIVE SURVEY OF THE RED RIVER, TAOS COUNTY, NEW MEXICO AUGUST 18-21, 1986

LARRY R. SMOLKA AND DAVID F. TAGUE

Surveillance and Standards Section
Surface Water Quality Bureau
New Mexico Environmental Improvement Division
P.O. Box 968, Harold Runnels Building
1190 St. Francis Drive
Santa Fe, New Mexico 87504-0968

October 1987

SUMMARY AND CONCLUSIONS

During the period of August 18-21, 1986, the Surveillance and Standards Section conducted a 4-day survey of a twenty-three mile reach of the Red River in water quality standards segments 2-119 and 2-120 (Fig. 1). The objectives of the survey were: (1) to assess the water quality of the Red River, (2) to ascertain what effects, if any, the discharges from the Red River wastewater treatment facility, the Questa wastewater ponds, and Molycorp have on the water quality of the Red River, (3) to determine whether water quality standards are being attained, and (4) to evaluate the biological integrity of this reach by inventorying the macroinvertebrate community. Chemical, physical, and biological data collected during this

survey are presented and discussed in this report. Conclusions reached were as follows:

1. The water quality of the Red River is generally good; exceptions are noted below.

2. The Red River WWTF discharges an effluent of excellent quality with no apparent effect on the river.

3. Concentrations of aluminum, iron, and manganese ranged 500-2,500 µg/l below the town of Red River. Low concentrations of zinc and copper were also found in this reach of the river. Molybdenum was elevated below the Molycorp outfall. Except for aluminum the ambient concentrations of these constituents were below the U.S. Environmental Protection Agency's criteria for the protection of human health and freshwater aquatic life.

4. During a thunderstorm runoff event which occurred during the survey, large increases in total non-filterable residue, turbidity, phosphorus, calcium, sulfate, total filterable residue, arsenic, barium, chromium, lead, silver, copper, manganese, molybdenum, nickel, iron, and aluminum were observed for a one-hour period in the Red River. The event also lowered pH from 8.1 to 3.8.

5. The thunderstorm runoff event observed during the survey resulted in violations of water quality standards for turbidity, pH, arsenic, barium, chromium, and lead in segment 2-120. During this event the domestic water-supply use of this segment was not attained.

6. The benthic macroinvertebrate communities of the Red River were indicative of a high quality mountain stream. Though diverse, sharply reduced numbers of macroinvertebrates in the reach between Red River and Questa may be attributable to periodically recurring aluminum-pH toxicity and, possibly, habitat restriction due to adsorption and co-precipitation of aluminum compounds.

7. The Red River below the fish hatchery supports a stable, reproducing trout fishery. The river between Red River and Questa, however, supports only a "put and take" fishery; this reach has very poor potential as habitat for reproducing trout. Impairment of fishery in this reach may be due in part to the paucity of both macroinvertebrates and spawning substrate.

8. Low pH values and high inputs of numerous elements into the river during thunderstorm runoff may be due to the characteristics of soils of the catchment. We postulate the following scenario. During runoff sulfides in eroding soils ~~hydrolyze~~ oxidize to sulfuric acid. The H^+ acidity thereby produced mobilizes trace elements and sharply reduces pH in the river. Downstream these materials precipitate or adsorb as pH returns to circumneutral values.

ACKNOWLEDGEMENTS

Dr. Gerald Jacobi of New Mexico Highlands University analyzed the macroinvertebrate samples for taxonomic composition, calculated the densities and diversities of taxa, prepared the tables, and wrote the section interpreting the results of this work. Robin Gelston-Walls (USEPA,

Reference 4

EID/SWQ-88/8

INTENSIVE WATER QUALITY SURVEY OF THE MIDDLE RED RIVER, TAOS COUNTY, NEW MEXICO

September 12 - October 25, 1988

Larry R. Smolka and David F. Tague

Surveillance and Standards Section
Surface Water Quality Bureau
Environmental Improvement Division
Harold Runnels Building
1190 St. Francis Drive
Santa Fe, New Mexico 87503

May 1989

SUMMARY AND CONCLUSIONS

During a 6-week period, September 12 through October 25, 1988, the Surveillance and Standards Section conducted an 8-day survey of a twenty-five mile reach of the Red River in water quality standards segments 2-119 and 2-120 (Fig. 1). The objectives of the survey were: (1) to assess the water quality of the Red River by sampling both water and sediments, (2) to evaluate the biological integrity of this reach by inventorying the diatom, macroinvertebrate, and fish communities, (3) to determine whether water or sediments from the Red River are toxic to invertebrates or fishes, and (4) to quantify ground-water influx between Zwergle Dam and the Questa Ranger Station. Chemical, physical, and biological data collected during this survey are presented and discussed in this report. Conclusions reached were as follows:

1. The water quality of the Red River is generally good, but exceptions are noted below.

2. During a rainstorm runoff event which occurred in the Bitter Creek drainage basin during the survey, the survey team measured increases in non-filterable residue, turbidity, total phosphorus, copper, lead, iron, zinc, manganese, and aluminum in the Red River below Bitter Creek. These increases resulted in 21 violations of the numeric standards of segment 2-120, including a pH of 5.7, and 26 exceedances of the U.S. Environmental Protection Agency's chronic or acute freshwater criteria for iron, lead, copper, and zinc. The exceedances of criteria occurred in the unfiltered samples, but not in the filtered samples, suggesting that metals were adsorbed to soil particles mobilized during the runoff event.

3. Episodic surface runoff continually erodes and oxidizes the sulfide-rich volcanic soils of barren, south-facing slopes. The strong acid formed in this process aids in mobilizing and transporting trace elements to the Red River and also temporarily reduces the pH of the river. Downstream these materials precipitate or adsorb as the pH of the river returns to near-neutral values.

4. Biomonitoring performed on water and sediments from seven stations using Daphnia pulex, trout fry, and fathead minnows, with one exception, showed no acute or chronic toxicity. An acute toxicity test of sediment eluate from Bitter Creek produced 60% mortality of Daphnia pulex.

5. Biological assessment of the Red River showed sharply reduced numbers of diatoms and benthic macroinvertebrates between the southeast Molycorp boundary and the Questa Ranger Station. At the Questa Ranger Station the survey team found no fish and an 80% reduction in numbers of benthic macroinvertebrates.

6. Historic and recent disturbances in the drainage basin of the Red River continue to contribute to the mobilization and transport of sediment-associated materials to the river.

ACKNOWLEDGMENTS

Dr. Gerald Jacobi of New Mexico Highlands University collected and analyzed the macroinvertebrate samples for taxonomic composition, calculated the densities and diversities of taxa, and prepared the tables summarizing the results. Bob Akroyd, Mike Hatch, and Jim Grasmick of the New Mexico Department of Game and Fish performed the electroshocking survey of the Red River included in this report. Herb Garn and Linda Garrabrant of the U.S. Geological Survey measured streamflows for the seepage study. Henry Holman, Mike Bastian, and William Lane from the USEPA Region VI office collected the water and sediment samples for biological toxicity studies performed in Houston, Texas, and at the Red River fish hatchery. Andrea Gallegos performed the word processing needed to prepare this manuscript. Danny Davis assisted in the collection of the water quality data and performed the diatom identifications. The Scientific Laboratory Division performed the analyses for water chemistry and the Red River fish hatchery provided equipment, facilities, and personnel for the trout toxicity tests and fish studies. Each one of these people and agencies contributed importantly to the informational value of this report and their efforts are gratefully appreciated and acknowledged.

Table A2. Continued.

STORET RETRIEVAL DATE 89/02/27
URG120.028045 URG120028045
36 41 55.0 105 28 46.0 5
RED RIVER ABOVE MOLYCORPS BOUNDARY
35055 NEW MEXICO TAOS
WESTERN GULF 120900
UPPER RIO GRANDE ABOVE THE PECOS RIVER /TYPA/AMBNT/STREAM/BIO
21NMEX 881217 13020101
0000 FEET DEPTH 2490 METERS ELEVATION

21M SOUT

DATE FROM TO		71900 MERCURY HG,TOTAL UG/L	71890 MERCURY HG,DISS UG/L	01147 SELENIUM SE,TOT UG/L	01145 SELENIUM SE,DISS UG/L	01077 SILVER AG,TOT UG/L	01075 SILVER AG,DISS UG/L	01042 COPPER CU,TOT UG/L	01040 COPPER CU,DISS UG/L	01045 IRON FE,TOT UG/L	01046 IRON FE,DISS UG/L
88/09/13	1040	0.5	0.5	5	5	1	1	100	50	33000	50
88/09/20	1015	0.5	0.5	5	5	1	1	50	50	540	50
88/09/26	0915	0.5	0.5	5	5	1	1	50	50	350	50
88/10/25	1300	0.5		5		1		50		230	
00/00/00											
STATION	NUMBER	4	3	4	3	4	3	4	3	4	3
	MAXIMUM	0.5	0.5	5	5	1	1	100	50	33000	50
	MINIMUM	0.5	0.5	5	5	1	1	50	50	230	50
	MEAN	0.5	0.5	5	5	1	1	63	50	8530	50
	STAND DEV	0.0	0.0	0	0	0	0	25	0	16314	0
	STAND ERR	0.0	0.0	0	0	0	0	13	0	8157	0

21M SOUT

DATE FROM TO		01055 MANGNESE MN UG/L	01056 MANGNESE MN,DISS UG/L	01062 MOLY MO,TOT UG/L	01060 MOLY MO,DISS UG/L	01067 NICKEL NI,TOTAL UG/L	01065 NICKEL NI,DISS UG/L	01092 ZINC ZN,TOT UG/L	01090 ZINC ZN,DISS UG/L	01105 ALUMINUM AL,TOT UG/L	01106 ALUMINUM AL,DISS UG/L
88/09/13	1040	620	360	10	10	50	50	150	50	8900	50
88/09/20	1015	100	90	10	10	50	50	50	50	600	140
88/09/26	0915	100	110	10	10	50	50	50	50	700	100
88/10/25	1300	150		10				50		1075	
00/00/00											
STATION	NUMBER	4	3	4	3	3	3	4	3	4	3
	MAXIMUM	620	360	10	10	50	50	150	50	8900	140
	MINIMUM	100	90	10	10	50	50	50	50	600	50
	MEAN	243	187	10	10	50	50	75	50	2819	97
	STAND DEV	253	150	0	0	0	0	50	0	4059	45
	STAND ERR	126	87	0	0	0	0	25	0	2030	26

99/99/99

Table A2. Continued.

STORET RETRIEVAL DATE 89/02/27
URG120.028040
36 40 52.0 105 30 53.0 5
RED RIVER ABOVE COLUMBINE CREEK
35055 NEW MEXICO TAOS
WESTERN GULF 120900
UPPER RIO GRANDE ABOVE THE PECOS RIVER /TYPA/AMBNT/STREAM/BIO
21NMEX 881217 13020101
0000 FEET DEPTH 2397 METERS ELEVATION

21M SOUT

DATE FROM TO	71900 MERCURY HG,TOTAL UG/L	71890 MERCURY HG,DISS UG/L	01147 SELENIUM SE,TOT UG/L	01145 SELENIUM SE,DISS UG/L	01077 SILVER AG,TOT UG/L	01075 SILVER AG,DISS UG/L	01042 COPPER CU,TOT UG/L	01040 COPPER CU,DISS UG/L	01045 IRON FE,TOT UG/L	01046 IRON FE,DISS UG/L
88/09/13 1055	0.5	0.5	5	5	1	1	110	50	45000	50
88/09/20 1035	0.5	0.5	5	5	1	1	50	50	1000	50
88/09/26 0925	0.5	0.5	5	5	1	1	50	50	400	50
88/10/25 1425	0.5		5		1		50		530	
00/00/00										
STATION NUMBER	4	3	4	3	4	3	4	3	4	3
MAXIMUM	0.5	0.5	5	5	1	1	110	50	45000	50
MINIMUM	0.5	0.5	5	5	1	1	50	50	400	50
MEAN	0.5	0.5	5	5	1	1	65	50	11733	50
STAND DEV	0.0	0.0	0	0	0	0	30	0	22180	0
STAND ERR	0.0	0.0	0	0	0	0	15	0	11090	0

21M SOUT

DATE FROM TO	01055 MANGNESE MN UG/L	01056 MANGNESE MN,DISS UG/L	01062 MOLY MO,TOT UG/L	01060 MOLY MO,DISS UG/L	01067 NICKEL NI,TOTAL UG/L	01065 NICKEL NI,DISS UG/L	01092 ZINC ZN,TOT UG/L	01090 ZINC ZN,DISS UG/L	01105 ALUMINUM AL,TOT UG/L	01106 ALUMINUM AL,DISS UG/L
n event — 88/09/13 1055	740	390	20	10	50	50	180	50	12000	70
Not used 88/09/20 1035	110	80	10	10	50	50	50	50	800	120
88/09/26 0925	110	100	10	10	50	50	50	50	700	100
88/10/25 1425	150		10				50		770	
00/00/00										
STATION NUMBER	4	3	4	3	3	3	4	3	4	3
MAXIMUM	740	390	20	10	50	50	180	50	12000	120
MINIMUM	110	80	10	10	50	50	50	50	700	70
MEAN	278	190	13	10	50	50	83	50	3568	97
STAND DEV	309	173	5	0	0	0	65	0	5622	25
STAND ERR	154	100	3	0	0	0	33	0	2811	15
99/99/99										

$\bar{x}$ 123 $\bar{x}$ 90 $\bar{x}$ 50 $\bar{x}$ 50 $\bar{x}$ 757 $\bar{x}$ 110

Table A2. Continued.

STORET RETRIEVAL DATE 89/02/27
URG120.028035
36 40 50.0 105 30 53.0 5
COLUMBINE CREEK ABOVE THE ~~PECOS~~ Red RIVER
35055 NEW MEXICO TAOS
WESTERN GULF 120900
UPPER RIO GRANDE ABOVE THE PECOS RIVER /TYPA/AMBNT/STREAM/BIO
21NMEX 881217 13020101
0000 FEET DEPTH 2397 METERS ELEVATION

DATE FROM TO	00010 WATER TEMP CENT	00095 CNDUCTVY AT 25C MICROMHO	21M SOUT 00300 DO MG/L	00400 PH SU	82079 TURBIDTY LAB NTU	00665 PHOS-TOT MG/L P	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3+NH4- N TOTAL MG/L	00612 UN-IONZD NH3-N MG/L	00625 TOT KJEL N MG/L
88/10/25 1410	6.5	130	9.5	8.1	1	0.01	0.14	0.10	0.00	0.37

DATE FROM TO	00640 T INORG. NITROGEN MG/L N	00605 ORG N N MG/L	21M SOUT 00600 TOTAL N N MG/L	00530 RESIDUE TOT NFLT MG/L	70300 RESIDUE DISS-180 C MG/L	00410 T ALK CACO3 MG/L	00440 HCO3 ION HCO3 MG/L	00915 CALCIUM CA,DISS MG/L	00940 CHLORIDE TOTAL MG/L	00925 MGNSIUM MG,DISS MG/L
88/10/25 1410	0.24	0.27	0.51	3	90	66	81	32	5	0.0

DATE FROM TO	00935 PTSSIUM K,DISS MG/L	00930 SODIUM NA,DISS MG/L	21M SOUT 00945 SULFATE SO4-TOT MG/L	00900 TOT HARD CACO3 MG/L	00680 T ORG C C MG/L
88/10/25 1410	1.0	2	7	80	

DATE FROM TO	01002 ARSENIC AS,TOT UG/L	01000 ARSENIC AS,DISS UG/L	01007 BARIUM BA,TOT UG/L	01005 BARIUM BA,DISS UG/L	01027 CADMIUM CD,TOT UG/L	01025 CADMIUM CD,DISS UG/L	01034 CHROMIUM CR,TOT UG/L	01030 CHROMIUM CR,DISS UG/L	01051 LEAD PB,TOT UG/L	01049 LEAD PB,DISS UG/L
88/10/25 1410	5		50		1		5		5	

DATE FROM TO	71900 MERCURY HG,TOTAL UG/L	71890 MERCURY HG,DISS UG/L	21M SOUT 01147 SELENIUM SE,TOT UG/L	01145 SELENIUM SE,DISS UG/L	01077 SILVER AG,TOT UG/L	01075 SILVER AG,DISS UG/L	01042 COPPER CU,TOT UG/L	01040 COPPER CU,DISS UG/L	01045 IRON FE,TOT UG/L	01046 IRON FE,DISS UG/L
88/10/25 1410	0.5		5		1		50		50	

DATE FROM TO	01055 MANGNESE MN UG/L	01056 MANGNESE MN,DISS UG/L	21M SOUT 01062 MOLY MO,TOT UG/L	01060 MOLY MO,DISS UG/L	01067 NICKEL NI,TOTAL UG/L	01065 NICKEL NI,DISS UG/L	01092 ZINC ZN,TOT UG/L	01090 ZINC ZN,DISS UG/L	01105 ALUMINUM AL,TOT UG/L	01106 ALUMINUM AL,DISS UG/L
88/10/25 1410	50		10				50		90	

Table A2. Continued.

STORET RETRIEVAL DATE 89/05/08
URG120.026030 URG120020010
36 41 19.0 105 32 25.0 5
RED RIVER AT THE GOAT HILL CAMPGROUND
35055 NEW MEXICO TAOS
WESTERN GULF 120900
UPPER RIO GRANDE ABOVE THE PECOS RIVER /TYPA/AMBNT/STREAM/BIO
21NWEX 881217 13020101
0000 FEET DEPTH 2324 METERS ELEVATION

21M SOUT

DATE FROM TO	00010 WATER TEMP CENT	00095 CNDUCTVY AT 25C MICROMHO	00300 DO MG/L	00400 PH SU	82079 TURBIDITY LAB NTU	00665 PHOS-TOT MG/L P	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3+NH4- N TOTAL MG/L	00640 T INORG. NITROGEN MG/L N	00625 TOT KJEL N MG/L
88/10/25 1520	0.1	287	8.9	7.5						

DATE FROM TO	00945 SULFATE SO4-TOT MG/L	00680 T ORG C C MG/L	00900 TOT HARD CACO3 MG/L	00940 CHLORIDE TOTAL MG/L	01105 ALUMINUM AL,TOT UG/L	70300 RESIDUE DISS-180 C MG/L	00945 SULFATE SO4-TOT MG/L	00925 MGNSIUM MG,DISS MG/L	00915 CALCIUM CA,DISS MG/L	00935 PTSSIUM K,DISS MG/L
88/10/25 1520			159.0	5.0	1050	214	72.8	4.6	56.0	2.0

21M SOUT

DATE FROM TO	00930 SODIUM NA,DISS MG/L	00440 HCO3 ION HCO3 MG/L	00410 T ALK CACO3 MG/L	31616 FEC COLI MFM-FCBR /100ML	01002 ARSENIC AS,TOT UG/L	01092 ZINC ZN,TOT UG/L	01007 BARIUM BA TOT UG/L	01027 CADMIUM CD,TOT UG/L	01034 CHROMIUM CR,TOT UG/L	01051 LEAD PB,TOT UG/L
88/10/25 1520	5.0	65.0	53.0		5	50	50	1	5	5

21M SOUT

DATE FROM TO	71900 MERCURY HG,TOTAL UG/L	01147 SELENIUM SE,TOT UG/L	01077 SILVER AG,TOT UG/L	01042 COPPER CU,TOT UG/L	01045 IRON FE,TOT UG/L	01055 MANGNESE MN UG/L	01062 MOLY MO,TOT UG/L
88/10/25 1520	0.5	5	1	50	420	270	10

Table A2. Continued.

STORET RETRIEVAL DATE 89/02/27
HRG24 URG120028025 08265000
36 42 12.0 105 34 04.0 4
LOWER RED RIVER AT USGS GAGE = USFS Ranger Station
35055 NEW MEXICO TAOS
120991
/TYPA/AMBNT/STREAM
21NMEX 13020101028 0001.250 ON
0003 FEET DEPTH

DATE FROM TO	71900 MERCURY HG,TOTAL UG/L	71890 MERCURY HG,DISS UG/L	01147 SELENIUM SE,TOT UG/L	01145 SELENIUM SE,DISS UG/L	01077 SILVER AG,TOT UG/L	01075 SILVER AG,DISS UG/L	01042 COPPER CU,TOT UG/L	01040 COPPER CU,DISS UG/L	01045 IRON FE,TOT UG/L	01046 IRON FE,DISS UG/L
88/03/25 1500	0.5		5		1		60		340	
88/09/13 1115	0.5	0.5	5	5	2	1	130	50	45000	50
88/09/20 1100	0.5	0.5	5	5	1	1	~~50~~	50	590	50
88/09/26 0940	0.5	0.5	5	5	1	1	50	50	440	50
88/10/25 1615	0.5		5		1		50		440	
00/00/00										
STATION NUMBER	5	3	5	3	5	3	5	3	5	3
MAXIMUM	0.5	0.5	5	5	2	1	130	50	45000	50
MINIMUM	0.5	0.5	5	5	1	1	50	50	340	50
MEAN	0.5	0.5	5	5	1	1	68	50	9362	50
STAND DEV	0.0	0.0	0	0	0	0	35	0	19922	0
STAND ERR	0.0	0.0	0	0	0	0	16	0	8910	0

DATE FROM TO	01055 MANGNESE MN UG/L	01056 MANGNESE MN,DISS UG/L	01062 MOLY MO,TOT UG/L	01060 MOLY MO,DISS UG/L	01067 NICKEL NI,TOTAL UG/L	01065 NICKEL NI,DISS UG/L	01092 ZINC ZN,TOT UG/L	01090 ZINC ZN,DISS UG/L	01105 ALUMINUM AL,TOT UG/L	01106 ALUMINUM AL,DISS UG/L
* 88/03/25 1500	1200	$\bar{X}$	$\bar{X}$ 10				260		$\bar{X}$ 4600	$\bar{X}$
no event — ~~88/09/13~~ 1115	1300	800	33	10	50	50	300	70	17000	70
not used 88/09/20 1100	600	610	10	10	50	50	100	120	2000	50
88/09/26 0940	640 } 673	660 } 635	10	10	50	50	120 } 117	100 } 110	2100 } 1800	100 } 75
88/10/25 1615	780		10				130		1310	
00/00/00										
STATION NUMBER	5	3	5	3	3	3	5	3	5	3
MAXIMUM	1300	800	33	10	50	50	300	120	17000	100
MINIMUM	600	610	10	10	50	50	100	70	1310	50
MEAN	904	690	15	10	50	50	182	97	5402	73
STAND DEV	325	98	10	0	0	0	91	25	6603	25
STAND ERR	145	57	5	0	0	0	41	15	2953	15
99/99/99										

* Data not used since other stations were not sampled on this date

Reference 5

SUMMARY REPORT

AMBIENT AIR QUALITY DATA AND ASSOCIATED DATA COLLECTED IN THE QUESTA, NEW MEXICO AREA (1979 - 1983)

Cecilia Williams, Environmental Specialist

State of New Mexico
Environmental Improvement Division
Air Quality Bureau

April 11, 1985

TABLE OF CONTENTS

Page

I. INTRODUCTION

A. Statement of Purpose 1

B. Background 1

II. DISCUSSION OF THE DATA

A. Federal and State Standards 2

B. Air Quality Bureau Ambient Air Quality Monitoring and Photographic Data 4

C. Tailings and Soil Data From Molycorp and EID 6

D. Airborne Particulate Matter and Health Effects 6

E. Reagents Used in Processing Ore 8

F. Air Quality Bureau Atmospheric Modeling. 8

G. Uncertainty in the Ambient Air Quality Data. 9

III. CONCLUSIONS. 9

IV. FOLLOW-UP 10

V. REFERENCES 17

VI. APPENDICES

A. Molycorp Registration Information. A-1

B. Molycorp Summary Report. B-1

C. Union Oil Company Report C-1

D. Letter dated March 20, 1985, from EPA to Governor Anaya regarding the Inhalable Particulate Matter Standard D-1

LIST OF TABLES

		Page
TABLE I	Total Suspended Particulate (TSP) Matter Summary Questa High School, Questa, New Mexico 1979-1983	11
TABLE II	Average Heavy Metals Data (from TSP samples) Questa High School, Questa, New Mexico	12
TABLE III	Comparison of Heavy Metals Data (TSP) to New York State and Michigan State Guidelines	13
TABLE IV	Federal Ambient Air Standards and Occupational Standards and Guidelines	14
TABLE V	Average Heavy Metals Data (from TSP samples) From Molycorp Mill Tailings Questa, New Mexico	16

GLOSSARY

Units and Measurements

g = gram

Hr. = hour

m^3 = cubic meter

mg = milligram = 10^{-3} gram or .001 gram

u = micron = 10^{-6} meter, micrometer

mppcf = million particles per cubic foot

ug/m^3 = micrograms per cubic meter

ppm = ppmv = parts per million (by volume). When ambient air quality standards or measurements are listed by ppm, it is in parts per million by volumes of gases.

ppm = ppmm = parts per million (by mass). When tailings deposits or other mass measurements are discussed and listed in ppm, it is in parts per million by masses of materials.

ug/g = microgram per gram. this is also a weight per weight unit and is equivalent to ppmm listed above.

Organizations

EID - State of New Mexico Environmental Improvement Division, Division of the Health & Environment Department (HED)

SLD - State of New Mexico Scientific Laboratory Division, Division of HED

Molycorp- Molycorp Incorporated, a subsidiary of Union Oil Company

I. INTRODUCTION

A. Statement of Purpose

This report has been prepared in order to discuss in summary form air quality data and other data collected in the Questa, New Mexico area through 1983. These data will be evaluated with respect to the possible adverse health effects of Molycorp mill tailings on the residents of the Questa area. The data discussed in this report consist of all data previously collected, made public, and analyzed by the State of New Mexico EID Air Quality Bureau or by Molycorp Incorporated before 1984. The Bureau will discuss data collected by Molycorp Incorporated or collected by other entities for Molycorp Incorporated, and made public, but the Bureau cannot attest to its quality, particularly in cases where the Bureau has not collected similar data to use as a comparison.

The majority of the data evaluated in this report consists of: ore composition data; mill tailings analyses; soil sample analyses; total suspended particulate matter samples, which have been analyzed for mass per volume (ug/m^3 for 24 hrs.), and analyses of total suspended particulate matter samples for various heavy metals. Not reviewed in this report are existing total suspended particulate matter data collected by Molycorp and requested by the Environmental Improvement Division in a letter dated January 10, 1984, which have not been received by the Division. Molycorp has operated as many as four hi-volume samplers simultaneously in the Questa area. This report does review limited non-ambient air quality data released publicly by Molycorp.

B. Background

The Molycorp Mining Company has mined in the Questa area since 1923, beginning with the underground mining of molybdenite ore. Large scale open pit mining began in 1965; the ore remaining after the molybdenum has been removed, known as tailings, has been placed at a site owned by Molycorp southwest of the Questa High School. The perimeter of the tailings area is approximately one-quarter to one-half mile from Questa High School. Questa High School opened at its current site in 1963. The area of tailings deposits has grown over the years to a current size of about 500 acres, or approximately one square mile.

Beginning in 1978, the first written complaint concerning the blowing of the Molycorp mill tailings was received by the Air Quality Bureau. In response to the complaints, limited sampling for total suspended particulate matter began, with analysis of some of the total suspended particulate matter for a number of heavy metals. The majority of complaints with regard to windborne tailings have involved complaints about air quality and tailings deposition at Questa High School, close to and frequently downwind directly from the tailings.

Complaints have continued to be sent to various public officials and the Air Quality Bureau by individuals concerned about the effects of the windborne mill tailings. Complaints were received in 1981 and again in 1983, in the form of letters to the Governor's Office and to the EID. The presence

of silica (SiO_2) in the mill tailings, its possible health effects and the inadequacy of sampling frequency were among the issues raised in the 1983 letter from the Concerned citizens of Questa to the Governor's Office.

Molycorp Mining Company voluntarily began efforts to control the extent to which their mill tailings became windborne beginning in 1979 (Appendix B, Page B-5) with the application of chemical stabilizers on the tailings. The chemical stabilizers when applied to the surface of the tailings form a thin crust. If the crust remains intact, and covers all tailings not covered by water, the stabilizers should aid in controlling the extent to which the ore tailings become windborne.

No New Mexico Air Quality Control Regulations require or regulate such efforts on the part of the company or require an air quality permit from Molycorp for their tailings operation. However, if valid evidence demonstrates that high particulate levels in Questa are responsible for a federal nonattainment area due to violations of the National Ambient Air Quality Standards for particulate matter, the Bureau would then be obliged to develop a regulatory control strategy under the federal Clean Air Act. This strategy would become part of the Bureau's overall State Implementation Plan. See the letter, from EPA to Governor Anaya of March 20, 1985, attached at Appendix D. New National Ambient Air Quality Standards for airborne particulates may change the significance of these data (discussed below).

II. DISCUSSION OF THE DATA

The tailings samples and ore analysis data that are discussed in this report have been collected by either the State of New Mexico Environmental Improvement Division Air Quality Bureau or by Molycorp or a company hired by Molycorp. The Division has not received any of Molycorp's air monitoring data. Samples collected by the Air Quality Bureau have been analyzed by the State of New Mexico Scientific Laboratory Division. These data are summarized in tables at the end of Section IV. Data collected and analyzed by and for Molycorp have been attached as appendices to this report. The Air Quality Bureau does not vouch for the validity of data collected by other entities.

A. Federal and State Standards

The applicable federal health standards with which to compare ambient air quality data are the primary National Ambient Air Quality Standards (NAAQS), and the secondary National Ambient Air Quality Standards. Of these, those which pertain to the data collected are the NAAQS for total suspended particulate matter (TSP) and lead. These standards are summarized in Table IV. Other federal air quality standards which exist for metals which have been measured in Questa are the National Emission Standards for Hazardous Air Pollutants (NESHAP). NESHAP emission standards exist for beryllium and mercury; however, these emission standards are for specific industrial source categories and do not regulate Molycorp industrial facilities. The state ambient air quality standards are also summarized in Table IV.

Other standards frequently used in an effort to discern health effects are standards or guidelines which have been created for occupational

exposures. These standards include the federal Occupational Safety and Health Administration (OSHA) standards. Also used frequently are a group of occupational exposure guidelines published by the American Conference of Governmental Industrial Hygienists (ACGIH). These guidelines are termed Threshold Limit Values (TLV) for chemical substances in the environment. Both federal occupational standards and Threshold Limit Values are based on different assumptions than those underlying ambient air quality standards. Thus, they must be used cautiously in analyzing ambient air quality data and non-occupational data for possible health effects. The ACGIH urges caution in the use of TLVs for other than evaluating occupational exposures under the stated conditions (1). For example, the TLV varies for different physical and chemical forms of mercury listed by the ACGIH, and all TLVs listed for mercury are for exposure via the skin. Therefore, the application of TLVs for mercury to concentrations in the ambient air must be viewed with those restrictions in mind.

Occupational standards generally allow much higher concentrations than NAAQS for the same substance because of the assumptions concerning the group at risk and the exposure time. For example, the OSHA standard for carbon monoxide is 50 parts per million (ppm) for an 8-hour average while the NAAQS for carbon monoxide is 9 ppm for an eight hour average and 35 ppm for a one hour average.

The primary differences in ambient air quality standards and occupational standards consist of:

1. Different populations at risk: Occupational standards assume a relatively young, healthy group exposed to the chemical. Ambient standards take into account a much wider population; including the elderly, the young and those with health problems; and

2. Differing exposure times: Occupational standards assume an eight-to-ten hour exposure in 24 hours with total exposure limited to 40 hours per week. Ambient standards assume the possibility of a continuous 24-hour exposure. The occupational standards assume as much as a sixteen hour exposure-free time per 24 hours in which to recuperate from exposure to hazardous substances.

Despite the described uncertainties, the frequent use of occupational standards and guidelines is beneficial and necessary for estimating potential health hazards where specific ambient air quality standards do not exist. A variety of schemes are used for converting the occupational standards and Threshold Limit Values to 24-hour, seven-days-a-week average concentrations, as well as incorporating an estimated margin of safety for sensitive populations.

The State of Michigan and New York have adopted the use of a small numerical fraction of the TLV as an emission limit guideline for evaluating new sources applying for air quality permits in cases where there are no applicable federal or state regulations (2, 3). Currently, this is a relatively uncommon application of the TLV and can be considered a

conservative application of the ACGIH guidelines, since both states use small percentages of the existing TLV's. The state of Michigan uses 1/180 of the TLV for continuous emission from a source and the State of New York uses 1/300 of the TLV for an annual average.

Occupational standards and Threshold Limit Values are compared to ambient values in this report in an attempt to ascertain information on potential health effects since ambient standards are unavailable for such comparisons. The State of New York and State of Michigan emission guidelines described above are also compared to data reviewed in this report.

B. Air Quality Bureau Ambient Air Quality Monitoring and Photographic Data

The Air Quality Bureau has operated a total suspended particulate matter high-volume (hi-vol) sampler on the Questa High School roof, under a full EPA-approved sampling schedule (once every six days for 24 hours) for 1981, 1982 and 1983. A limited number of samples were collected in 1979 (9 samples) and 1980 (18 samples). The TSP data for 1979 through 1983 are summarized in Table I. The NAAQS for TSP, by definition, is not to be exceeded more than once per year. Thus, if only one sample collected during the calendar year exceeds the NAAQS for TSP, it is an "exceedance" and not a violation of the standard. There was one exceedance of the federal primary 24-hour standard in 1979 (9 samples), one exceedance of the federal primary 24-hour standard in 1981 (54 samples collected) and again in 1982 (52 samples collected). Three violations of the secondary NAAQS occurred in 1981 and two violations of the secondary NAAQS occurred in 1982 (Table I). The secondary NAAQS is, like the primary NAAQS, not to be exceeded more than once per year.

There has been one violation of the state 24-hour standard in 1979, four violations of the state 24-hour standard in 1981, three violations of the state 24-hour standard in 1982, and one violation of the state standard in 1983 (Table I). There have been no values approaching the federal NAAQS for lead.

The Bureau considers the TSP monitor on the high school roof to be a high impact site because of its close promixity, one-half mile, from the tailings piles, and because the highest frequency of complaints from citizens and students has been due to dust conditions at Questa High School.

The decrease in the annual geometric means for TSP from 1981 through 1983 cannot yet be attributed to improvements in Molycorp's tailings stabilization without additional information, primarily meteorological data in the area, which the state of New Mexico does not have for the period 1979 through 1983. The changes in annual geometric means could easily reflect meteorological differences from year to year.

The EPA national sampling schedule for total suspended particulate matter calls for sampling once every six days. It is likely, based on the number of exceedances of the primary NAAQS and the five violations of the

secondary NAAQS, that violations of the TSP federal primary and secondary NAAQS were missed when windy days occurred between sampling days. The TSP samples were collected by an EID Environmentalist located in the area. The chemical analyses were performed by the state HED Scientific Laboratory Division (SLD).

A small number of the TSP samples collected by the hi-vol at Questa High School have been analyzed for heavy metals. The heavy metal concentrations analyzed from TSP samples and collected by the Air Quality Bureau range from a high value of 1.4403 ug/m^3 for iron to a low value of .0007 ug/m^3 for uranium. The heavy metal concentrations have been compared to the OSHA standards and ACGIH guidelines in this report by calculating the percentage of the standard or guideline the concentration comprises. The metals data have been summarized by their means and can be found on Table II, which also contains the percent calculations. The percent calculations range from the highest value of one-fourth of one percent for the ACGIH TLV for beryllium (.25%), to the smallest percentage for molybdenum which is four ten-thousands of one percent (4×10^{-5}%).

When the heavy metals data from TSP samples are compared to the State of New York and the State of Michigan guidelines which use a small fraction of the TLV, shown on Table III, only iron exceeds both the New York guidelines for an annual average and the Michigan guidelines for a 24 hour average. Iron is frequently found in soils, in concentrations exceeding 19,000 ppm. Cobalt measured from TSP samples exceeds the New York guideline for an annual average. The amount of iron or cobalt in the respirable particulate matter size range cannot be determined from the TSP data.

The Air Quality Bureau operated a time-lapse camera from the roof of a Questa High School building, facing towards the tailings deposits, from September 1, 1982, through June 10, 1983. The camera operated automatically for approximately twelve hours per day using eight millimeter (mm) color silent movie film, with one frame exposed per minute. This photographic record is contained in 34 reels of film. The period of time for which the camera operated represents a period in 1983 during which Molycorp changed the type of chemical stabilizer.

The time lapse film is descriptive, qualitative information. Throughout the approximate ten-month span during which the camera operated, there are periods when airborne ore tailings are visible on the film. The amount of tailings that become airborne, the length of time the tailings remain airborne and the frequency of their becomming airborne varied during the ten-month period. After review of the film by Bureau staff, a quantitative statement cannot be made about a decrease in airborne tailings in frequency or amount as a result of the change in use of chemical stabilizers by Molycorp. Changes in meteorological conditions could readily account for changes in the frequency and severity of occurrences of airborne tailings; random meteorological variation may be more significant than the change in chemical stabilizers. The film does provide, however, a certain record verifying that the tailings deposits do become airborne despite the application of chemical stabilizers.

C. Tailings and Soil Data From Molycorp and EID

Data collected by Molycorp Corporation and released publicly to date consist of tailings samples and soil samples which have been analyzed by Union Oil Company, the Colorado School of Mines and Camp Dresser Mckee Incorporated. These data are in the form of a summary report by Molycorp attached to this report in Appendix B. Appendix A of this report contains the registration information submitted by Molycorp to the Air Quality Bureau in 1973, which contains an analysis of the ore processed by Molycorp.

The Colorado School of Mines performed two analyses of Molycorp mill tailings deposits for 23 metals and 8 additional substances; the first report is shown on page B-13 of Appendix B. The initial value reported for arsenic was 450 ppm and 100 ppm for selenium. The tailings were again analyzed for arsenic and selenium. The second analysis yielded 3 ppm for the wet tailings sample and 8 ppm for the dry tailings sample for arsenic and less than 5 ppm for selenium for both wet and dry tailings samples. A letter from the Colorado School of Mines, page B-14, 15 and 16 of Appendix B, attributes the first measured concentrations to laboratory error.

The State of New Mexico also analyzed tailings samples in 1979 for arsenic and selenium. The Scientific Laboratory Division reported 5.7 micrograms per gram (ug/g) for arsenic, which is equivalent to parts per million by mass (ppmm), and reported less than 0.25 ug/g (ppmm), for selenium. The State of New Mexico analyses for heavy metals in tailings deposits, are shown in Table V. The second value reported by the Colorado School of Mines for arsenic is approximately one part per million by mass less than the State of New Mexico value. The second values reported by the Colorado School of Mines for selenium are about 12 (3ppm) times and 32 (8ppm) times larger than the State of New Mexico results. Therefore, based on the comparison of the State of New Mexico laboratory results and the Colorado School of Mines laboratory results for arsenic and selenium, the explanation of laboratory error could be acceptable at face value. Further analyses would not be scientifically inappropriate, however.

D. Airborne Particulate Matter and Health Effects

There has been considerable scientific controversy concerning the relationship of total suspended particulate matter measurements to public health. Recent information indicates that the health effects of airborne particulate matter depend strongly on that portion which can be inhaled into different regions of the human respiratory system including the nasal passages, tracheobronchial region and the bronchioles and alveoli (4). The human respiratory system has different responses and clearing times depending on where materials are deposited. The U. S. Environmental Protection Agency has proposed a new standard for "inhalable" particulate matter. The new standard is stated in terms of "inhalable" particulate matter of less than a nominal 10 microns in diameter. Total suspended particulate matter includes particulate matter with an upper limit of 25-45 microns in diameter depending on wind speed and other factors (4). Thus, the TSP measurements for the Questa area contain an un-quantified portion of particulate matter which may not affect public health as directly as the deeply respirable portion of the airborne particulate matter.

The proposed federal PM-10 primary NAAQS for particulate matter is linked even more directly to the deeply inhalable, very fine particles of acute concern in terms of serious health threats. To the degree that the tailings may contribute substantially to particulate matter in the inhalable size range. serious health concerns remain. The tailings, in large proportion, are probably finer than most local soils because of the mechanical grinding which occurs during milling. If such is the case, the tailings could certainly present a large, significant proportion of the airborne particulate matter in Questa in the inhalable size range. Fine particulate matter can become airborne more readily at lower windspeeds and remain airborne longer than larger dust particles.

The presence of silica (SiO_2) in the mill tailings and its possible health effects on Questa area residents were raised as issues in a 1984 letter from the Concerned Citizens of Questa to the Department of Health and Environment. The health effects of silica are well documented for many workers who are occupationally exposed (5,6). There are Occupational Safety and Health Administration standards for crystalline silica; amorphous silica and total respirable dusts (Table IV). The National Institute for Occupational Safety and Health (NIOSH) has recommended that these standards be greatly lowered to an average exposure of 50 micrograms of silica per cubic meter of air for no more than a ten-hour exposure during a forty-hour maximum work week (5, 6). There are also TLVs for different silica dusts for which lower TLVs have been recommended (1). Silica is the single largest component of the Molycorp mill tailings. Appendix A, Page A-2, contains the composition of ores processed by Molycorp. The two main ores contain between 60 and 70 percent silica. It is unknown how much of the silica is in the inhalable particulate size range after processing. There are no ambient air quality standards for silica separate from the particulate NAAQS. The Air Quality Bureau was unable to analyze total suspended particulate matter samples for silica because the samples are collected on glass fiber filters. The glass fiber filters are composed primarily of SiO_2. Attempts by the Bureau in the past to use cellulose filters for hi-vol samplers as an alternative to glass fiber problems met with difficulties in accurate mass determinations. The cellulose fiber filters proved to be highly hydrophilic, so that pre-sampling and post-sampling weights were inaccurate.

Silicosis and other less serious physiological changes in the structure and function of the lung have been established as serious risks in occupational case studies after years of exposure. The major exception to this is extremely high exposures to crystalline silica during sandblasting, which can cause silicosis and death in a relatively short time after exposure (5).

Studies of desert inhabitants exposed to silica dusts have shown changes in lung structure, including pneumoconiosis (7). High silica content has been measured in lung tissue samples taken from the desert inhabitants (7). Injection of silica into the lungs of rats has resulted in changes in lung structure (8).

Measurements of the amount of airborne silica in the inhalable size range, as well as its physical shape, would provide more information on the specific silica exposures to which Questa area residents are exposed. There

will be substantial uncertainty, however, in applying occupational standards and experimental case studies to 24-hour residential exposures in the Questa area.

E. Reagents Used in Processing Ore

During the processing of the molybdenite ore, it is crushed and reagents are used to separate the molybdenum from other minerals present in the raw ore. As reported by Molycorp (9), listed in the table below are some of the substances used in the ore processing:

REAGENTS USED IN ORE PROCESSING (9)

	Reagent	Amount Used in lb/ton
1.	Vapor oil	0.132, 0.013 *
2.	Pine oil	0.045, 0.008 *
3.	Methyl isobutyl carbonol	0.038, 0.013 *
4.	Lime	0.145, 0.020 *
5.	Nokes (P_2S_5)	0.039
6.	Sodium cyanide	0.013
7.	Sodium thiosulfate	0.010

* The two values shown indicate amounts used in different parts of ore processing.

The State of New Mexico does not have data concerning the amount of total organic carbon or hydro-carbon compounds in tailings samples, which might result from the presence of some of the above reagents as residues in the tailings deposits after processing. Molycorp has had measurements of total organics and cyanide analyzed in tailings samples. These data are in Appendix C, page C-3, 4. Since the State of New Mexico does not have similar data, Molycorp's results cannot be verified. More information on ore processing at Molycorp can be found in the report by A. Filyk, Molycorp Mill Superintendent(9).

F. Air Quality Bureau Atmospheric Modeling

Atmospheric or dispersion modeling is another technique used by air resources professionals when trying to determine the effect of a potential emitter on surrounding air quality. Using a set of equations which simulate atmospheric conditions, the modeler can use different emission factors for different emitting source categories to predict downwind concentrations of pollutants.

In addition to the small quantity of scientifically acceptable air quality data collected from 1979 through 1983, the Air Quality Bureau conducted some preliminary modeling analysis for demonstration purposes. These analyses raise scientifically reasonable concerns that under high wind conditions, the existing tailings facility could cause 24-hour average ambient particulate concentrations as high as 322 ug/m^3 in the town of Questa. Even if the Section 36 tailings impoundment is removed as a source from the

modeling calculations, 24-hour average ambient particulate concentrations in town could be 259 ug/m^3. As shown in Table IV, the federal health-related primary 24-hour NAAQS is 260 ug/m^3, not to be exceeded more than once a year, the secondary NAAQS, and the state 24-hour standard are 150 ug/m^3. The secondary NAAQS is also not to be exceeded more than once per year; the state standard is not to be exceeded at all.

G. Uncertainty in the Data

The number of TSP samples averages approximately fifty samples per year for 1981-1983. Since the TSP sample collection was fifty 24-hour samples out of a possible 365 24-hour samples per year, and particularly since there were exceedences of the federal primary NAAQS, the possibility of undetected violations of the primary NAAQS is significant. In order for a single monitor to measure a violation, several events must coincide. The wind must blow in the right direction from the source of the particulate matter to the monitor at the same time the particulate matter is being emitted. In most cases, the likelihood is very low of a monitor being in the right place at the right time to detect an exceedance. The likelihood of a single monitor picking up the maximum concentration is very low. Therefore, when a single monitor picks up an exeedance of the standards, it is indicative of the high potential for even higher concentrations somewhere else and the high potential for unacceptable frequencies of exceedances; violations of the standards. This is further reinforced by the aforementioned modeling analyses. Even in the middle of the Town of Questa, which is further from the tailings and substantially below the level of the tailings than the EID monitor, the expected ambient TSP levels will be well above the health-related primary NAAQS.

III. CONCLUSIONS

As a result of the review of the limited air quality data available from 1979-1983, significant concerns exist concerning adverse health effects due to exceedances of and a high probability of violations of the primary NAAQS, violations of the secondary NAAQS and violations of the state 24- hour standard. The probability of undetected violations of the primary NAAQS is very significant.

Based on the data reviewed for this report, there were unanswered questions concerning the portion of the TSP which is in the deeply inhalable size range. Unanswered questions also remained concerning the portion of TSP and respirable particulate matter which originate from the tailings. Additionally, the type and proportion of silica in windborne particulate matter, crystalline or amorphous, was unknown. The type of silica which becomes windborne is important; the severity of adverse health effects is significantly worse for crystalline silica.

Other deficiencies in the available data included lack of Air Quality Bureau measurements for cyanide, and organics in the tailings and in windborne particulate matter.

IV. FOLLOW-UP

As a result of the preliminary review conducted of the available data in preparation for this report, the Bureau recommended and designed a short-term study for 1984 in an attempt to provide additional information on the potential adverse effects due to windborne tailings material in the Questa area. EID will release a summary report on the short-term study in May, 1985.

The special study was designed to include the operation of four samplers at two sites, collecting samples twice a week. The two sampling sites are at Questa High School, which is frequently downwind of the tailings deposits, and the Red River Fish Hatchery which appears to be generally upwind of the tailings deposits. The Red River Fish Hatchery site was chosen to provide background measurements which are unaffected by any tailings deposits that become airborne during windy episodes which would affect the High School site. The Bureau also collected wind speed and wind direction data during part of the study to determine actual patterns of prevailing winds in the area. Each site contained one hi-volume sampler, which measures TSP, and one dichotomous particulate matter sampler, which measures particulate matter of less than 15 microns in diameter. Measurements from the dichotomous sampler will provide information on that portion of particulate matter which can be inhaled and is thus of greater concern with respect to health effects. Although EPA has proposed a particulate matter standard of a nominal 10 microns, measurement of a nominal 15 microns, as in the Bureau's study, provides a more conservative measurement that collects more of that portion of particulate matter depositing in the upper regions of the respiratory system (4). Health effects in the upper respiratory system which larger particles can reach have been reported from exposures to airborne silica (10). A comparison of the TSP and inhalable particulate matter samples will provide information on the portion of TSP in the inhalable size range.

Related information collected during the special study includes the collection and analysis of additional Molycorp mill tailings samples and soil samples in the area, analyzed for cyanide and heavy metals. Additionally, a time lapse camera operated at the Questa High School facing in the direction of the tailings deposits which are visible from the high school. Operation of the camera provided qualitative information on the source of high concentrations measured at Questa High School during the duration of the special study.

Clearly, the very limited scope of this short-term follow-up study does not provide the capacity to develop final answers on potentially serious health-related issues. However, the Bureau expects to be able to more adequately identify the scope of additional research necessary to answer these questions as a result of the short-term study.

Table I

TOTAL SUSPENDED PARTICULATE (TSP) MATTER
DATA IN MICROGRAMS PER CUBIC METER (ug/m^3)
For a 24 - HOUR AVERAGE

Questa High School
Questa, New Mexico

Collecting Agency

State of New Mexico
EID Air Quality Bureau

Collection Year	High 24 Hr. Ave.	2nd High 24 Hr. Ave.	Annual Geometric Mean	Total Number of Samples Collected	Exceedances of the primary NAAQS	Exceedances of the State 24 hr. std. and secondary NAAQS	Violations of the secondary NAAQS
					Samples 260 ug/m^3	Samples 150 ug/m^3	
1979	216	145	85	9	0	1	0
1980	82	75	45	18	0	0	0
1981	399	180	49	54	1	4	3*
1982	301	161	34	52	1	3	2+
1983	187	137	29	48	0	1	0

Federal Primary Standards
24 Hour - 260 ug/m^3,
"...not to be exceeded more than once per year" (40 CFR Part 50)
Annual Geo. Mean -75 ug/m^3

Federal Secondary Standards
24 Hour - 150 ug/m^3,
"...not to be exceeded more than once per year" (40 CFR Part 50)
Annual Geo. Mean - 60 ug/m^3

State Standards
24 Hour - 150 ug/m^3
Annual Geo. Mean - 60 ug/m^3

*1981 Secondary NAAQS Violations in ug/m^3 were: 180, 399, 153

+1982 Secondary NAAQS Violations in ug/m^3 were: 161, 301

TABLE II
Average Heavy Metals Data (TSP samples)
Samples Collected in 1979 and 1981
(Data in ug/m^3 for a 24 hr. Ave.)
Questa High School
Questa, New Mexico

Collecting Agency
State of New Mexico
EID Air Quality Bureau

	Average ug/m^3		Number of Samples		Percent of the OSHA std.		Percent of the ACGIH TLV	
	1979	1981	1979	1981	1979	1981	1979	1981
Lead	.09		11		.18%		.06%	
Arsenic	.003	.0016	11	10	.03%		.005%	
Beryllium	.0005*		11		.25%		.25%	
Mercury	.0002		11		.004%		.04%	
Selenium	.001		11		.0005%		.0005%	
Chromium	.005		2		.001%		.001%	
Zinc	.028	.1713	11	10	.006%			
Molybdenum	.002		2		4×10^{-5}%		4×10^{-5}%	
Uranium	.0007		2		.0003%			
Iron		1.4403		10		.014%		.144%
Cobalt		.1441		7		.14%		.144%
Cadmium	.0014		11		.007%		.0028%	

* A less than symbol ( ) indicates that at least one value in the mean was reported at less than the lowest analytical standard range for that metal.

Air Quality Standards for Heavy Metals

1. National Ambient Air Quality Standards (NAAQS):
   Lead: 1.5 ug/m^3 for a 3-month calendar average.

2. National Emission Standards for Hazardous Air Pollutants (NESHAP):
   Beryllium: 0.01 ug/m^3 for a 30-day average for specific emission sources.
   Mercury: 3200 g/24-hr. period for specific emission sources.

Table III
Comparison of Heavy Metals Data (TSP)
to New York State and Michigan State Guidelines

ls	Time Weighted Average Threshold Limit Value TLV-TWA mg/m³, ug/m³	New York Dept. of Conservation Acceptable Ambient Air Level for an Annual Average - AAL AAL = (TWA-TLV)/300 ug/m³	Michigan Air Pollution Control Commission Emission Guidelines (TWA -TLV) x .024 ug/m³	N.M. EID Heavy Metals Data From TSP Samples Arithmetic Mean for All Samples			N.M. EID Heavy Metals Data from TSP Samples High 24 Hour Concentrations		
				1979,1981 ug/m³	Exceeds New York Guidelines	Exceeds Michigan Guidelines	ug/m³	Exceeds New York Guidelines	Exceeds Michigan Guidelines
l	0.15, 150	0.500	3.6	.09	No	No	0.16	No	No
enic	0.2, 200	0.667	4.8	.003,.0016	No	No	0.0032	No	No
yllium	0.002, 2.0	0.007	0.048	.005	No	No	.005	No	No
mium	0.05, 50	0.167	1.200	.0014	No	No	.0039	No	No
cury[A]	0.01, 10	0.033	0.240	.0002	No	No	.0005	No	No
	0.05, 50	0.167	1.200						
	0.10, 100	0.333	2.400						
enium	0.2, 200	0.667	4.8	.001	No	No	.0016	No	No
omium[B]	0.05, 50	0.167	1.2	0.0005	No	No	.0005	No	No
c[C]	10.0, 10,000	33.333	240.0	.028,.1713	No	No	.2517	No	No
	5.0, 5,000	16.667	120.0						
ybdenum	5.0, 5,000	16.667	12.0						
	10.0, 10,000	33.333	240.0	.002	No	No	.003	No	No
nium	0.2, 200	.667	4.80	.0007	No	No	.0008	No	No
tural)									
n[D]	1.0, 1,000	3.33	24.0	1.4403	No	No	7.2428	Yes	Yes
alt[E]	0.1, 100	0.333	2.40	.1441	No	No	1.0	Yes	No

TWA-TLV's for Mercury are listed for 3 different forms: Alkyl compounds (0.01 mg/m³), all forms except alkyl vapor (0.05 mg/m³), l aryl and inorganic compounds (0.1 mg/m³).

The TWA-TLV listed for chromium is for Chromium (VI) compounds including water soluble and certain water insoluble compounds. re is a less restrictive TWA-TLV of 0.5 mg/m³ for Chromium I, II and III compounds.

The TWA-TLVs listed are for zinc oxide dust where dust is less than 1% quartz (10 mg/m³) or 5 mg/m³ for respirable dust. re are TWA-TLV's listed by the ACGIH for other zinc compounds: 5 mg/m³ for zinc oxide fumes, 1 mg lm³ for zinc.

The TWA-TLV listed is for soluble iron salts, as Fe.

The TWA TLV listed is for cobalt metal, dust and fumes as Co. The ACGIH has proposed that the TWA-TLV be changed to 0.05 mg/m³.

TABLE IV
FEDERAL STANDARDS OR GUIDELINES

	Primary National Ambient Air Quality Standards (NAAQS)	National Emission Standards for Hazardous Air Pollutants (NESHAP)	Occupational Safety and Health Administration Standards (OSHA) 8 Hr. Exposure	American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for 1983-84 8 Hr. Exposure
Total Suspended Particulate Matter	260 ug/m^3, 24 Hr. std. 75 ug/m^3, Annual geo. mean			
Lead (Pb)	1.5 ug/m^{3}month calendar ave.		50 ug/m^3	Lead, inorganic, dusts & fumes, as Pb: 0.15 mg/m^3
Arsenic (As)			10 ug/m^3, inorganic As	0.2 mg/m^3 Time Weighted Average (TWA)
Beryllium (Be)		10 g/24 hr source emissions, .01 ug/m^3 stationary NESHAP source specific	2 ug/m^3	[B] 0.002 mg/m^3
Cadmium (Cd)			.02 mg/m^3	Dust and Salts, as Cd: 0.05 mg m^3
Mercury (Hg)		3200 grams/24 hr period for specific NESHAP sources	1.0 mg/10 m^3	[C] 0.01 mg/m^3, alkyl cmpds. [C] 0.05 mg/m^3, all forms except Alkyl vapor [C] 0.1 mg/m^3, aryl and inorganic cmpds.
Selenium (Se)			0.2 mg/m^3	Selenium cmpds., as Se: 0.2 mg/m^3
Chromium (Cr)			0.5 mg/m^3	Cr metal, compounds (II,III) as Cr: 0.5 mg/m^3 0.05 mg/m^3 for Cr VI cmpds., water soluble
Zinc (Zn)			Zinc oxide fume 5 mg/m^3	[D] Zinc oxide dust
Molybdenum (Mo)			5-15 mg/m^3	5 mg/m^3, soluble cmpds.

TABLE IV (Continued)
FEDERAL STANDARDS OR GUIDELINES

	Primary National Ambient Air Quality Standards (NAAQS)	National Emission Standards for Hazardous Air Pollutants (NESHAP)	Occupational Safety and Health Administration Standards (OSHA) 8-hr. Exposure	American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for 1983-84
anium (U)			.5 - .25 mg/m^3	
on (Fe)			Iron oxide fumes 10 mg/m^3	Iron salts, soluble, as Fe: 1.0 mg/m^3
balt (Co)			0.1 mg/m^3	Metal, dust and fume, as Co: [E] 0.1 mg/m^3
ystalline silica (SiO_2)			[A] 10 mg SiO_2/m^3 air ÷by % SiO_2 +2 Averaged over 8 hour shift	[F] 20 mppcf
orphous silica (SiO_2)			20 x 10^6 particles/ $ft.^3$ air (mppcf)	6 mg/m^3 total dust 3 mg/m^3 respirable dust

The National Institute of Occupational Safety and Health (NIOSH) has recommended that the permissible exposure limit be changed to 50 micrograms respirable free silica per cubic meter of air (ug/m^3) averaged over a work shift of up to 10 hrs/day, 40 hrs/week.

Listed as a suspected human carcinogen by ACGIH.

All guidelines listed for mercury are for exposure through the skin.

Zinc oxide dust, listed under nuisance dust, has a TLV of 30 mppcf or 10 mg/m^3 of total dust 1% quartz, or, 5 mg/m^3 respirable dust, other TLVs for zinc compounds: includes 5 mg/m^3 for zinc oxide fumes, 1 mg/m^3 for zinc chloride fumes, and 0.05 mg/m^3 for zinc chromate, which is listed as a suspected human carcinogen.

ACGIH has proposed a change to 0.05 mg/m^3

ACGIH has proposed to change to 5 mg/m^3 for respirable dust, 10 mg/m^3, total dust.

Table V
Heavy Metals Data
Molycorp Mill Tailings Samples
Questa, New Mexico

micrograms per gram (ug/g)

Collecting Agency
State of New Mexico
EID Air Quality Bureau

	Lead Pb	Arsenic As	Beryllium Be	Cadmium Cd	Mercury Hg	Selenium Se	Chromium Cr	Zinc Zn	Molybdenum Mo	Uranium U
Fine Screening 250/u diam.	164.80	10.80	0.40	L. A.*	L. A.	0.25+	30.50	168.0	273.20	1.85
Coarse Screening 250 u diam.	58.60	5.80	0.58	L. A.	0.003	0.25	26.40	218.0	325.40	1.94
Unscreened Sample	76.90	5.70	0.57	0.57	0.011	0.25	23.50	166.0	292.1	1.49

*L. A. is an abbreviation for laboratory accident.

+ = less than

V. REFERENCES

1. "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment With Intended Changes for 1983-84", American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio. 1983.

2. "A Proposed Framework for Processing Air Quality Permit Applications for New Emission Sources of Non-Criteria Pollutants", Final Report of the Special Air Advisory Committee to the Michigan Air Pollution Control Commission. Michigan Department of National Resources. November 16, 1981.

3. "Air Guide-1: Application of 6 NYCRR Part 212-Toxic Air Contaminants", New York State Department of Environmental Conservation, Robert Flacke, Commissioner. Albany, New York. Revised on November 11, 1982.

4. "Review of the National Ambient Air Quality Standards for Particulate Matter: Assessment of Scientific and Technical Information". U. S. Environmental Protection Agency, Research Triangle Park, N.C. January 1982. NTIS Publication Number: PB 82-177874

5. "Occupational Health Guideline for Amorphous Silica", U. S. Department of Health and Human Services and the U. S. Department of Labor. September 1978.

6. "Occupational Health Guideline for Crystalline Silica", U.S. Department of Health and Human Services and the U. S. Department of Labor. September 1978.

7. "Simple Siliceous Pneumoconiosis in Negev Bedoins", J. BarZiv, and G. M. Goldberg. Archives of Environmental Health. 1974. Vol. 29, 121-126.

8. "Pulmonary Toxicity of Mount St. Helens Volcanic Ash", C. L. Sanders, A. W. Conklin, R. A. Gelman, R. R. Adee, and K. Rhoads. Environmental Research Vol. 27, 118-135, 1982.

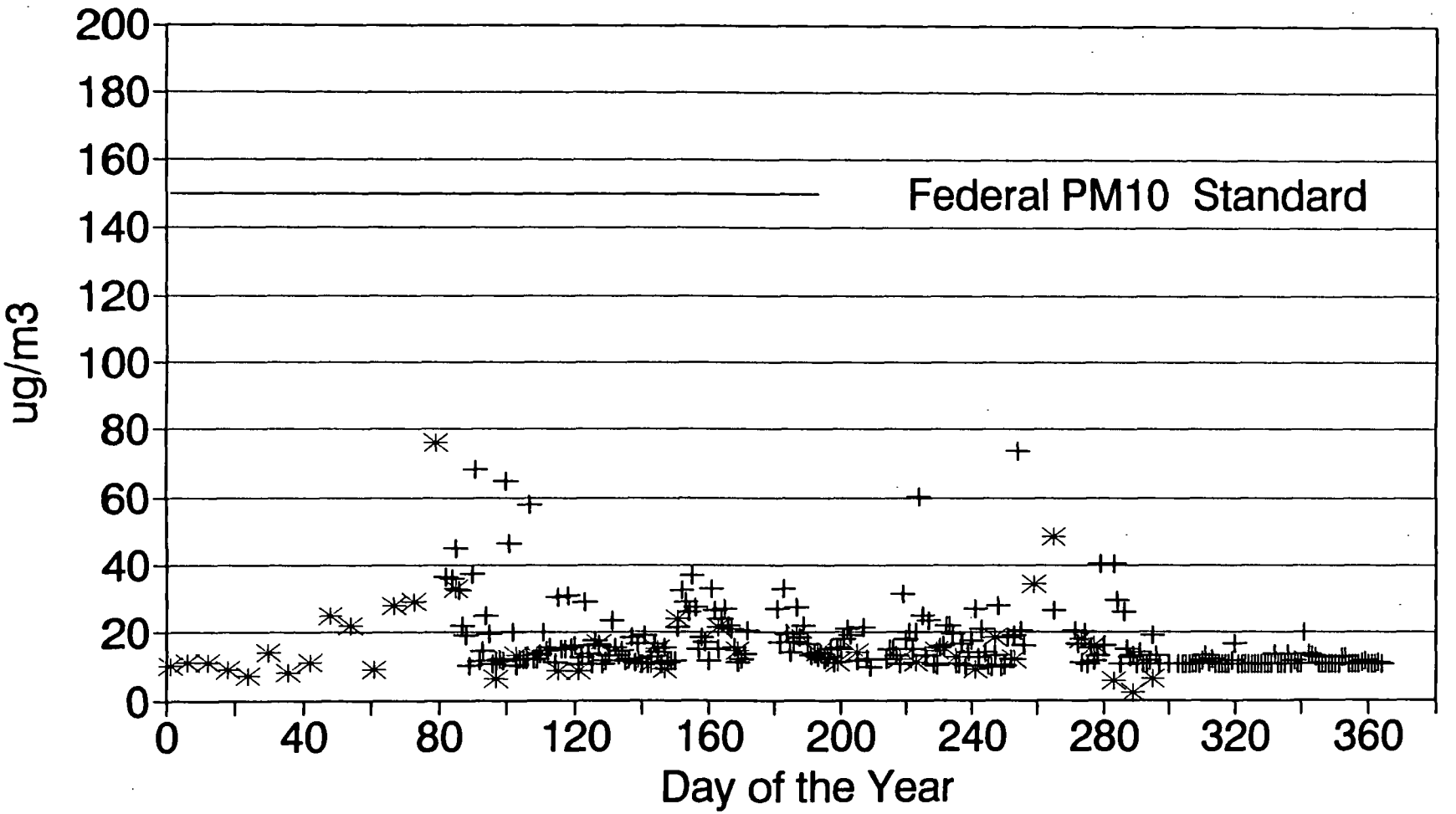
9. "A Review of Plant Practice at Molycorp Inc., Questa Division", by A. Filyk, Mill Superintendent. Flotation, Volume 2, M. C. Fuerstenau, Editor. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. New York 1976.

10. "Criteria for a Recommended Standard - Occupational Exposure to Crystalline Silica". National Institute for Occupational Safety and Health, Rockville Maryland. 1979. NTIS Publication Number: PB-246 697.

Reference 6

QUESTA PM-10 VALUES

1993 - 24 HOUR averages



+ Continuous Monitor ✳ High Volume Sampler

Reference 7

SELECTION: ** SPECIAL **
SEQUENCE: STATE, SITE NAME

EVENTS: ALL

EPA ID NO.	SITE NAME / STREET / CITY / COUNTY CODE AND NAME	STATE / ZIP / CONG DIST.	OPRBLE UNIT	EVENT TYPE	EVENT QUAL	ACTUAL START DATE	ACTUAL COMPL DATE	CURRENT EVENT LEAD
NMDCC28998 96	POLYCORP INC, QUESTA DIVISION		00	DS1			02/01/80	EPA (FUND)
	NM HWY 38 RED RIVER CANYON			PA1	NO FURTHER REMDL ACT PLND	05/01/80	05/01/80	EPA (FUND)
	QUESTA	NM 87556		SI1	LOWER PRIORITY	06/01/81	06/01/81	EPA (FUND)
	055 TAOS	NM-01						
NM2162333496	MONTEREY CONSTRUCTION COMPANY		00	DS1			10/20/90	FED. FAC.
	P. O. BOX 2248							
	CARLSBAD	NM 88220						
	15 EDDY	NM-02						
NMD987429317	MORTON BROTHERS		00	DS1			11/01/79	EPA (FUND)
	2.81 M.UN HWY 70 W			PA1	NO FURTHER REMDL ACT PLND	09/01/80	09/01/80	EPA (FUND)
	LAS CRUCES	NM 88001						
	013 DONA ANA	NM-02						
NMD980750061	MOSQUERO CITY OF DUMP		00	DS1			09/01/81	EPA (FUND)
	2 MI E OFF HWY 65			PA1	NO FURTHER REMDL ACT PLND	08/01/81	08/01/81	EPA (FUND)
	MOSQUERO	NM 87733						
	021 HARDING	NM-01						
NMD000804229	MOTOROLA CERAMIC PRODUCTS		00	DS1			04/12/90	OTHER
	9733 COORS RD. NW			PA1	DEFERRED TO RCRA OR NRC		10/02/91	EPA (FUND)
	ALBUQUERQUE	NM 87114						
	001 BERNALILLO	NM-01						
NMD981523015	MOUNTAINVIEW SUBDIVISION		00	DS1			10/01/86	STATE(FUND)
	ST RT 47, 3 MI N INTST HWY 25			PA1	LOWER PRIORITY	10/01/86	10/01/86	STATE(FUND)
	ALBUQUERQUE	NM 87105		SI1	LOWER PRIORITY	03/01/87	03/01/87	STATE(FUND)
	001 BERNALILLO	NM-03						
NMDL979068795	MPI CORPORATION		00	DS1			02/01/80	EPA (FUND)
	HWY 200 SI			PA1	NO FURTHER REMDL ACT PLND	06/01/80	06/01/80	EPA (FUND)
	DEMING	NM 88030						
	029 LUNA	NM-02						

Reference 8

Pm

EPA

POTENTIAL HAZARDOUS WASTE SITE
TENTATIVE DISPOSITION

EPA

REGION	SITE NUMBER
VI	NMD002899094

File this form in the regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking System; Hazardous Waste Enforcement Task Force *(EN-335)*; 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION NM HWY 38, 4 mi. E of Questa

A. SITE NAME	B. STREET	
Molycorp, Inc. Questa Mine	Sec 35+36, T29N, R12E	
C. CITY	**D. STATE**	**E. ZIP CODE**
Questa (Taos County)	NM	87556

II. TENTATIVE DISPOSITION

Indicate the recommended action(s) and agency(ies) that should be involved by marking 'X' in the appropriate boxes.

RECOMMENDATION	MARK 'X'	ACTION AGENCY: EPA	STATE	LOCAL	PRIVATE
A. NO ACTION NEEDED -- NO HAZARD					
B. INVESTIGATIVE ACTION(S) NEEDED *(If yes, complete Section III.)*		X	(RCRA jurisdiction)		
C. REMEDIAL ACTION NEEDED *(If yes, complete Section IV.)*					
D. ENFORCEMENT ACTION NEEDED *(If yes, specify in Part E whether the case will be primarily managed by the EPA or the State and what type of enforcement action is anticipated.)*					

E. RATIONALE FOR DISPOSITION This is an active molybdenum mining and milling facility, whose area is approx. 3500 acres. A 9-mile slurry pipeline transports tailings to a large landfill area west on the facility. A break in the slurry pipeline reportedly was responsible for a major fish kill at the Red River Fish Hatchery 2 miles SW of Questa. Other spills have been reported by the Carson National Forest Service. The pipeline reportedly has been replaced. Drinking water wells should be resampled due to the presence of 111-trichloroethane (Columbine well). Another landfill located at the headwaters of Spring Gulch Creek near the mine appears to be contributing to the elevated concentrations of organics and inorganics downstream. Spring Gulch Creek flows into the Red River. Since contaminants appear to be migrating off-site, further investigation is recommended.

F. INDICATE THE ESTIMATED DATE OF FINAL DISPOSITION *(mo., day, & yr.)*	G. IF A CASE DEVELOPMENT PLAN IS NECESSARY, INDICATE THE ESTIMATED DATE ON WHICH THE PLAN WILL BE DEVELOPED *(mo., day, & yr.)*
	9/23/84

H. PREPARER INFORMATION

1. NAME	2. TELEPHONE NUMBER	3. DATE *(mo., day, & yr.)*
J. De Carlo Cecil 6H-ES	(214) 767-9702	9/24/86

III. INVESTIGATIVE ACTIVITY NEEDED

A. IDENTIFY ADDITIONAL INFORMATION NEEDED TO ACHIEVE A FINAL DISPOSITION.

B. PROPOSED INVESTIGATIVE ACTIVITY *(Detailed Information)*

1. METHOD FOR OBTAINING NEEDED ADDITIONAL INFO.	2. SCHEDULED DATE OF ACTION *(mo, day, & yr)*	3. TO BE PERFORMED BY *(EPA, Contractor, State, etc.)*	4. ESTIMATED MANHOURS	5. REMARKS
a. TYPE OF SITE INSPECTION				
(1)				
(2)				
(3)				
b. TYPE OF MONITORING				
(1)				
(2)				
c. TYPE OF SAMPLING				
(1)				
(2)				

EPA Form T2070-4 (10-79)

Continue On Reverse

CC: 6H-CE

PA

POTENTIAL HAZARDOUS WASTE SITE
TENTATIVE DISPOSITION

EPA

REGION | SITE NUMBER
V | NMD002899094

(1)

Form in the regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking Hazardous Waste Enforcement Task Force (EN-335); 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION NM HWY 38, 4 mi. E of Questa

A. NAME	B. STREET	
Molycorp, Inc. Questa Mine	Sec 35+36, T29N, R12E	
CITY: Questa (Taos County)	D. STATE: NM	E. ZIP CODE: 87556

II. TENTATIVE DISPOSITION

Indicate the recommended action(s) and agency(ies) that should be involved by marking 'X' in the appropriate boxes.

RECOMMENDATION	MARK 'X'	ACTION AGENCY: EPA	STATE	LOCAL	PRIVATE
A. NO ACTION NEEDED – NO HAZARD					
B. INVESTIGATIVE ACTION(S) NEEDED (If yes, complete Section III.)		X	(RCRA jurisdiction)		
C. REMEDIAL ACTION NEEDED (If yes, complete Section IV.)					
D. ENFORCEMENT ACTION NEEDED (If yes, specify in Part E whether the case will be primarily managed by the EPA or the State and what type of enforcement action is anticipated.)					

E. RATIONALE FOR DISPOSITION: This is an active molybdenum mining and milling facility, whose area is approx. 3500 acres. A 9-mile slurry pipeline transports tailings to a large landfill area west on the facility. A break in the slurry pipeline reportedly was responsible for a major fish kill at the Red River Fish Hatchery 2 miles SW of Questa. Other spills have been reported by the Carson National Forest Service. The pipeline reportedly has been replaced. Drinking water wells should be resampled due to the presence of 111-trichloroethane (Columbine well). Another landfill located at the headwaters of Spring Gulch Creek near the mine area appears to be contributing to the elevated concentration of organics and inorganics downstream. Spring Gulch Creek flows into the Red River. Since contaminants appear to be migrating off-site, further investigation is recommended.

F. INDICATE THE ESTIMATED DATE OF FINAL DISPOSITION (mo., day, & yr.)

G. IF A CASE DEVELOPMENT PLAN IS NECESSARY, INDICATE THE ESTIMATED DATE ON WHICH THE PLAN WILL BE DEVELOPED (mo., day, & yr.)

9/23/86

H. PREPARER INFORMATION

1. NAME	2. TELEPHONE NUMBER	3. DATE (mo., day, & yr.)
J. De Carlo Cecil, H-ES	(214) 767-9702	9/24/86

III. INVESTIGATIVE ACTIVITY NEEDED

A. IDENTIFY ADDITIONAL INFORMATION NEEDED TO ACHIEVE A FINAL DISPOSITION.

Transcribed, this says the following (in Part):

Another landfill located at the headwaters of Spring Gulch Creek near the mine area appears to be contributing to the elevated contribution of organics and inorganics downstream.....Since contaminants appear to be migrating off-site, further investigation is recommended.

(2)

ECOLOGY AND ENVIRONMENT INC.,

REGION VI

MEMORANDUM

TO: Keith Bradley, RPO, EPA Region VI

FROM: Jairo Guevara, FIT Chemical Engineer

PRELIMINARY REPORT
This does not constitute
final opinion of EPA

THRU: K.H. Malone Jr., FIT RPM

DATE: June 4, 1986

SUBJ: Sampling Inspection at Molycorp Inc., Questa, N.M. (NM558)
TDD# R6-8510-06

A six person FIT (Team Leader J. Guevara and Team Members D. Hall, D. Smith, D. Tanksley, K. Dodd and M. Pike) sampled Molycorp Inc. on December 4, 1985. This sampling inspection was conducted as a follow up to the May 18, 1983 FIT sampling inspection of the site.

A total of ten liquid and eight soil/sediment samples were collected and analyzed for organics - base/neutral/acid (BNA's) and volatiles (VOA's); and inorganics - metals (including molybdenum) and cyanides. Five of the locations which were sampled were specified by the EPA task request. These sample locations were the slurry pipeline discharge, the Molycorp Columbine well, the Roger Herrera well, the NPDES outfall 002 and the Red River at the Questa fish hatchery. Other locations were sampled to obtain additional information in order to address all TDD requirements.

The FIT was accompanied during the inspection by Mr. John Stribling, Molycorp Environmental Coordinator. Split samples were collected for Molycorp. Most of the split samples were to be analyzed by Molycorp only for VOA's.

During this sampling inspection a small oil spill was observed on the ground near some drums which had been discarded on the Molycorp landfill. This location was not sampled. Mr. John Stribling, the Molycorp representative, stated that dumping of oily waste in the landfill was not company policy. Based on FIT observations, it appears that this landfill is still active as a dump area for the disposal of empty drums and old equipment parts.

The exact location of the sample which was collected downstream of the landfill during the FIT sampling inspection of May 18, 1983 could not be precisely determined. The collection of an upstream sample in Spring Gulch Creek (Station 01) was judged impractical because the creek starts where some landfill waste has been dumped in the past.

The sample collected from Spring Gulch Creek downstream of the Molycorp landfill (Station 02A) showed the highest levels of inorganic and organic contamination of all samples collected (see organic and inorganic summary tables attached). The inorganic compounds detected at significant levels in this sample were cadmium, calcium, copper, iron, lead, nickel, molybdenum, sodium and zinc. Significant organic contaminants found at this location included hexadecane, heptadecane, pentadecane 2,6,10,14 tetramethyl, other alkanes and unknowns.

Low levels of contaminants were found at the other sampling locations as follows:

Stations 03A and 04A (Sediment samples, Red River upstream from the mill)-heptane dimethyl and organic unknowns. The concentrations of these compounds were much lower than those found at Station 02A.

Station 05A (Sediment sample at the Red River downstream from the Molycorp Mill and Spring Gulch Creek)-eight organic unknowns were detected at concentrations higher than the levels of the same compounds found at Stations 03A and 04A. Six of these unknowns were also detected in the background sample collected at the Carson Ranger Station (Station 12A). The levels of these compounds at Station 12A were lower than those found in Station 05A. Twelve other organics, most of them unknowns, were also detected in this background sample.

Station 05 (Liquid sample at same location of sample 05A)-molybdenum.

Station 10A - (Red River where old pipeline crosses Red River near Eagle Rock Lake) and Station 11A (Red River fish hatchery) showed six to seven unknown organics. Five of these compounds were detected at lower concentrations than the background sample from the Carson Ranger Station.

Stations 10 and 11 (Liquid samples at the same locations as samples 10A and 11A) - cyclopentanol 2 methyl in both samples, an unknown organic compound in sample 10, manganese in sample 10 and molybdenum in sample 11.

Station 09A (Discharge of slurry pipeline - solid phase) - Two unknown organics, calcium and molybdenum.

Station 09 (Liquid phase at the same location as sample 09A) - Four unknown organics. No liquid phase was analyzed for inorganics.

Station 06 (Molycorp Columbine well - Liquid samples) - calcium, magnesium and nickel.

Station 07 (Molycorp NPDES 002 - Liquid sample) - calcium, magnesium, manganese, sodium and molybdenum.

Station 08 (Roger Herrera well - Liquid sample) - calcium, magnesium, sodium and molybdenum.

Organic contamination of the site downstream sediment samples at the Red River (Stations 04A, 05A, 10A and 11A) is inconclusive. This is due to the

nic contamination in the two Red River upstream sediment samples (Stations 03A and 04A) and the soil background sample (Stations 12A).

The TDD task also requested further characterization of chlorocyclohexane which was detected in the sediment samples collected by the FIT during the May 18, 1983 inspection at the following locations (see attachment):

a) Landfill upstream
b) Red River one mile upstream of the mill, and
c) Red River fish hatchery.

No chlorocyclohexane was detected in any of the samples collected during the December 4, 1985 FIT inspection.

Another item discussed in the May 18, 1983 FIT sampling analyses results was the contamination of the Columbine well with 1,1,1 trichloroethane. This compound was again detected in the Columbine well sample collected in the December 4, 1985 FIT inspection (Station 06) at an estimated concentration (below the instrument detection limit) of 3.6 ppb. However this compound was also found in the field rinsate blank, at an estimated concentration (below the detection limit) of 2.3 ppb. Therefore, the presence of this compound in the Columbine well is not verified. The possibility exists that traces of this compound in the well could have resulted from Molycorp employees servicing the well motor or/and pump.

Toluene, another contaminant found in samples collected by the FIT on May 18, 1983, i.e. in the Roger Herrera well (less than 5 ppb), at a location downstream of the landfill disposal area (less than 5 ppb) and at the Molycorp NPDES outfall 002 (11 ppb), was also found in all the samples but one collected by the FIT on December 4, 1985. However it was determined that its presence was due to lab contamination.

Based on the analytical results and field observations, FIT recommends that a RCRA inspection be conducted at the site landfill/dump. This inspection should attempt to determine if the surface soil contamination detected during the FIT inspection downstream from the landfill dump area is due to the dumping of residual amounts of wastes or products from drums which have been deposited on the landfill.

The organic contamination detected in the Red River samples collected upstream and downstream of Molycorp could be due to past discharges (1971 - 1983) of poorly treated effluent from the town of Red River waste water treatment plant which is located upstream of the Molycorp facilities. Also past discharges from the town of Questa septic tanks into the Red River could contribute to the organic contamination found in the Red River fish hatchery sample. The problesm with the discharges from these two towns apparently have been resolved. See attached report "Intensive Survey of the Red River in the vicinity of the Red River and Questa wastewater treatment facilities and the Molycorp complex, Taos County, New Mexico, January 25-27, 1984 by Gerald Z. Jacobi and Larry R. Smolka, Surface Water Quality Bureau of the Environmental Improvement Division, New Mexico Health and Environment Department, June 1984".

Also attached to this report are a listing of sample locations and descriptions and the chain of custody documentation for this effort.

SAMPLING LOCATIONS

STATION 02 - Spring Gulch downstream of landfill, on-site soil/sediment.

STATION 03 - On Red River about 1 1/4 mile upstream of mill gate, off-site soil/sediment & liquid.

STATION 04 - On Red River about 1 mile upstream of mill gate, off-site soil/sediment & liquid.

STATION 05 - On Red River downstream of mill Spring Gulch Creek, off-site soil/sediment & water.

STATION 06 - Columbine well, on-site property, water.

STATION 07 - Molycorp NPDES outfall 002, on-site water.

STATION 08 - Roger Herrera well, off-site water.

STATION 09 - Discharge of slurry pipeline or sample of tailing ponds, on-site liquid and soil phases.

STATION 10 - On Red River where old pipeline crosses Red River near Eagle Rock Lake, off-site soil/sediment & water.

STATION 11 - On Red River at fish hatchery, off-site soil/sediment & water.

STATION 12 - Background soil, off-site at Carson Ranger Station.

STATION 13 - Field rinsate blank, water.

NOTE: Water samples have the same designation as the station number. Soil/sediment samples are identified by the station number followed by the letter A.

NOTE: STATION 01 Upstream of landfill on Spring Gulch Creek was not taken because the creek starts where some landfill waste has been dumped in the past.

Reference 9

STATE OF NEW MEXICO
ENVIRONMENT DEPARTMENT

June 1, 1993

David R. Shoemaker
Mine Manager
Molycorp, Inc.
P.O. Box 469
Questa, New Mexico 87556

Dear Mr. Shoemaker:

This letter is in reference to your request of January 27, 1993, for an exemption under Section 108.C, for on-site disposal of construction and demolition waste generated at the Molycorp Site.

The Department accepts your claim for exemption of this solid waste under Section 108.C of the Solid Waste Management Regulations, provided the waste does not infringe upon the Goathill Gulch and Spring Gulch drainage systems.

Please let me know if you have any questions or need additional information regarding this matter.

Sincerely,

J. David Duran
Program Manager, Permitting & Compliance Section
Solid Waste Bureau

cc. Earnie Gutierrez, District II, Santa Fe

Bruce King
Governor

Judith M. Espinosa
Secretary

Ron Curry
Deputy Secretary

Harold Runnels Building
1190 St. Francis Drive
P.O. Box 26110
Santa Fe, NM 87502
(505) [illegible]
FAX (505) [illegible]

Molycorp, Inc.
A Unocal Company
Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

UNOCAL 76
MOLYCORP

State of New Mexico
Environment Department
Solid Waste Bureau
1190 St. Francis Drive
Santa Fe, NM 87503

January 27, 1993

Attention: J. David Duran
Program Manager,
Permits & Compliance

Reference: NMED Form for On-Site
Disposal of Construction
& Demolition Debris

Dear Sir:

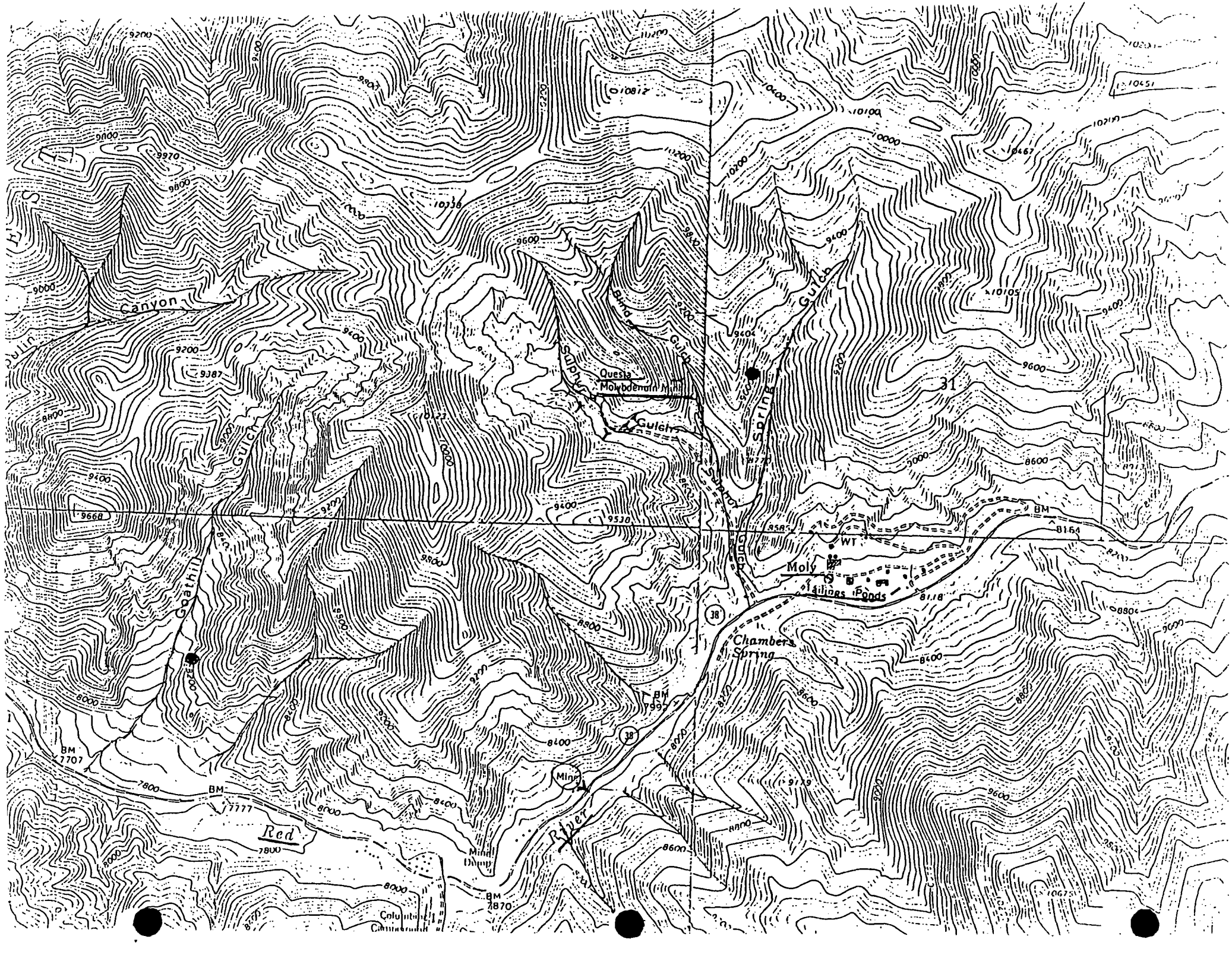
With the enclosed and completed referenced form, Molycorp is requesting that it be exempted from the State of NM Solid Waste Management Regulations under Section 108 Part C since the Questa mine now only places "construction and demolition debris" in its landfills. All lunchroom garbage and office paper waste are disposed of through a private contractor SANCO; and waste oil and cleaning solvent are handled by licensed EPA approved contractors. The two on-site landfills listed on the referenced form have been capped with dirt overburden.

Your consideration of this request is appreciated. If you have any questions please phone me at 586-7~~601~~. 586-0212 3001 3013 3017 = Bill Renison

David R. Shoemaker

David R. Shoemaker

Mine Manager



Canyon
Goathill
Gulch
Sulphur
Blind
Gulch
Questa
Molybdenum Mine
Gulch
Spring
Gulch
Moly
Tailings Ponds
Chambers
Spring
Red
River
Mine
Mine
Dump
31
38
BM
7707
BM
7777
BM
7870
BM
7995
BM
8164
WT
9668
9530
9387
10812
10338
10100
10000
10467
10451
10105
9404
9179
8118
8804
8800
8600
8400
8200
8000
7800
9000
9200
9400
9600
9800
10200
10400

Reference 10

SK

4 ~~3~~-15-93

Attendance: Bob Saltor
Larry Smolka
Mary Ann Menetry
Karen McCormack
Stuart Kent

①

- Bob S.: only 1 family below tailings
Not on public water

outfall #002 - only outflow sampled for
NPDES

photo 11 seeps below 002
12: outflow 002 + dam upstrm.

contam. in stream Al, Cu, Zn accord. to B.S. + L.S.

Cubesto Crk - low flow, dark
organic color of bottom

Red R. at Ranger Station -
milky (ph. 13+14)

photo 15: [illegible] exposed
S[illegible] rocks

- Tailing pipeline being dismantled

- seeps along Red River (Northside)
- ph. 16-17: Al Oxide ppt
Fe Oxide ppt
Li Sandhaulis

[Downgrad from pit]

SK

Pulse rate contamination a water shed problem

ph 21, 20 : Al oxide ppt

Goat Hill
Forested on 63 map

ph 22 : Wst Rock
Some isn't reactive in reactivity tests
Some is "

ph 23 : Bulkhead at end of
Moly Tunnel (~1 mi long, 1% grade)

Bloody Lik 20-30 yr old stress
w/ exposed rock

Mine timbers

More [illegible]
Oxidation of sulfides or natural [illegible]

- H. conduct measured by Bob Salter
low pH " " in Bloody Gulch

Bitter Crk → R.R. + mine (opposite)
pH lowered ~ .1 or .3 units

Fig. 28: Tailings Pond Green
Question Middle (?) School

called Acid Scars

(4)

Wells

~~[illegible]~~ [illegible] from State Engineers Office

#	Title
RG-2935	Mohr C.
Jam RG-54172	
RG-17116	Green
RG-44856	MC
RG-12797	"
RG-13904	

SK

(5)

Surface Area Calculations of Waste Sources at Molycorp using planimeter (transcribed)

		planimeter units
1 mi^2 (from topo):	1)	3596264
	2)	3604608
	$\bar{X}$ =	3600436
Dam #1 (Pond #1)	1)	1335040
	2)	"
	$\bar{X}$ =	1335040
Dam #4 (Pond #4)	1)	1335040
	2)	"
	$\bar{X}$ =	1335040

Pond #1 = Pond #4 = 1335040/3600436 = .3708 mi^2

= 10,300,000 sq. ft.

Open Pit + Wst Rock: 1) 7175840, 2) 7142464 } $\bar{X}$ = 7159152

Surface Area = 7159152/3600436 = 1.988 sq. mi.

Trees: 367136 = .102 sq. mi.

Open Pit − Wst Rock = 1.89 sq. mi. = 1.988 − .102

= 5.26×10^7 sq. ft

Open Pit = 1.26×10^7 sq. ft.

Waste Rock = 4.0×10^7 sq. ft.

SK

Average Diam. of Pit:

$(40 + 55\ mm)/2 = 47\ mm$

Surface Area Wst Rock = $40 \times 10^6\ ft^2$

Average Depth of wst Rock is approx. 30' as stated by David Shoemaker during site visit on Apr. 23 1993

Volume of Wst Rock is approximated by Surface Area (by planimeter) x Average Depth

$40 \times 10^6\ ft^2 \times 30' = \boxed{120 \times 10^7\ ft^3}$

$= 44 \times 10^7\ yd^3$

From HRS Table 2.5

Wst Qnty Value for Source I (Waste Rock) is

$4.4 \times 10^7\ yd^3 / 2.5 = 1.76 \times 10^7$ (using volume

OR

$40 \times 10^6\ ft^2 / 13 \cong 3.08 \times 10^6$ (using area)

Wst Qnty Value for Wst Source II is

$(2 \times 10{,}300{,}000)$ sq. ft $/ 13 = 1.58 \times 10^6$

Since volume of tailings pond cannot be accurately determined using readily available information, source waste quantity is determined using Surface Area.

Surface Area $= 20.6 \times 10^6 \text{ ft}^2$

$\therefore$ Wst quantity value (from Table 2-5) is $20.6 \times 10^6 \text{ ft}^2 / 13 = \boxed{1.58 \times 10^6}$

Transcribed

Date: 4-23-93 Present: Karen McCormack - NMED
Stuart Kent - NMED
David Shoemaker - Molycorp site Mngr

Mining Info.

Ore bodies near contact btwn aplite granite & volcanics (aplite intruding volcanics)

Accord. to D.S.

Waste Rock is mostly aplite

Volcanics:
- consists of rhyolite / andesite
- yellow & causes erosional scars
- contains sulphides which cause acid drainage
  → Acid drainage is all natural

Aplite:
- gray
- located beneath volcanics in the west piles
- provides buffering capacity (carbonate ? in the rock)
- placed over scars in some areas

4-27-93 1978: Unocal purchases Molyb. Corp. America & changes name to Molycorp

Slurry transport ~~Lines~~ (pipe lines)
- trouble w/ spills in the past
1983 — lines double-lined w/ rubber in upper reaches + No spills since
- sections are currently dismantled for Hwy widening
+ replaced by late summer

- sections presently buried will be replaced w/ above ground pipes
+ This helps w/ maintenance

Employees:

Maximum ~ 1100
1989 → '92 ~ 200
Currently 11

photos 12-14 : Tailings pond - looking south
dam 5A (smaller) on right

#15 : Revegetation on West side of
16 tailings ponds - Natural reveget
"Works better than our reseeding" D.S.

Transcribed

4-27-93

Photo #17: Ion exchange plant from Dam #4 - looking south

WINDY on Dam #4 - hard hat flies

→ ~ 30 mph

Photo 18: Soil Cap on Dam (or Pond) #4 - little dust considering the wind.

use of chemical dust suppressant OK until broken

→ Wind blown particulates seem to come from cover soil currently being deposited by scrapers

Seepage Barriers

#002 is below Dam #1

#003 is east of Dam #4 & flows into #002 discharge (photo 19)

Monitoring Well #1 is below #003 but above Herrera well (drinking?)

— New seepage barrier will be installed below #003. Hits in MW-1?

SK

Transcribed

4-27

Along Red River

- ∃ several dump sumps
  + used to temporarily hold tailings slurry while repairs are made on pipelines.

According to D.S.
- Acid drainage to Red River is from Natural scars

photo #20 : Culvert ~~from~~ sk conveying drainage from natural scar
— CORRODED!

photo 21 : Drainage from Hanson Crk (= Elephant Rock)

photos 22-24 : Open Pit

- delineation btwn sulphide volcanics (yellow) & aplite granite (gray) clearly visible

- Open Pit may be used as a future tailings pond

Sk

Transcribed

4-27-93

Open Pit (cont'd.)

- Dewatering Necessary
- Surrounding rock drains necess
  + prevents runon from entering underground mine.

Run-on is purposely funneled into pit & down to new underground workings

- aplite supposedly neutralizes

Surface run-off to Red River (outside open pit)

- minimized by reseeding on benches (photos # 25, 26)

- waste rock is non-homogeneous
  - hard crust develops (promotes run-off)

Gorthill Gulch (photos 27, 28)

- ~~collects~~ OK bore hole to new underground workings (~700')
- collects H_2O (natural & waste wtr) & conveys to mine (below Red River)

Transcribed

4-27-93

Accord. to D. Shoemaker
Run-off (both natural + from open pit area) drains to groundwater (below Red River) via open pit or bore hole in Goathill Gulch.

- Water is near neutral due to buffering of aplite.

∴ Molycorp mine actually reduces acid drainage which would otherwise be naturally occurring

- Water level in new underground mine is rising
  - 6 months of pumping 1st before mining resumes
  - Water ~~p~~ will be pumped to tailings ponds.

Transcribed

4-27-93

Red River WWTP

- located in Hotentot drainage
- pH ~ 2.6 (above Molycorp)
  → according to D.S.
- higher in metals than Hanson Crk (also above Molycorp)

Hanson Crk = Elephant Rk Drainage

ATTACHMENT I, PARAGRAPH 3
TAILS AREA GROUND WATER DISCHARGE PLAN APPLICATION
Item 16

MOLYCORP, INC.
QUESTA DIVISION

EXISTING TAILINGS DISPOSAL AREA

PLAN OF OPERATIONS

1. INTRODUCTION:

This Plan of Operations covers the operation and maintenance of Molycorp's Questa mine existing tailings facilities located in Sections 2/35/26 and 36/25, approximately one mile west of Questa, New Mexico.

2. LOCATION:

The attached Map No's 100 & 200 outlines the existing impoundment area.

The site covering 2,132 acres, is located in Township 29N, Range 12E, Sections 2/25, 26/35 and 36. The property is made up of patented and fee simple land owned by Molycorp. A location map, patented and fee simple land recordation information are available at the BLM State office in Santa Fe and at the Taos County courthouse.

Approximately 555 acres of the site are covered with tailings of which 390 acres of tails have been temporarily capped with a topsoil cover and reseeded. Another 150 acres of tailings will be temporarily capped by July, 1993. Soil stabilizer has and will be sprayed on the remaining small area of tails sand.

3. HISTORY:

A brief history of the development of the Questa mine tails storage area from the 1965 start of open-pit mining to placing the underground mine on standby in 1992 is as follows:

. Table I chronologically lists the construction sequences of dams shown on Map No.'s 100 & 200.

. In 1965, tails disposal was started by constructing starter Dam #1 in a large arroyo at the south end of Section 36. This dam was constructed of earthfill and incorporated an internal drain system. The upstream face of the dam was sealed with the slime fraction of the tailings. The water clarification pond was at the dam face. Clarified water was piped via decant structures raised on the upstream dam face through culvert tunnels under the dam and then by ditch to the Red River.

MOLYCORP, INC.
Questa Mine

TABLE I

TAILS STORAGE DEVELOPMENT

(Chronologically Listed)

YEAR	SECTION 36	SECTION 35
1964/65	Dam 1 to 7425' elevation (starter dam)	---
1966	Dam 1 to 7560' elevation	---
1967	Dam 1 to 7484' elevation	---
1968	Dam 1 to 7500' elevation	---
1969	Dam 1 to 7520' elevation Dam 2 to 7520' elevation	---
1970	-----	---
1971	Dam 1 to 7525' elevation	Dam 4 to 7440' elevation (starter dam)
1972	-----	Dam 4 to 7460' elevation
1973	-----	Dam 4 to 7478' elevation Dam 3A to 7532' elevation avg.
1974	East diversion ditch	West diversion ditch
1975	Dam 1C to 7560' elevation by cyclones Dam 1B, 2A to 7560' elev. Seepage barrier #1 below Dam 1	Dam 4 to 7505' elevation Seepage barrier #2 east of Dam 4
1976/79	-----	---
1980	Dam 2B to 7580' elevation by cyclones	Dam 4 to 7512' elevation
1981/82	Dam 1C, 1B, 2A, separator dike to 7584' elevation	Dam 4 to 7517' elevation
1983	-----	Ion exchange water treatment plant
1990	-----	Dam 5A to 7525' elevation

3. HISTORY (continued)

Dam #1 raises and operation continued in this fashion until 1969, when a small Dam #2 was constructed at the north end of Section 36. The clarification pond was then shifted to the north and the existing decant structures abandoned for a new overflow weir structure constructed in the bank along side the new Dam #2. Clarified water overflowed the weir and traveled down a decant ditch cut around the west side of Section 35 to a small holding pond named Pope Lake located at the south end of Section 35. From Pope Lake, the water flowed over a Parshall flume (later called Outfall 001) and on to the Red River.

The final 7520 ft. and 7525 ft. elevation raises in 1969 and 1971, on Dam #1, were shifted upstream of the existing dam west and constructed on tailings. These lifts were of compacted earthfill.

. In 1971, additional tails storage was created by constructing starter Dam #4 in the Section 35 arroyo, parallel to and just south of Section 36 and Dam #1. This dam and all its subsequent lifts were constructed of earthfill with internal drain systems. The upstream dam face was also covered with an asphalt or plastic membrane to ensure that the upstream face was impermeable. A decant weir was built to the north of the dam so that the clarification pond could be kept away from the dam face. Clarified water was released over the weir structure into the west ditch to Pope Lake and the Red River.

. In 1973, Dam #3A was constructed north of Dam #4, inside the west ditch, in order to close off the north end of Section 35 for additional tails storage.

. In 1974, east and west diversion ditches were constructed around both tails storage areas in order to divert all natural drainage away from the impounded tailings. Diverted water re-entered the watershed below the Dams 1 and 4.

. In 1975, seepage barriers were constructed below Dam #1, and to the east of the ridge separating Dam #4 and Dam #1 areas. These barriers were excavated to clay and sealed on the downstream side and filled with suitable drain material so that ground water from the tails storage ponds could be collected and diverted around the dwellings situated downstream of the tails storage area. This water was then piped to the Red River through Outfall 002.

HISTORY (Continued)

. In the 1975 time period, new dam construction in Section 36 consisted of constructing a new structure approximately 1200 feet upstream of Dam #1. This dam was labeled Dam #1C and was constructed of cycloned tailings. Dams #1B & 2A, were also constructed of earthfill and extended north from the east abutment of Dam #1C, to the far end of Section 36. These structures did not have internal drains and were sealed with tails slimes.

In 1980, a cyclone berm was raised several hundred feet upstream of Dam #2A, and in 1981, new Dams #'s 1C, 1B & 2A, were raised to their present 7584 ft. elevation.

These structures were constructed of earthfill with internal drain systems and upstream face plastic membranes. All structures were constructed downstream of their earlier counterparts. A separator dike was also constructed on the the ridge between Sections 35 & 36, extending north from the west abutment of Dan #1C.

. In 1983, an ion exchange water treatment plant was constructed alongside Pope Lake. This plant processed all tails decant water before it was discharged into the Red River.

. In 1990, Dam 5A was constructed in the old west decant channel on the north side of Dam 3A to an 7525 ft. elevation. The dam is designed to be raised to 7540 ft. elevation at a later date.

4. DAM DESIGN PARAMETERS

The dams impounding the tailings are hydraulic structures of compacted earth fill with internal drains. Dams 1C and 4, have impermeable membranes installed on their upstream faces. Existing Dams 1C, 1B, 2A in Sections 36/25, have a common crest elevation of 7585 ft. with design approval by the State Engineer to 7610 ft. elevation. Existing Dam 4, in Section 35, has a crest elevation of 7520 ft. with State Engineer approval to 7537 elevation. Dam 5A was designed with a rock downstream core in order to store water on both sides. State Engineer approval is to the 7540 ft. elevation. The existing dam crest is at 7525 ft. elevation.

5. BASIC OPERATING SCHEME

Tailings are transported from the mill to the tails pond in two, 50,000 foot long, rubber lined tails lines in a slurry at 38% by weight solids.

The tailings are discharged from spigot points located around the tails disposal area. After the tailings are discharged into the disposal area, the tails water is retained for a long enough period to allow the solids to settle out. This retention time is governed by overflow weirs constructed at strategic points in the impoundment area. Water flow from the impoundment area is controlled by adding weir boards to the structures.

After water overflows the final weir, west and north of the No. 4 dam, the tails water is conveyed by ditch and pipeline to the water treatment plant located below Dam No. 4. After water treatment, the tails water is discharged into the Red River at Pope Lake (Outfall 001).

6. OPERATING PARAMETERS

The following tailings disposal operating philosophy is used.

a) Utilize pond areas efficiently in order to eliminate mill disruptions.

b) Control tails disposal areas so that areas are either wet with tailings, under water in clarification phase, or tails sand covered with chemical stabilizer for short term dust control, or soil top cover for long term dust control.

c) Keep clarification ponds away from dam faces.

d) When introducing tailings into new areas not covered with tailings, initially establish tails beach against structure, or over natural ground to seal area against seepage.

e) Where feasible, minimize exposed tails sand areas by berming area with tails sand or controlling spigotting of tails to form ridges to attempt to isolate tails into cells.

f) Adjust decant overflow weirs to maximize water clarification.

7. FACILITIES MAINTENANCE AND INSPECTION

The following maintenance and inspection procedures are used.

a) When the mill is operating, Tails patrol over lines, pond areas and dams, 24 hours/day.

b) Daily recording of #002 seepage outflow and inspection of seep barrier No. 2 pipeline.

c) Monthly readings of piezometers in dam structures and visual inspection of all structures.

d) Continuous monitoring in mill control room of tails lines flow rates, pressure and sampling of tails to check density of slurry.

8. ENVIRONMENTAL

The following environmental controls are utilized.

a) Rainwater and snow melt diversion ditches have been constructed around the area in order to divert all material runoff away from the tails containment ponds.

b) Two seepage barriers and drain systems have been constructed below No. 1 Dam and adjacent ot No. 4 Dam to collect and divert seepage water to #002 Outfall.

c) Tails Dust Control: Either by soil top cover and revegetation for long-term stabilization; or by coating exposed dry sand with chemical soil stabilizer for short-term.

d) Tails Decant Water Treatment: All clarified water from ponds is conveyed to a water treatment plant before final discharge into the Red River.

e) Tails lines are rubber lined for their entire length in order to reduce pipeline wear.

Reference 12

RECORD OF TELEPHONE CONVERSATION

Time: 2:30	Date: 7-12-95
Originating Party: Stuart Kent - WRS II	Other Parties: Superintendent's office - Questa Schools
NMED - Superfund	(505) 586-0421

Subject: Number of Students + Faculty at Questa Jr. High

Discussion:

+ 171 students
17 Faculty
188 Total

Stuart Kent
Signed

Reference 13

EPA REGION 6
FIRST QUARTER FY94 PROJECTIONS
FOR OCTOBER
(4 Weeks:Lab receipt Oct 04 - 30)

	SUPERFUND	NON-SUPERFUND
ORGANIC ANALYSES		
Full TCL (35 Day TA)		
VOA Only		
BNA Only		
Pesticide/PCB Only		
14 Day TA Full TCL		
14 Day TA VOA Only		
14 Day TA BNA Only		
14 Day TA Pesticide/PCB Only		
INORGANICS		
Full Metals w/ Cyanide (35 TA)		
Metals Only		
14 Day TA Metals w/ Cyanide		
14 Day TA Metals Only		
High Concentration Metals with/without CN		
High Concentration pH & Conductivity only		
DIOXIN		
Dioxin/Furan (PCDD/PCDF) 45 Day TA		
Fast TA 2,3,7,8 TCDD		
OTHER		
* Full TCL High Conc. Organics		
* Low Conc. Water Inorganics		
* Low Conc. Water Organics		
* QTM (Quick Turnaround Method)		
* TCLP		
* Wet Chemistry		

Signed By: EPA Site Manager, RPM, OSC _____ Mail Code _____ Date _____

* = IFB not currently in place ; TA = Turnaround Time ;
CN = Cyanide
RETURN THESE FORMS (SIGNED), WITH OR WITHOUT YOUR PROJECTIONS BY
COB Aug/18/1993, TO: Myra Perez
USEPA - Houston Branch
10625 Fallstone Rd
Houston, Tx. 77099

FAX # (713) 983-2248

1992 Draft

Federally Listed and Candidate Species Distribution in New Mexico by County

This information is not for public distribution.

Only animals and plants classified as Federal endangered, threatened, proposed or candidates are included. Category 1 species are taxa for which the Service currently has substantial information on biological vulnerability and threats to support listing as threatened or endangered. Category 2 species are taxa for which information indicates proposing to the list as endangered or threatened may be appropriate, but conclusive biological data are not available.

STATEWIDE

Black-footed ferret, Mustela nigripes, endangered; in association with prairie dog towns in grassland plains and surrounding mountain basins up to 10,500 feet elevation. Surveys for black-footed ferrets are required if the prairie dog town is over 80 acres for black-tailed prairie dogs, and 200 hundred acres for white-tailed and Gunnison's prairie dogs. If the prairie dog town is greater than 1,000 acres, then the area should be evaluated for possible reintroduction of black-footed ferrets. Three counties that must list for black-footed ferret at all times: McKinley, Rio Arriba and San Juan.

Bald eagle, Haliaeetus leucocephalus, endangered; over-winters in most counties from October through April; from the northern stateline, southward regularly to the Gila, lower Rio Grande, middle Pecos and Canadian valleys. Nest have been reported in San Juan, Colfax and Catron counties. Key winter habitat areas include such areas as Navajo Lake, Chama valley (Rio Arriba), Cochiti Lake, northeastern lakes (Raton to Las Vegas), lower Canadian valleys, Sumner Lake, Elephant Butte Lake, Caballo Lake, upper Gila Basin, Santa Rosa Lake, Tucumcari and Ute Lakes. Dry land areas: Region between Pecos Valley and the Sandias and Manzanos, Capitan and Sacramento Mountains, and the Mogollon Plateau.

American peregrine falcon, Falco peregrinus anatum, endangered; summers in montane areas almost statewide; mainly in northern and Mogollon highlands. Nests in areas with steep cliffs and wooded/forested habitats, often near water. Prefers 6,500-8,500 feet elevations, but can be found from 3,500-9,000 feet. Migrates and winters almost statewide.

Ferruginous hawk, Buteo regalis, Category 2 candidate; resident locally almost statewide; most regular in summer in the eastern plains and the San Agustin Plains. Key habitat are wide open grasslands and prairies at lower and middle elevations. Migrates and winters almost statewide.

SOUTHWESTERN WILLOW FLYCATCHER

(*Empidonax trailii extimus*)

STATUS: Category 2 candidate

DESCRIPTION: A sparrow-sized dark headed, olive green flycatcher with a whitish throat, pale olive breast and pale yellow belly. Lacks conspicuous eye ring. Dusky wings have two whitish bars. Has a habit of flicking tail upward. Song is a sneezy "Fitz-bew", a whistle superimposed on a buzz.

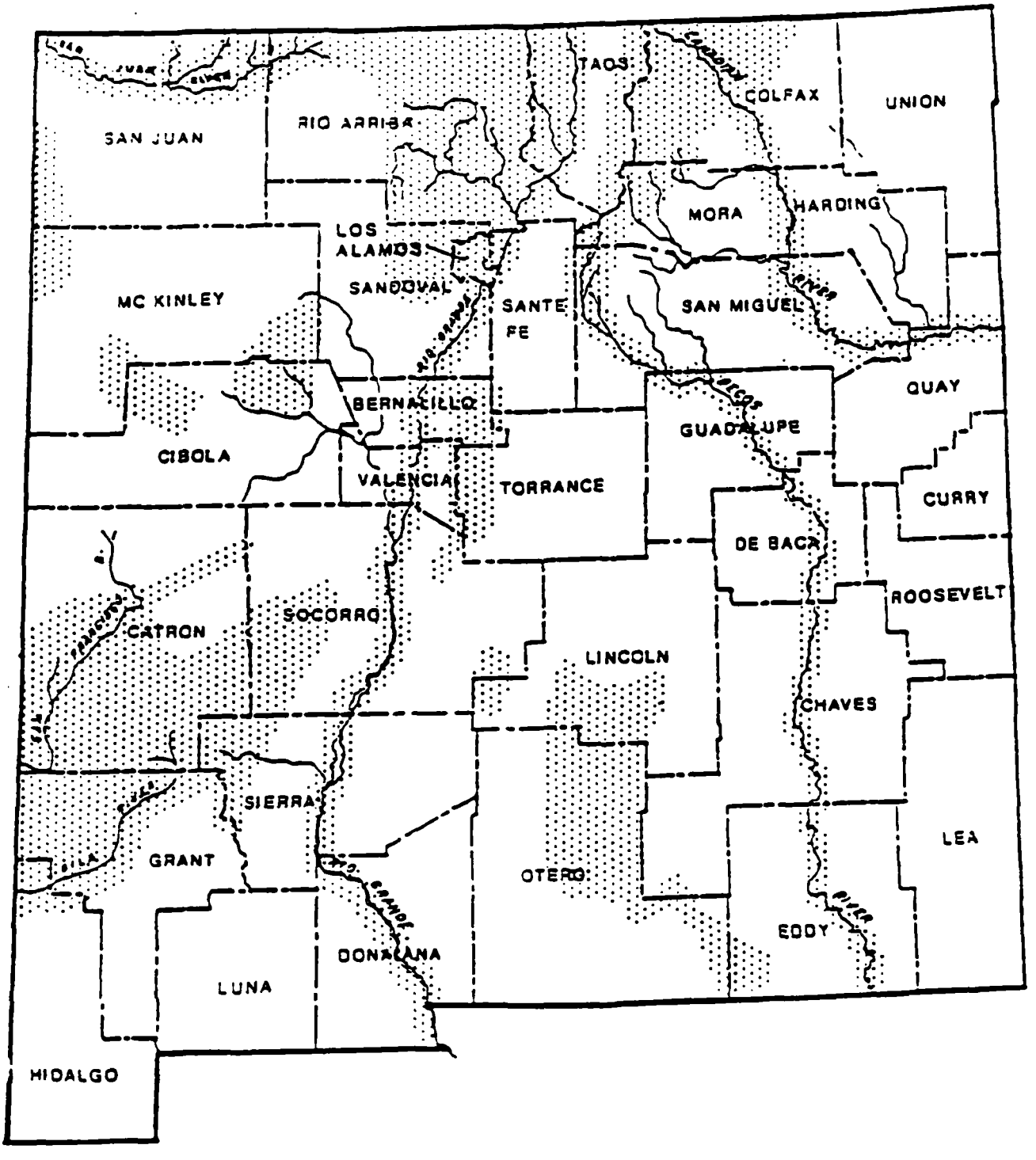
HABITAT: Deep shaded mature woodlands, swamps, willow or alder thickets, along streams, bogs, muskegs, edges of mountain meadows, orchards, and dry, brushy upland pastures. Nests in a neat but loosely woven cup nest in an upright crotch of a low shrub. Found over a wide elevational range, but primarily between 1,100-1,700 m (3,700-5,500 feet).

DISTRIBUTION: See map. Current population centers are small and widely dispersed. Populations in New Mexico are estimated at 100 pairs. Summers in the San Juan, Chama, Rio Grande, San Francisco, Gila valleys, and San Juan Mts. Breeding areas records include: the Jemez Mts.; Red River, Carson National Forest; Eagle Nest Lake, Colfax Co.; Philmont Scout Camp, Colfax Co.; Maxwell NWR, Colfax Co.; Las Vegas, San Miguel Co.; Santa Rosa, Guadalupe Co.; Bitter Lake NWR; Silver City, Grant Co.; and Artesia, Eddy Co.

REASONS FOR DECLINE: Loss of riparian habitat. Brown-headed cowbird parasitism is considered a serious threat to the sub-species.

MANAGEMENT RECOMMENDATIONS:

1. Monitor sample populations to determine condition and trends.
2. Protect existing riparian in the southwest, and promote the native revegetation of stream corridors.



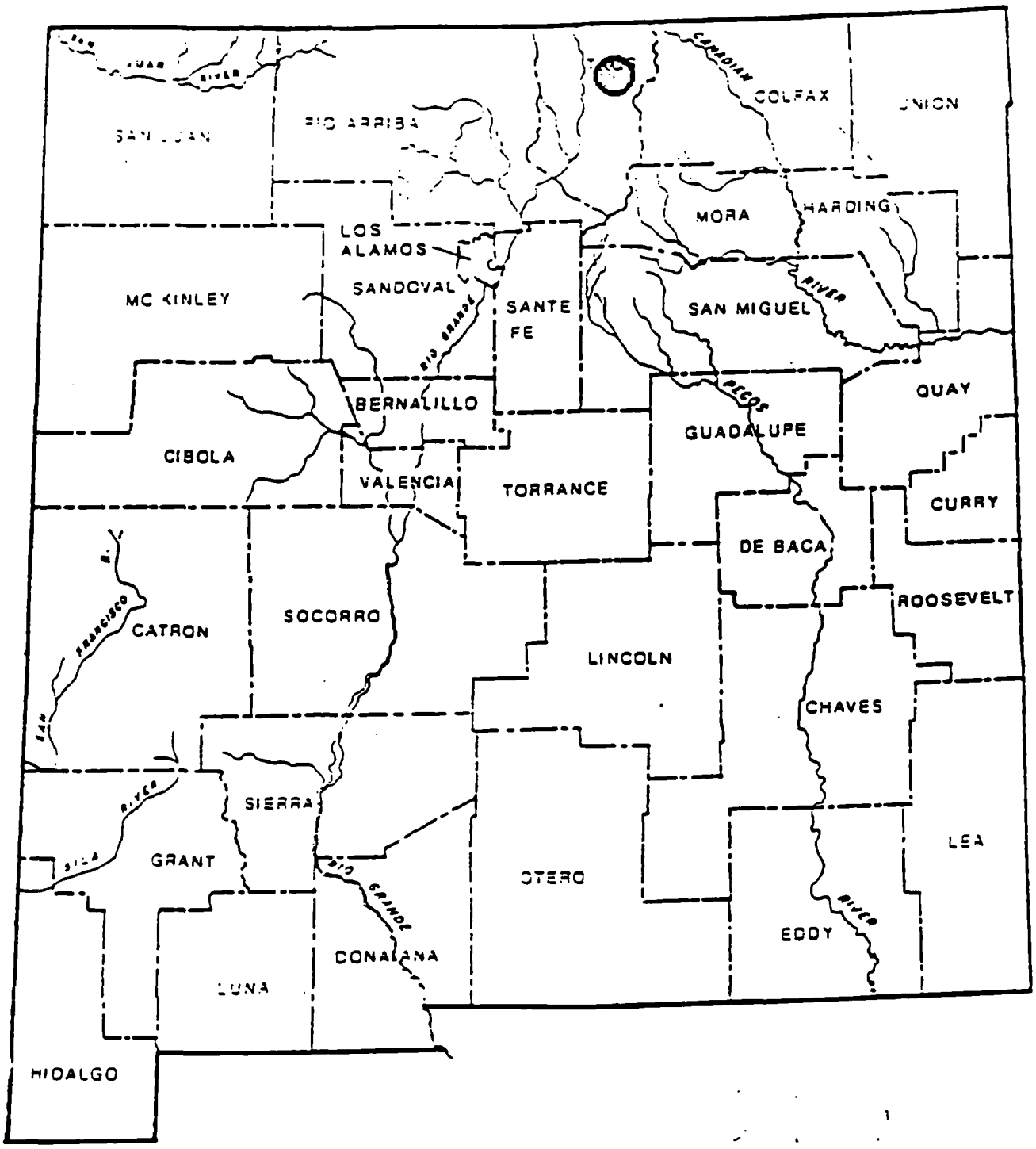
RANGE - POTENTIAL SUITABLE HABITAT

ONLY KNOWN OCCURANCE

SPECIFIC RECORD

NEW MEXICO

SOUTHWESTERN WILLOW FLYCATCHER



RANGE - POTENTIAL SUITABLE HABITAT

ONLY KNOWN OCCURANCE

SPECIFIC RECORD

NEW MEXICO

SMALL-HEADED GOLDENWEED

SMALL-HEADED GOLDENWEED

(*Haplopappus microcephalus*)

STATUS: Category 2 candidate

DESCRIPTION: Asteraceae family. Mat-forming perennial with spreading stems to 5 cm long; leaves numerous, lanceolate, 2-4 cm long to 3.5 mm wide, usually without toothed margins or with occasional minute tooth; flower heads, 6-8 mm high, several to many in a rather flat-topped cluster, the outer flowers of each head with inconspicuous yellow rays about 3 mm long; involucral bracts firm, translucent, in several series, the outermost bracts gradually tapering to a point. Flowers in June and July.

HABITAT: Crevices on granite rocks, usually in ponderosa forests; 2,450-2,600 m (8,000-8,500 ft).

DISTRIBUTION: See map. This species is known only from one collection from the western Sangre de Cristo Mountains in Taos county, New Mexico.

REASONS FOR DECLINE: Population trends and threats to taxon are unknown.

MANAGEMENT RECOMMENDATIONS:

1. Survey and inventory additional populations.
2. Regularly monitor the population to determine condition and trends.
3. Initiate studies characterizing habitat.

Reference 14

INVENTORY OF RARE AND ENDANGERED PLANTS OF NEW MEXICO

EDITED BY:
ROBERT SIVINSKI
AND
KAREN LIGHTFOOT

NEW MEXICO FORESTRY AND RESOURCES CONSERVATION DIVISION
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
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TABLE OF CONTENTS

Page No.

Description of State of New Mexico Lists 1
Information Included
R-E-D Code 3
Federal Status 4
Distribution 4
Habitat Descriptions 4
Permits 6

LIST 1. PLANT SPECIES ENDANGERED IN NEW MEXICO 7

LIST 2. NM RARE AND SENSITIVE PLANT SPECIES 19

LIST 3. NM RARE PLANT REVIEW LIST 33

LIST 4. PLANT SPECIES DROPPED FROM CONSIDERATION 42

Species by Family 47
Species by County 51
Acknowledgements 57
References 58

FEDERAL STATUS

LE Listed as endangered by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (ESA).

LT Listed as threatened by the USFWS under the ESA.

PE Proposed by the USFWS to be listed as endangered under the ESA.

PT Proposed by the USFWS to be listed as threatened under the ESA.

C1 Category 1 Candidate for which the USFWS has sufficient information to support a proposal to list as threatened or endangered.

C2 Category 2 Candidate for which the USFWS needs additional information to support a proposal to list as threatened or endangered.

3A Extinct Species. Taxa for which the USFWS has persuasive evidence for extinction.

3B Taxonomic problems. Taxa which do not meet the USFWS's definition of a "species".

3C Taxa which have proven to be more abundant or widespread than previously believed and/or which have no identifiable threats.

FSS Forest Service Sensitive. Rare plant species which the U.S. Forest Service consider sensitive to land use practices within National Forests.

DISTRIBUTION

The New Mexico distribution of each species is given by county. Each county abbreviation is usually the first two letters of the word (eg. OT = Otero County). If the county name has two words, then the first letter of each is the abbreviation (eg. SF = Santa Fe). Other states are indicated by conventional abbreviations.

BE	Bernalillo	MC	McKinley
CA	Catron	MO	Mora
CH	Chaves	OT	Otero
CI	Cibola	QU	Quay
CO	Colfax	RA	Rio Arriba
CU	Curry	RO	Roosevelt
DA	Dona Ana	SA	Sandoval
DB	De Baca	SF	Santa Fe
ED	Eddy	SI	Sierra
GR	Grant	SJ	San Juan
GU	Guadalupe	SM	San Miguel
HA	Harding	SO	Socorro
HI	Hidalgo	TA	Taos
LA	Los Alamos	TO	Torrance
LE	Lea	UN	Union
LI	Lincoln	VA	Valencia
LU	Luna		

HABITAT

Habitat information for each species is compiled from field observations, herbarium labels, and published reports and floras. The plant community descriptions used here conform to the map of Biotic Communities of the Southwest

by Brown and Lowe (1977). Please refer to Brown (1982) for a more complete discussion of each community type. Consistent substrate characteristics, such as gypsum, shale, sand dune, etc., are also indicated after the community abbreviation.

AlTun — Alpine Tundra. Above tree line from about 12,000 feet elevation. Typically rocky with a very short growing season. Low or prostrate cover of cool-season grasses, sedges, perennial forbs and shrubs. Sangre de Cristo Mts.

CDScr — Chihuahuan Desert Scrub. Hot, dry plains with widely scattered shrubs typically of creosote, tarbush, mesquite, Acacia and Yucca with warm-season grasses, forbs and cacti in the shrub interspaces. Widespread throughout S. NM, usually at elevations below 5,500'.

GBDScr — Great Basin Desert Scrub. A dry, cold winter desert with typical shrub dominance of sagebrush, saltbush, winterfat and greasewood. San Juan and Northern Rio Grande Basins.

IntChap — Interior Chaparral. Relatively dense shrub association on desert mountain slopes. Diverse composition, with Chihuahuan, Sonoran and Great Basin Desert affinities, including shrub live oak, manzanita, mountain mahogany, silktassel, sotol, catclaw and many more. Lower slopes of mountains throughout S. NM.

MEvgWdl — Madrean Evergreen Woodland. A mild winter-wet summer woodland of Mexican oaks and pines, such as Chihuahua pine and Emory, Silverleaf and Arizona white oaks. Peloncillo, Animas, Burro and Organ Mts.

P&GBGrl — Plains & Great Basin Grassland. Mostly short-grass plains of grama, wheatgrass, three-awn, muhly, galleta and buffalograss. Dominated by snakeweed when continuously grazed by livestock. Widespread throughout NM, usually at elevations below 7,500'. A large variant area with shinnery oak occurs in SE NM.

PJWdl — Great Basin Conifer Woodland. Cold adapted evergreen woodland at intermediate elevations. Short stature trees of pinyon pine and juniper. Tree interspace species of grasses and shrubs vary depending on elevation and latitude. Widespread throughout NM, usually at elevations between 5,500' and 7,500'.

RMMCF — Rocky Mountain Montane Conifer Forest. These mountain forests represent Merriam's Transitional Zone (ponderosa pine) and Canadian Zone (Douglas fir-white fir). Gambel oak and New Mexico locust are also important species. Aspen forms extensive fire replacement stands at the higher elevations of this type. Mountain ranges, at elevations between 7,500' and 10,000'.

RMSCF — Rocky Mountain Subalpine Conifer Forest. The highest elevation forests in the State. Contains Engelmann spruce, blue spruce, subalpine fir, corkbark fir and bristlecone pine. Large areas are dominated by aspen after forest fires. Mountain ranges, at elevations between 10,000' and 12,000'.

SAGrl — Subalpine Grassland. Cold, high elevation grasslands that occupy valleys, slopes and ridges within montane and subalpine conifer forests. Perennial, bunchgrasses of fescue, bluegrass, wheatgrass and tufted hairgrass accompanied by forbs such as sedges, cinquifoil, yarrow, vetch and dandelion. Mountain ranges, between 7,500' and 12,000'.

SDGrl — Semidesert Grassland. Hot, dry plains of warm season grasses such

LIST 2. NM RARE AND SENSITIVE PLANT SPECIES

Eriogonum lonchophyllum Torr. & Gray var. nudicaule (Torr.) Reveal
Bare-stemmed buckwheat Polygonaceae
R-E-D Code: 1-1-3 **Fed. Status:** None
Distribution: NM(MC,RA,SA,SF)
Habitat: PJWdl, P&GBGrl
Note: This variety is less shrublike, and the inflorescence is less branched than var. lonchophyllum.

Eriogonum scabrellum Reveal
Westwater buckwheat Polygonaceae
R-E-D Code: 1-2-2 **Fed. Status:** None
Distribution: NM(SJ), adjacent CO and UT
Habitat: GBDScr; shale
Note: A Colorado Plateau endemic. Occurs in areas with surface minable coal reserves.

Euphorbia strictior Holz.
Tall plains spurge Euphorbiaceae
R-E-D Code: 1-2-2 **Fed. Status:** 3C
Distribution: NM(CH,CU,RO), TX
Habitat: P&GBGrl
Note: Most known locations for this plant are within highway right-of-ways.

Graptopetalum rusbyi Rose
Rusby's stonecrop Crassulaceae
R-E-D Code: 1-1-2 **Fed. Status** 3C
Distribution: NM(GR), adjacent AZ
Habitat: MEvgWdl, IntChap; cliffs
Note: Known in NM from only a single location. It is the only NM species in the stonecrop family with an erect flowering habit.

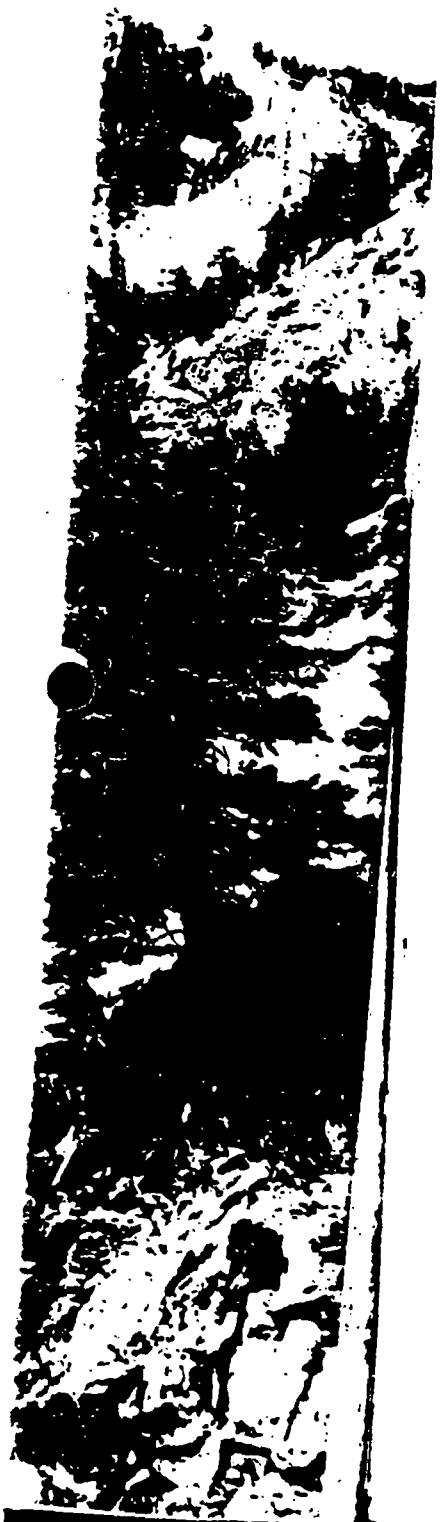
Haplopappus microcephalus Cronq.
Small-headed ericameria Asteraceae
R-E-D Code: 2-1-3 **Fed. Status:** C2, FSS
Distribution: NM(RA,TA)
Habitat: RMMCF; granite outcrop
Note: Not uncommon within its limited range. Dr. Guy Nesom proposes to transfer this species to the genus Ericameria.

Hedeoma pulcherrimum Woot. & Standl.
Mescalero pennyroyal Lamiaceae
R-E-D Code: 1-1-3 **Fed. Status:** 3C
Distribution: NM(LI,OT)
Habitat: RMMCF
Note: Readily colonizes disturbance areas such as road cuts.

Hedyotis aqulata Fosberg ex. Shinners
Rock bluet Rubiaceae
R-E-D Code: 1-1-2 **Fed. Status:** None
Distribution: NM(ED,GU), adjacent western TX
Habitat: P&GBGrl, CDScr; limestone or gypsum
Note: Synonymous with Hedyotis nigricans var. parviflora in Correll and Johnston (1972). A fairly widespread, but infrequently located plant.

Mill Superfund site. The State will do its best to insure that effective transportation controls and road maintenance will be adhered to during implementation of the preferred remedy. If you have any further questions or need additional information, please call Randy Merker of my staff at (505) 827-0078.

Sincerely,



BULLETIN 51

Geology of the Questa Molybdenum (Moly) Mine Area, Taos County, New Mexico

BY JOHN H. SCHILLING

Local structure and stratigraphy, and detailed description of mineral deposits as related to regional geology, with guides to ore exploration in the surrounding area

1956

STATE BUREAU OF MINES AND MINERAL RESOURCES
NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
CAMPUS STATION SOCORRO, NEW MEXICO

NEW MEXICO INSTITUTE OF MINING & TECHNOLOGY
E. J. Workman, *President*

STATE BUREAU OF MINES AND MINERAL RESOURCES
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FRONTISPIECE

View of Sulphur Gulch showing W level dump (lower left), landslide covering portals of Glory Hole workings (center), and the altered area – hydrothermal pipe – at the head of Sulphur Gulch (treeless area, upper right).

Contents

	Page
ABSTRACT	ix
INTRODUCTION	1
Purpose and Scope	1
Methods of Investigation	1
Previous Work	2
Acknowledgments	2
Geographic Features	4
Location and Accessibility	4
Physical Features	4
Climate	4
History and Production	6
Surface Plant and Mine	8
Mining Methods	8
Prospecting and Exploration	8
Development	9
Stoping	9
Transportation	10
Drainage and Ventilation	10
Milling Methods	10
GEOLOGIC SETTING	11
Descriptive Geology	11
Introduction	11
Precambrian	11
Amphibolite Complex	11
Cabresto Metaquartzite	16
Granite	18
Pegmatites	19
Diabase Dikes	19
Pennsylvanian-Permian (?) Sangre de Cristo (?) Formation	20
Tertiary	23
Volcanic Complex	23
Andesite and Rhyolite Intrusives	25
Soda Granite	26
Postgranite Dikes	30
Quaternary	30

Page

Terrace Gravels 30
Cemented Gravels 31
Alluvium 31
Mud-Flows 31
Cover 32
Structural Geology 33
Introduction 33
Regional Structures 33
Folds 33
Faults 34
Fractures 35
Brecciation 37
Foliation 37
Alteration 37
Introduction 37
Hydrothermal Pipes 38
Propylitic Alteration 39
Geologic History 40

MINERAL DEPOSITS 42
Introduction 42
Questa Molybdenum Mine Deposit 42
Introduction 42
Spacial Relation of Veins to Rock Units and Structure 42
Size and Form of Veins 46
Ore Shoots 51
Vein Mineralogy 54
Introduction 54
Ore Minerals 54
Molybdenite 54
Gangue Minerals 55
Apatite 55
Biotite 55
Calcite 55
Chalcopyrite 55
Chlorite 56
Ferrimolybdite 56
Fluorite 56
Galena 56

Page

Gold 56
Graphite 56
Hübnerite 57
Limonite 57
Malachite 57
Orthoclase 57
Pyrite 57
Quartz 57
Rhodochrosite 58
Rhodonite 58
Silver 58
Sphalerite 58
Wall Rock and Gouge 58
Changes with Depth 58
Paragenesis 58
Wall-Rock Alteration 59
Movements During Vein Formation 62
Genesis 62
Manner of Emplacement 62
Depositional Control 62
Physical Conditions 65
Source of the Ore-Forming Solutions 65
Age 65
Summary of Vein Formation 65
Classification 66
Other Mineral Deposits 66
Bear Canyon (Horseshoe) Prospects 68
Log Cabin Canyon Prospects (Steve's Prospect ?) 68
Bernhardt Prospects 68
Horner Prospects 71
Hercules Prospects 71
BJB Prospects 71
Other Prospects in Hydrothermal Pipes 73
Silver Bell Prospect 73
Summary and Conclusions 73
Secondary Enrichment in Hydrothermal Pipes 74
Future Possibilities and Guides 75
High-Grade Molybdenite Deposits 75

Page

Questa Molybdenum Mine 75
Other Areas 76
Low-Grade Molybdenite 77
Low-Grade Copper 77
Other Types 78
Summary and Conclusions 78

REFERENCES 79

INDEX 83

Illustrations

Page

TABLE

1. Vein minerals of the Questa molybdenum mine 54

FIGURES

1. Index map showing the location of the Questa molybdenum mine ..... Facing 1
2. Isometric diagram of the Questa molybdenum mine area 3
3. Climatic data for the Questa molybdenum mine area 5
4. Molybdenite concentrates produced from the Questa molybdenum mine 7
5. Generalized rock section of the Questa molybdenum mine area 13
6. Generalized geologic map of the Taos Range and Taos Plain .. 14
7. Precambrian rocks 17
8. Section of the Pennsylvanian-Permian (?) sediments north of State Highway 38, at the east edge of the mine camp 21
9. Soda granite 28
10. Generalized geologic map of the Questa molybdenum mine area 43
11. Cross-section through No. 3, W, and Glory Hole levels of the Questa molybdenum mine showing veins pinching out as they extend into the granite stock 45
12. Cross-section through No. 3, W, and Glory Hole levels of the Questa molybdenum mine showing en echelon veins paralleling contact 45
13. Cross-section through No. 3, W, and Glory Hole levels of the Questa molybdenum mine showing vein cutting across irregularity of the contact 47
14. Cross-section through No. 3, W, and Glory Hole levels of the Questa molybdenum mine showing a stope block, or large xenolith, and a vein 47

Page

5. Plan of a level in the Questa molybdenum mine showing en echelon veins, pinching of veins as they extend into the propylitized volcanics, and a vein offset by faulting 48
6. Plan of a level in the Questa molybdenum mine showing a vein pinching as it extends into the propylitized volcanics 48
7. Plan of a level in the Questa molybdenum mine showing a vein that divides into many small veins as it extends into the soda granite 49
8. Plan of a level in the Questa molybdenum mine showing a vein along a soda granite dike 49
9. Plan of a level in the Questa molybdenum mine showing a vein in the soda granite paralleling the contact 50
10. Plan of a level in the Questa molybdenum mine showing an ore shoot at the intersection of two veins 50
11. Cross-section of two veins 51
12. Plan of a typical large stope in the Questa molybdenum mine 53
13. Paragenesis of the vein minerals of the Questa molybdenum mine 59
14. Drawings of polished sections of vein minerals 60
15. Formation of the open space in which the ore shoots occur ... 64
16. Geology of the area covered by reconnaissance mapping 67
17. Geology of the Bear Canyon (Horseshoe) prospect 69
18. Geology of the southern Bernhardt prospect 70
19. Geology of the Hawk tunnel, northernmost BJB prospect 72

PLATES

1. Block diagram of the Questa molybdenum mine, Taos County, New Mexico ..... In pocket
2. Geologic map and sections, Questa molybdenum mine area, Taos County, New Mexico ..... In pocket
3. View of Sulphur Gulch ..... Frontispiece
4. Typical veins ..... Opposite 56
5. Specimens of vein materials ..... Opposite 57

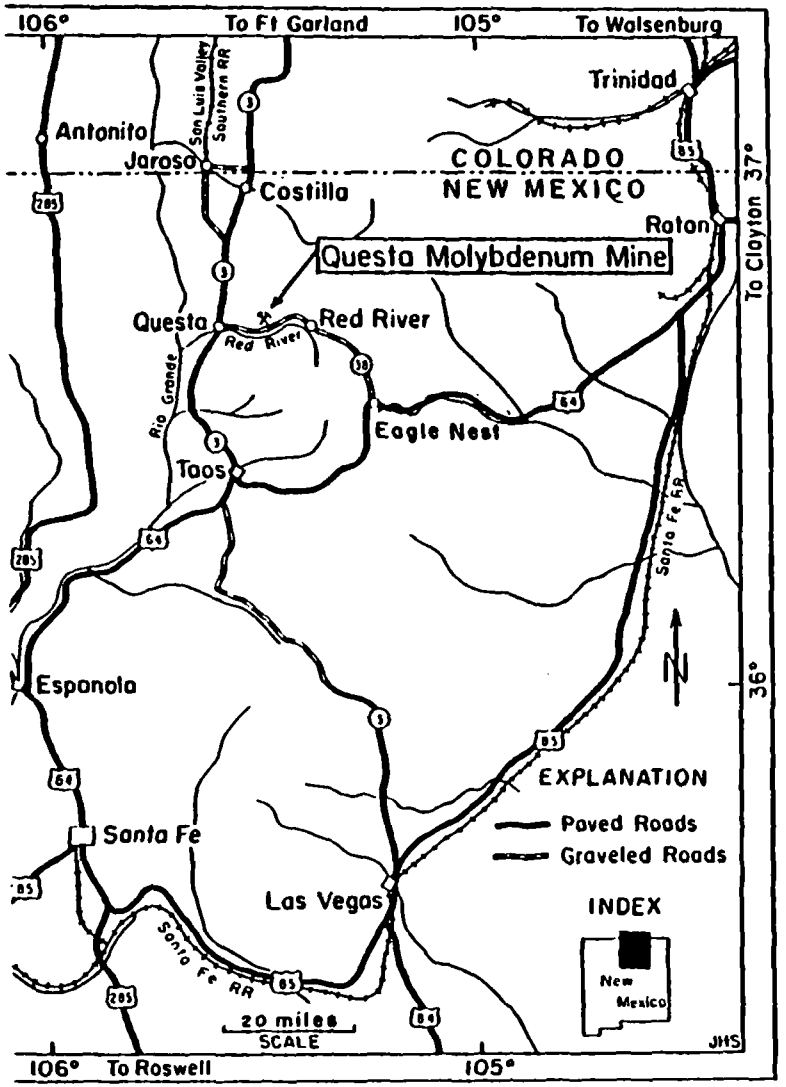
Abstract

The Questa molybdenum mine (known locally as the Moly mine), 6 miles east of Questa, in the Taos Range of the Sangre de Cristo Mountains, Taos County, New Mexico, is unique in containing high-grade molybdenite ore in fissure veins, whereas in most other mines production is from low-grade, disseminated deposits. The true nature of the veins first was recognized in 1916. In 1920 the Molybdenum Corporation of America acquired the property, and the mine has been in almost continuous production since then. Total production to Jan. 1, 1956, was 18,095,000 pounds of molybdenite. Mining is by overhand, horizontal slicing in stull-supported stopes; concentration is by flotation.

The Taos Range is made up chiefly of Precambrian metamorphic rocks overlain by Tertiary volcanic rocks. In the vicinity of the mine, Precambrian amphibolites and quartz-biotite schist of the amphibolite complex are overlain by Cabresto metaquartzite, and all these units are intruded by Precambrian granite. Late Paleozoic and Mesozoic sediments crop out along the eastern edge of the range and in small scattered areas elsewhere in the range. At the mine, conglomerates, arkosic graywackes, siltstones, and limestones overlie the Precambrian and are correlated tentatively with the Pennsylvanian-Permian Sangre de Cristo formation. A thick sequence of Miocene (?) volcanics (the volcanic complex) overlies the older rocks. The lower series of this complex includes andesite and quartz latite flows, breccias, and tuffs (the andesitic series); these in turn are overlain by an upper series of rhyolite flows, breccias, and tuffs (the rhyolite series). Numerous dikes, sills, and small plugs of rhyolite and andesite may be the intrusive equivalents of this volcanic complex. Late Tertiary soda granite stocks and dikes intrude the older rocks. Quaternary alluvial gravels cover the valley bottoms and terraces, and mud-flows form fans in Red River Canyon at the mouths of some of the side gulches.

Folding is not an important structural feature of the Taos Range. Faults are common, the majority being divisible into three systems: (1) north trending thrust faults along the east edge of the range, active during late Cretaceous and early Tertiary time, with thrusting toward the east; (2) north to northwest trending high-angle frontal faults along the west edge of the range and associated parallel faults throughout the range, active during late Tertiary and early Quaternary time; and (3) east to northeast trending high-angle faults throughout the range, active during the Precambrian or Paleozoic, with later Tertiary and Quaternary movement along some faults. Fractures parallel the east to northeast trending fault system. The Precambrian rocks show foliation, which most commonly strikes N. 50° E. to N. 70° E. and dips vertically.

Important local structures are superimposed on the regional structures of the Taos Range, forming the structural pattern in which the ore deposits occur. The mine is located in a downfaulted zone several



N MAP SHOWING THE LOCATION OF THE QUESTA MOLYBDENUM MINE.

Figure 1

Introduction

PURPOSE AND SCOPE

The Questa molybdenum mine, known locally as the Moly mine, is unique in containing high-grade molybdenite ore in large veins, whereas nearly all other production is from low-grade, disseminated deposits. This report describes the geology of the Questa molybdenum mine and the other nearby prospects in detail, relates this detailed picture to the regional geology, and discusses the possibilities of future mineral production in the surrounding area, offering practical guides thereto. It is hoped that the ideas presented here will be useful also in locating and evaluating other mineral deposits with similar features.

METHODS OF INVESTIGATION

The writer first became interested in the mine during the summer of 1950 while serving as an assistant to Philip McKinlay, of the New Mexico Bureau of Mines and Mineral Resources, who was mapping the Taos Range of the Sangre de Cristo Mountains.

A total of 14 months was spent during the years 1951-55 examining the mine and surrounding area. Accessible workings were mapped on a scale of 1 inch to 20 feet; the surface over the mine (area of pl 2) was mapped on a scale of 1 inch to 500 feet. Maps of Molybdenum Corporation of America were used as bases.

For the detailed surface mapping, a dividing line between outcrop and cover was set up arbitrarily. The following rules were made and followed as closely as possible during mapping. All outcrops over 50 by 50 feet in size were delineated. All dikes over 1 foot wide also were mapped. Smaller isolated outcrops that could not be shown on the map were included with the cover. Locally small, isolated outcrops surrounded by a large area of cover (soil, talus, etc.) or other rock types, but important to the overall geologic picture, are shown on the map and are exaggerated slightly in size. A number of smaller outcrops spread over an area larger than 50 by 50 feet, but not more than 20 feet apart or covering less than 25 percent of the area, were mapped as one outcrop.

An area of approximately 20 square miles in the vicinity of the mine (area of fig 26) was mapped on a scale of 1 inch to 1 mile by a series of reconnaissance traverses designed to outline the important geologic features. Most of the prospects in the area were mapped by Brunton compass and tape.

A large number of specimens of the different rock types and vein materials were collected, from which over 150 thinsections and 7 polished sections were made and examined. The laboratory work, drafting, and writing were done in Socorro, with the aid of the facilities of the New Mexico Bureau of Mines and Mineral Resources.

PREVIOUS WORK

The deposit was described initially in a brief paper by Larsen and oss (1920). A more detailed study was made by Vanderwilt (1938), who ent 4 months at the mine, mostly in underground studies. McKinlay 956) mapped the geology of the Taos Range, in which the mine is cated. Vanderwilt's paper and McKinlay's work were the foundation r the more detailed investigation made for this report.

ACKNOWLEDGMENTS

The writer is indebted to members of the Questa molybdenum mine aff who helped in so many ways to make this report possible, includ- g Mr. J. B. Carman, former general manager; Mr. A. L. Greslin, gen- al manager; Mr. E. William O'Toole, mine clerk; Mr. Francis C. owe, mining engineer; Mr. Ben Horner, former mine foreman; and Ir. Jose Varela, mine foreman.

Sincere appreciation is due Dr. Eugene Callaghan, director of the ew Mexico Bureau of Mines and Mineral Resources, for his guidance id support, to Dr. Edmund H. Kase, Jr., Dr. Robert H. Weber, and Ir. Max E. Willard for critically reading the manuscript and making any helpful suggestions, and to Dr. Brewster Baldwin for critically iecking and making suggestions for Plate 2. Other members of the ureau staff have checked various parts of the report and helped in any other ways.

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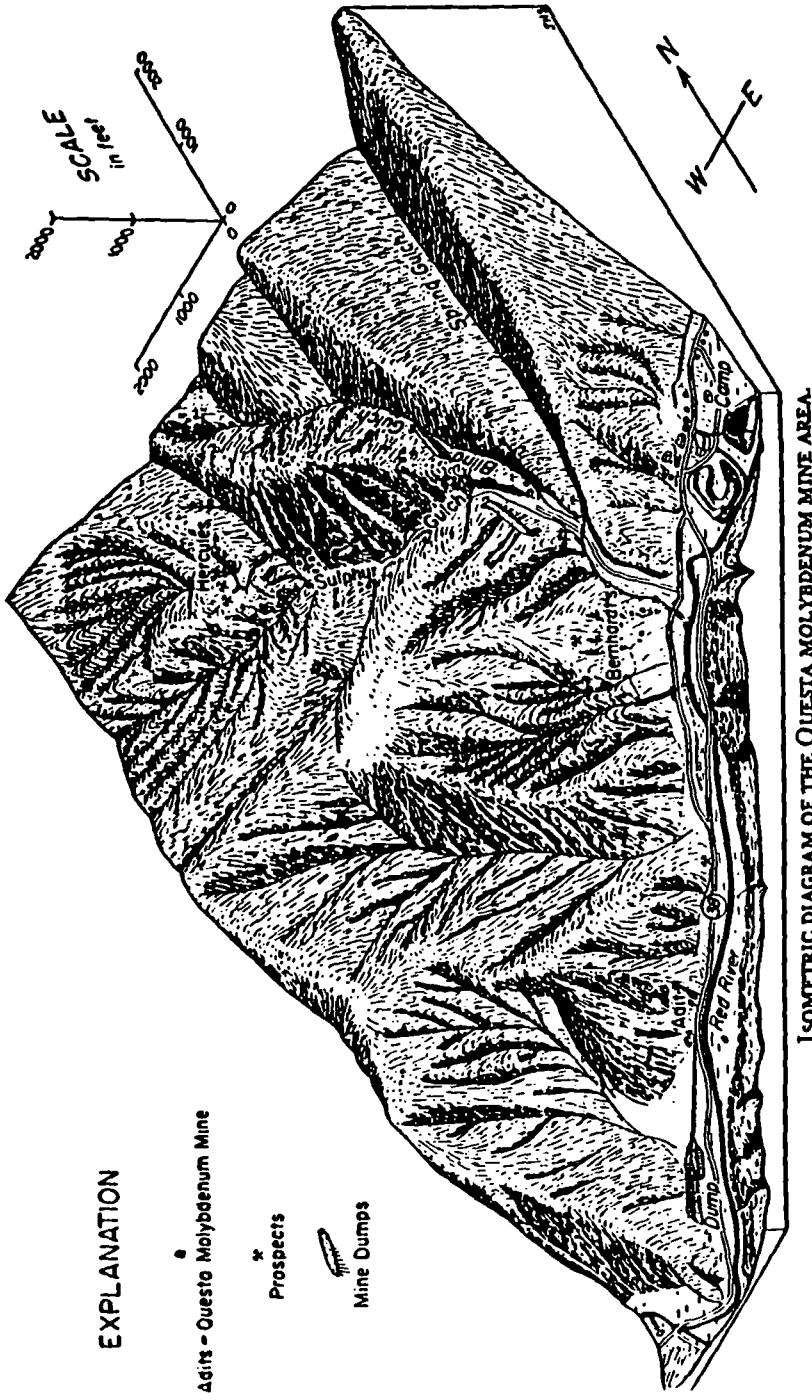
A special word of acknowledgment is due my wife Constance. She as my field assistant, did all the necessary secretarial work, and has elped in so many other ways to make the completion of this study isier and more enjoyable.

Space will not permit the mention by name of the many other indi- iduals who helped make this report possible. Their help is gratefully cknowledged.



ISOMETRIC DIAGRAM OF THE QUESTA MOLYBDENUM MINE AREA.
The main haulage adit (Moly tunnel) is labeled "adit."

GEOGRAPHIC FEATURES

Location and Accessibility

The Questa molybdenum mine is located on the western slope of the Taos Range of the Sangre de Cristo Mountains, Taos County, New Mexico (see fig 1). The various mine portals range in altitude from 8,000 to 9,000 feet. The mill, camp, haulage adit, and dump are distributed along Red River Canyon, 5-6 miles east of Questa. The adits to the older workings are along Sulphur Gulch, an intermittent tributary of the Red River (see fig 2).

State Highway 38, a graded gravel road, passes the mine and camp. It follows Red River Canyon and connects the mine with Questa, 6 miles to the west, and with the town of Red River, 6 miles to the east (see fig 1). Paved highways lead from Questa to Taos, New Mexico (to the south), and Fort Garland, Colorado (to the north). East of Red River, State Highway 38 crosses Red River Pass and continues to Eagle Nest, a distance of 19 miles. From Eagle Nest, paved highways lead to Taos and Raton, New Mexico (see fig 1). All other roads are primitive and in many places ungraded and badly washed.

The nearest railroad is at Jarosa, Colorado, 25 miles north of Questa. Jarosa is the southern terminal of the San Luis Valley Southern Railway, which connects with the Denver and Rio Grande Western Railroad at Blanca, Colorado (see fig 1). Only freight service is available.

Physical Features

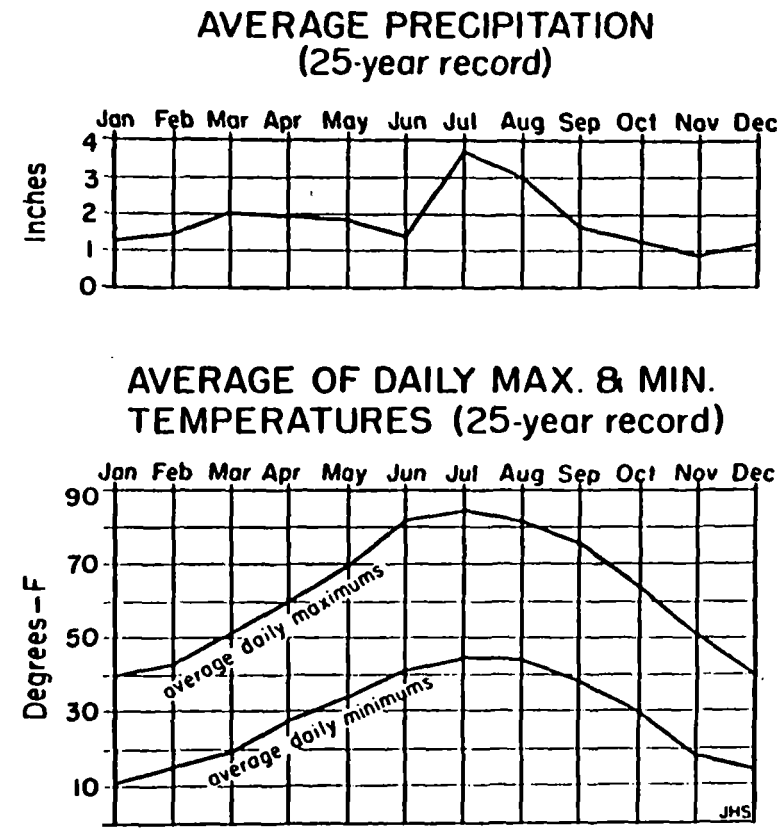
The Sangre de Cristo Mountains, in which the mine is located, are part of the Southern Rocky Mountains physiographic province. The maximum relief in the Taos Range of these mountains is over 6,000 feet; local relief at the mine is over 3,500 feet. Wheeler Peak (elevation 13,155 ft), which lies 10 miles southeast of the mine, is the highest point in New Mexico.

The surface over the mine is drained by intermittent tributaries of the Red River (see fig 2); the largest of these is Sulphur Gulch. The Red River (called the Rio Colorado or Colorado Creek in old reports) flows westward into the Rio Grande, 4 miles west of Questa. Where the Red River passes the mine, it has an average gradient of 2.0 percent. In comparison, the lower mile of Sulphur Gulch has an average gradient of 11 percent.

Climate

The climate at the mine is similar to that of the Rocky Mountains of Colorado, but is modified by the semiarid plateau to the west (see fig 3).

Summer is characterized by hot days and cool nights. The rainy season is during July and August, some rain occurring also in May and June. Heavy, but localized, rains during July and August cause flash



Climatic data for the Questa molybdenum mine area.

(Rainfall from *Climate and Man,* 1941 Yearbook of Agriculture, U. S. Dept. of Agriculture; temperatures from Molybdenum Corporation of America records.)

Figure 3

oods and mud-flows which often block the highway and occasionally amage the mine plant.

Fall is a period of warm days and cold nights. The first killing frost sually is in mid-September, and occasional snows can be expected.

Winters are mild, and the roads seldom are blocked by snow. The eaviest snowfall is limited to the higher parts of the mountains. Al- ıough the winters are long, protracted periods of freezing weather are mited to December through February. There are many sunny days, nd the ground is often bare in areas exposed to the sun.

Spring arrives in late May with warmer, windy weather. Dust storms re common. The last killing frost is in mid-June. The aspen, willow, nd cottonwood trees leaf out in late May or early June.

HISTORY AND PRODUCTION

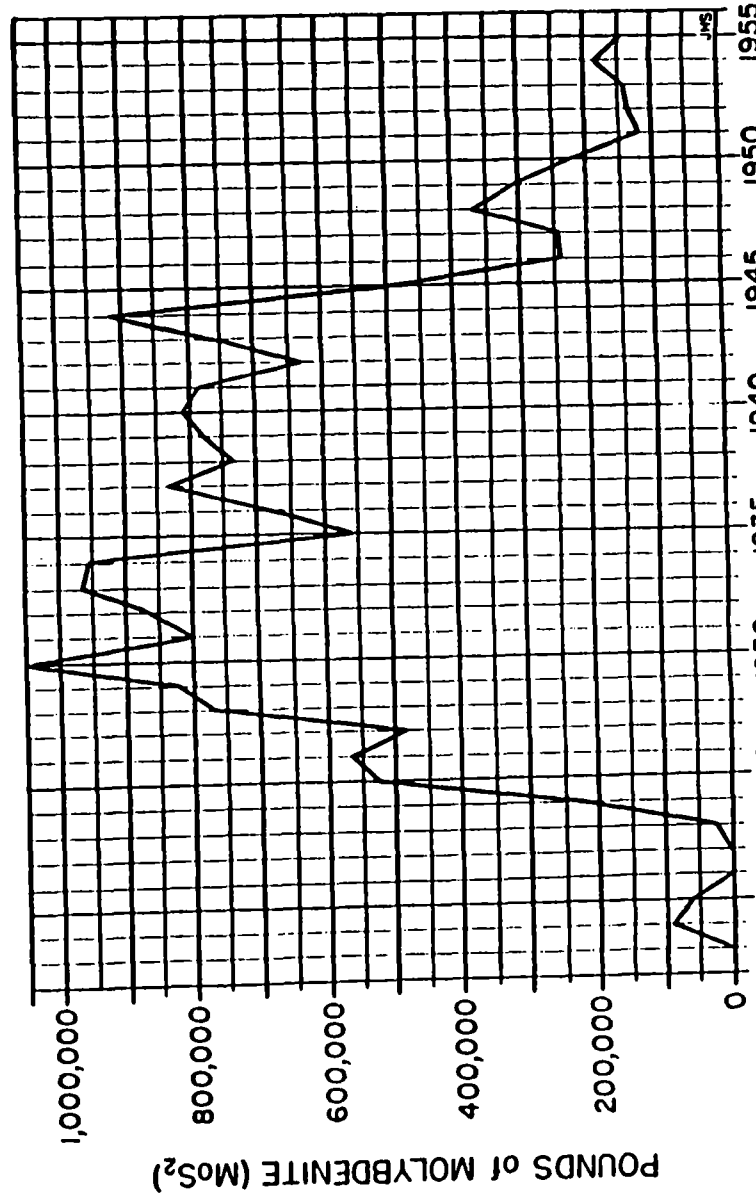
Prior to 1916 the bright-yellow molybdic gossan at the outcrops of ıe veins was thought to be sulfur, giving the name Sulphur Gulch to ıe valley in which the outcrops occur. The black molybdenite was istaken for graphite, and the mineral was mixed with grease and used ically to lubricate wagon wheels. It also served as a shiny shoe polish, hich unfortunately rubbed off on everything.

In 1916 or 1917 Jimmy Fay, a prospector having claims along ılphur Gulch, sent a specimen of ore containing molybdenite to San rancisco to be assayed for gold and silver. The beginning of World 'ar I had greatly increased the demand for molybdenum, and assayers ere becoming aware of the value of the mineral molybdenite. When ıe assayer returned his report, he mentioned the presence of molyb- nite and its value.

Some claims were located during the war. The Western Molybde- ım Company, of La Jara, Colorado, was organized but did little to evelop the claims. In November 1918, the R and S (Rapp and Savery) olybdenum Company, of Denver, was formed and took over seven ıims of the Western Molybdenum Company, filing additional claims. evelopment work was done throughout the winter of 1918-1919; pro- ıction began in the spring. The ore was treated at a converted gold ill on the Red River, about 4 miles above the mine.

The Molybdenum Corporation of America was incorporated in 20, in the same year acquiring the property of the R and S Molyb- num Company. Mining was discontinued during the depression of 21; however, development work was continued. Operations were on a ıall scale until 1923, when a mill was built on the present mill site. 1929, this mill was rebuilt. Because of the inaccessible location of the orkings, burros were used to haul the ore from the portals to the bot- m of Sulphur Gulch.

By 1941 mining and exploratory work had extended to such dis- nces below and to the west of the lowest adit, Z tunnel level, that the esent haulage adit (Moly tunnel) was driven to facilitate transporta-



MOLYBDENITE CONCENTRATES PRODUCED FROM THE QUESTA MOLYBDENUM MINE. (Data from Vanderwilt, 1938; Annual Reports of the State Inspector of Mines; and Mineral Yearbooks of the U. S. Bureau of Mines.)

Figure 4

tion, ventilation, and drainage. This adit was driven north from the Red River for 1 mile, where it joined the lowest level in the mine (8,000 ft elevation). The mill was rebuilt again at about the same time. By 1955 the workings had reached a point 240 feet below the haulage adit.

Total production to January 1, 1956, was 18,095,000 pounds of molybdenite (MoS_2). See Figure 4 for production by years.

Other companies have attempted to mine molybdenite in the surrounding area, but with little success. In 1924, the Hercules Molybdenum Corporation built a camp at the head of Sulphur Gulch. Some development work was done, but apparently little ore was found; the company abandoned the camp the following year.

More recently several adits, the BJB prospects, were driven by Bill Wilde along Goat Hill Gulch, 3 miles west of the mine. Some ore was mined, but the prospects no longer are being worked.

Dan Cisneros and Juan Aragon, of Questa, worked a group of claims, known as the Horseshoe or Bear Creek claims, for many years. These claims are located along the south side of Red River Canyon where it meets Bear Canyon, 4 miles west of the Questa molybdenum mine. No ore has been milled, although a few tons have been stockpiled.

The late Leroy Bernhardt had a group of claims along the lower part of Sulphur Gulch. A good vein of silver ore was found, but proved to be limited in extent. Only traces of molybdenite were present.

SURFACE PLANT AND MINE

The present camp consists of an office building, which also contains the warehouse and commissary, a mill, assay laboratory, cookhouse, bunkhouse, school, and houses for employees (see fig 2).

At the haulage-adit portal, 1 mile west of the camp, there is a building containing a lamp room, change room, blacksmith shop, and the compressor and generating equipment. Another small building is used for cutting mine timber. Surface track from the adit continues a quarter of a mile down the canyon to the mine ore bins and dump (see fig 2).

The mine has over 35 miles of workings, with a vertical extent of 1,200 feet. The mine is divided into three parts: (1) the Sulphur Gulch north workings, located north of Sulphur Gulch; (2) the Sulphur Gulch south workings, which include all workings south of Sulphur Gulch mined through adits on the gulch; and (3) the Tunnel shaft workings, which include all workings mined through the Tunnel shaft (a vertical winze) and the Moly tunnel. The relationship of the levels to each other and to the geology is shown by Plate 1 (in pocket).

MINING METHODS

Prospecting and Exploration

The veins do not form bold outcrops but are easily located by the bright canary-yellow color of the ferrimolybdite in the gossan. Underground exploration is carried on by drifting or raising along veins that have known ore shoots or appear favorable, and by crosscutting and raising to intersect known veins or explore new areas. Diamond drilling is not used.

These factors are used as guides: (1) Most of the ore shoots are near or on the contact of the granite with the altered rocks. (2) Ore-grade mineralization is usually weak in the "tight" altered rocks and strong in the more "open" granite near the contact. (3) Veins are usually thicker where the contact dips steeply. (4) Most of the ore is found where the contact has an east-west trend and a south dip. (5) Dikes of granite near the main granite mass often have good ore shoots.

Electrical prospecting (Sunberg and Nordstrom) was tried in 1917. Good ore was found in several places indicated by the survey, but many of the indications turned out to be gouge zones containing water.

Development

The mine is developed by adits, drifts, crosscuts, raises, and winzes at intervals of 15-100 feet vertically. There is no standard pattern because of the irregular vein systems. Exploration openings are used wherever possible.

Drifters are used to drill a 15-hole, bottom V-cut round; this is loaded with a total of 45 sticks of 40-percent gelatin dynamite, and normally breaks 4½ feet. Stopers are used to drill center V-cuts when raising; there is no standard drilling pattern for a round. Machine mucking is used in all easily accessible drifts; hand mucking is employed in drifts on intermediate levels inaccessible to mucking machines. The rock, when granite, is moderately hard and usually stands well without timbering; the altered volcanics are usually soft and broken and require considerable timber.

Stoping

Stoping methods are adapted to local conditions. Most of the ore shoots are mined by overhand methods in open, stull-supported stopes. Where the hanging wall is weak, back filling or pillars are used for support. Much of the stoping is done by hand drilling, which is possible because of the soft vein material. This permits highly selective mining. The ore occurs so irregularly in the veins that stoping practices often must be changed every round. In narrow veins, the foot wall is broken away from the ore, and the ore shot down separately. In wide veins, no breaking of the wall rock is needed, and light shooting or picking is used. If the vein splits, the waste in between often is removed first. There are numerous other variations. Where the veins are more regular machine drilling is used.

Reserves cannot be estimated, since mining closely follows exploration and development. Only the Tunnel shaft workings are being mined actively.

ANSPORTATION

The ore and waste are hand-trammed to the Tunnel shaft in 1-ton d-dump cars, hoisted, and dumped into 3-ton rocker-dump cars. A rage-battery engine pulls these larger cars out the mile-long haulage it and over the surface track to the dump and ore bins.

AINAGE AND VENTILATION

Water from the levels above the haulage adit drains by gravity out : various adits. Water from the workings below the haulage adit ins into a sump at the bottom of the Tunnel shaft; then it is pumped the shaft and flows out the adit. Ventilation is natural.

MILLING METHODS

The present mill has a capacity of 50 tons of ore per day. Two types material are milled: (1) ore from the mine, and (2) tailings from the ler of two tailing ponds. Ore is trucked to the mill and stored in bins ich feed through a crusher into a ball mill. The tailings are loaded o trucks by a shovel, and then hauled a short distance to bins which d directly into the ball mill. The ball mill is run in a closed circuit h a classifier; the overflow goes to the rougher flotation cells, which nove most of the waste as tailings. The concentrates from the rough- go to the regrind mill, which is in a closed circuit with a classifier; : overflow goes to the cleaner flotation cells, which remove most of : remaining waste. The concentrates, averaging 85 percent MoS_2, are watered by a thickener tank, filter, and dryer, and then sacked and pped to the company plant at Washington, Pennsylvania, where they made into ferromolybdenum or calcium molybdate for use in alloys.

Geologic Setting

DESCRIPTIVE GEOLOGY

INTRODUCTION

The Taos Range of the Sangre de Cristo Mountains is made up chiefly of Precambrian metamorphic (amphibolites, schists, and quartzites) and intrusive (granite) igneous rocks overlain by late Tertiary volcanic rocks (andesite, quartz latite, and rhyolite flows, breccias, and tuffs) and interbedded sediments. Permian and Pennsylvanian sediments (arkosic sandstone and conglomerate, shale, and limestone) occur along the eastern edge of the range; also, a few poorly exposed outcrops of sedimentary rocks in other areas probably are late Paleozoic in age. Tertiary granitic rocks intrude the older rocks (see figs 5 and 6).

All the rock types, except the sediments, are well represented in the vicinity of the Questa molybdenum mine (see fig 5). Sediments, probably of late Paleozoic age, are present, although evidence for their correlation and dating is poor. None of the other rock units could be dated accurately because of the lack of fossil or other direct evidence of their age.

PRECAMBRIAN

Because of the poor exposures and complex relationships of the Precambrian rocks, only the granite and quartzite were mapped as separate units; the other Precambrian rocks are predominantly amphibolites, and were mapped as a single unit, the amphibolite complex. The metamorphic rocks are assigned tentatively to the Precambrian, but only because of their position below late Paleozoic (?) rocks, their metamorphic character, and their similarity to more accurately dated Precambrian rocks elsewhere in the Rocky Mountains. It must be emphasized that metamorphism alone is not a good criterion for Precambrian age.

Amphibolite Complex

The amphibolite complex covers large areas along the south side of Red River Canyon, both east and west of the mine camp (see pl 2). North of the Red River, these rocks are more limited in extent. One area of outcrop, approximately 100 feet above the canyon floor, extends west from the mouth of Sulphur Gulch to the main haulage adit (Moly tunnel). In the mine, quartz-biotite schist of the amphibolite complex is exposed in the main haulage adit (Moly tunnel). Rocks of this complex are found also in the long crosscuts extending south from the main drift of Z tunnel level, although here alteration by the Tertiary soda granite makes identification difficult (see pl 1). Vanderwilt (1938, p 610) reports that these rocks are exposed also above Z tunnel level in the east ends of No. 3 and W levels, where the workings are now caved.

The base of the complex is not exposed. The total exposed thickness

the vicinity of the mine is probably several thousand feet, although accurate measurements could be made.

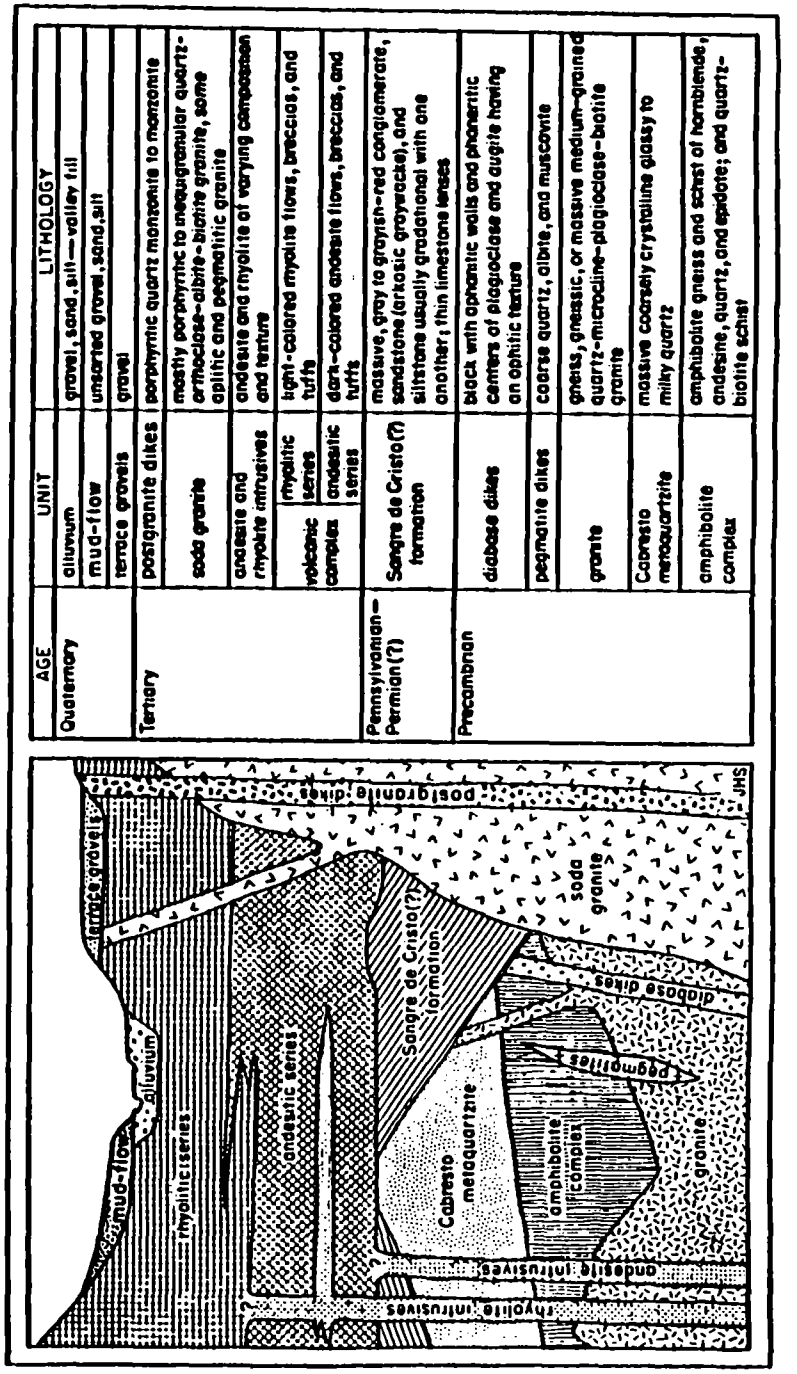
The amphibolite complex includes many varieties of amphibolite d interlayered quartz-biotite schists. The complex is not resistant to athering, and areas underlain by these rocks usually are covered with :ky soil or talus. At a distance, the few outcrops appear darker gray in any of the other rock types, except some of the andesitic volcanics. itcrops commonly are stained brown. A few outcrops contain alternat-; layers of quartz-biotite schist and amphibolite; these layers may resent bedding. No other primary structures were noted.

In hand specimen the rocks which have been grouped together in : amphibolite complex are massive to foliated, range from black to rk green, usually with specks or bands of white, and can be separated ughly into four varieties: (1) massive, coarse-grained; (2) massive, dium-grained; (3) gneiss; and (4) coarse-grained schist.

The massive, coarse-grained amphibolites contain large, black horn-nde crystals up to 3 cm across in a fine-grained phaneritic ground-ss of hornblende and andesine (?). In thinsection large, green, sub-dral crystals of hornblende, with no preferred orientation, are set in groundmass of smaller hornblende crystals, cloudy andesine (?), and nor quartz. Epidote, in clumps of small anhedral grains, replaces the rnblende; many of the larger hornblende crystals are poikiloblastic, th inclusions of epidote and magnetite. The andesine (?) is highly ered to clay and sericite. A typical thinsection contains 70 percent rnblende, 15 percent andesine (?), 10 percent epidote, 3 percent artz, and 2 percent magnetite, by volume.

The massive, medium-grained amphibolites are equigranular aggre-tes (average grain size: 3 mm) of black hornblende and white plagio-se, closely resembling a diorite in appearance. In thinsection (see fig large, ragged, unoriented, green hornblende in groups or individual ystals is set in a groundmass of cloudy, lathlike to irregular aggregates twinned andesine and small, irregular quartz grains. Magnetite is attered through the hornblende, commonly along the hornblende eavage. In some specimens, the hornblende is altered to chlorite and accompanied by more abundant magnetite. In some sections the horn-ende is poikiloblastic, with inclusions of quartz (?) or plagioclase (?). he andesine is altered to clay and sericite. Thinsections examined con-in 45-60 percent hornblende, 30-40 percent andesine, 5 percent artz, and 5-10 percent magnetite, by volume. Epidote probably occurs rock of this variety, but was not noted in the sections examined.

The amphibolite gneisses are coarsely foliated with oriented trains f black hornblende and white plagioclase. If the hornblende and lagioclase were not oriented, this rock type would resemble closely the assive, medium-grained amphibolite. In thinsection, small to medium-zed, green, subhedral hornblende, paralleling the plane of foliation, is t in a cloudy, granular aggregate of smaller anhedral andesine (?). uartz grains are scattered through the andesine (?). Although the



AGE	UNIT	LITHOLOGY
Quaternary	alluvium	gravel, sand, silt—valley fill
	mud-flow	unsorted gravel, sand, silt
	terrace gravels	gravel
Tertiary	postgranite dikes	porphyritic quartz monzonite to monzonite
	soda granite	mostly porphyritic to inequigranular quartz-orthoclase-albite-biotite granite, some aplitic and pegmatitic granite
	andesite and rhyolite intrusives	andesite and rhyolite of varying composition and texture
	volcanic complex: rhyolitic series	light-colored rhyolite flows, breccias, and tuffs
	volcanic complex: andesitic series	dark-colored andesite flows, breccias, and tuffs
Pennsylvanian–Permian(?)	Sangre de Cristo(?) formation	massive, gray to grayish-red conglomerate, sandstone (arkosic graywacke), and siltstone usually gradational with one another; thin limestone lenses
Precambrian	diabase dikes	black with aphanitic walls and phaneritic centers of plagioclase and augite having an ophitic texture
	pegmatite dikes	coarse quartz, albite, and muscovite
	granite	gneiss, gneissic, or massive medium-grained quartz-microcline-plagioclase-biotite granite
	Cabresto metaquartzite	massive coarsely crystalline glassy to milky quartz
	amphibolite complex	amphibolite gneiss and schist of hornblende, andesine, quartz, and epidote; and quartz-biotite schist

GENERALIZED ROCK SECTION OF THE QUESTA MOLYBDENUM MINE AREA.

Mineral Deposits

INTRODUCTION

The Questa molybdenum mine is the only mine in the area. Many other small deposits in the surrounding area have been prospected for molybdenum, gold, silver, copper, lead, or zinc, but always with unfavorable results. Nearly all these deposits, including that of the Questa molybdenum mine, apparently are late Tertiary in age and were formed by hydrothermal solutions emanating from the soda granite intrusives.

Oxidation and enrichment of the disseminated sulfides in the hydrothermal pipes may have formed minable copper deposits at depth, although the present scanty evidence is unfavorable. More detailed study is needed.

QUESTA MOLYBDENUM MINE DEPOSIT

INTRODUCTION

A group of molybdenite-bearing veins form the mineral deposit in which the Questa molybdenum mine is located. This deposit is unique in containing high-grade molybdenite ore in fissure veins, whereas most other production is from low-grade disseminated deposits. The ore occurs in the Sulphur Gulch soda granite stock along a locally east striking, south dipping part of the contact with propylitized rocks. Most veins parallel the contact, range from less than 1 inch to over 7 feet in thickness, and are largely quartz and molybdenite, with locally abundant biotite, fluorite, pyrite, chalcopyrite, calcite, and rhodochrosite. The veins were deposited as cavity fillings during late Tertiary time soon after the soda granite was intruded. The upward force of intrusion apparently sheeted the granite along the contact, and hydrothermal solutions from the granite entered the sheeting to form the veins.

SPACIAL RELATION OF VEINS TO ROCK UNITS AND STRUCTURE

The veins of the ore deposit occur along the western side of the Sulphur Gulch soda granite stock where the north trending contact locally strikes east and dips to the south. To the east and west, where the contact swings north-south, very few veins are found. At the surface the east-west portion of the contact is over 1,500 feet long. The propylitized Tertiary andesitic series is in contact with the soda granite over much of the area where the veins occur. On the upper levels, at the east end of the deposit, the propylitized Pennsylvanian-Permian (?) sediments, dipping steeply to the west and striking northwest, are in contact with the soda granite. East of these sediments Precambrian quartz-biotite schist is in contact with the soda granite where the contact begins to swing south. The Sulphur Gulch soda granite stock, in which the deposit is found, is in the downfaulted zone and near several hydrothermal pipes.

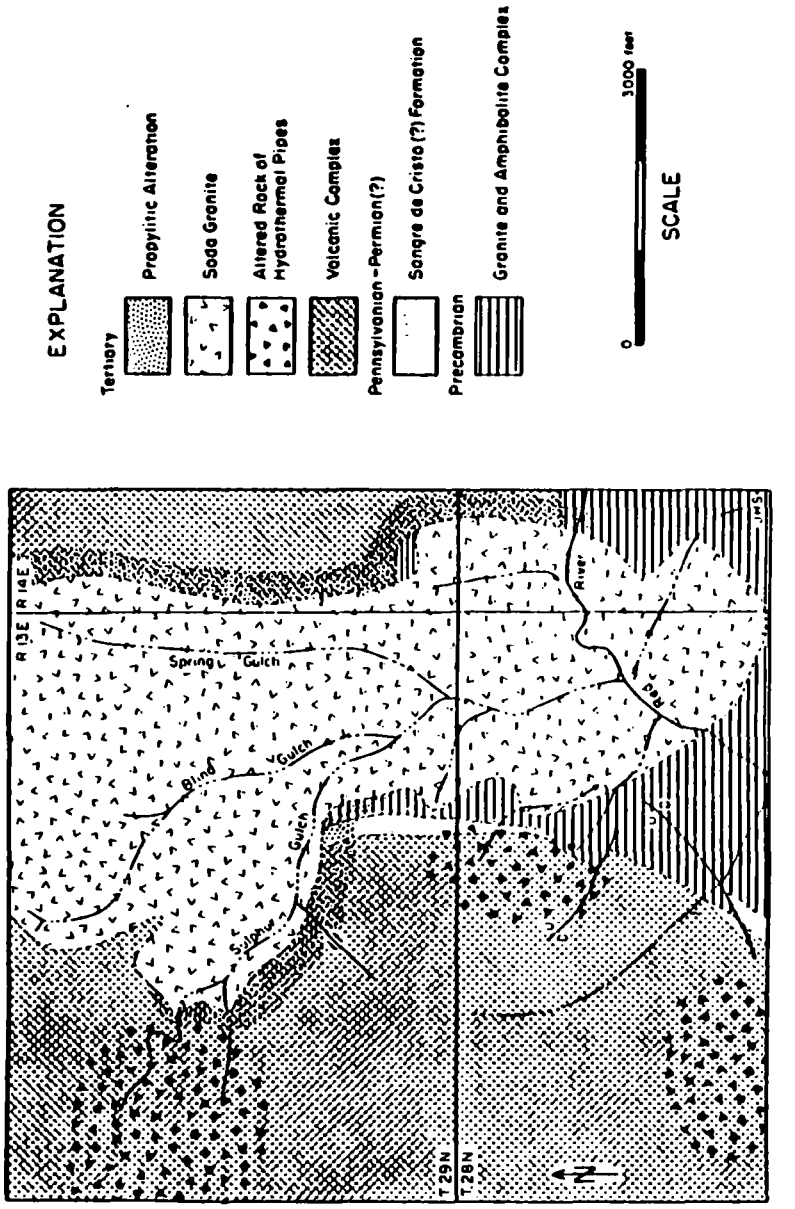


Figure 10

GENERALIZED GEOLOGIC MAP OF THE QUESTA MOLYBDENUM MINE AREA.

Reference 16

August 7, 1993

Don Rauch, Executive Director
Southwest New Mexico Council of Governments
P.O. Box 2157
213 N. Bullard
Silver City, New Mexico 88082

Dear Don:

Thank you for your comments on the proposed remedy, Alternative 5, outlined in the Proposed Plan for the Cleveland Mill Superfund site. I regret that the Southwest New Mexico Council of Governments does not agree with the remedy preferred by the State which consists of excavation of all contaminated surficial materials and off-site treatment through reprocessing and reclamation of beneficial metals. The New Mexico Environment Department (NMED) and the U.S. Environmental Protection Agency (EPA) have conducted and exhaustive assessment of a wide range of alternatives and have determined that Alternative 5 to be the most permanent and protective of human health and the environment of the remedial alternatives considered.

EPA and NMED have re-analyzed transportation issues in response to recent concerns expressed by Grant County and Silver City officials regarding truck traffic through the community during implementation of the preferred alternative. Implementation of all the alternatives, with the exception of taking no action at the site, will cause an increase in truck traffic in the short term. These short term risks could be mitigated by using engineering controls and by working closely with the City and County to develop a transportation plan. EPA has also assured the City and County that the costs of repair of any road that is damaged during implementation of the remedy will be included in the overall cost of the project. I have enclosed a copy of a letter from EPA to Grant County and Silver City which discusses the transportation issues in more detail.

I hope that this information will address your concerns regarding potential problems which might arise during implementation of the proposed remedial action to address contamination at the Cleveland

RECORD OF TELEPHONE CONVERSATION

Time: 10:00	Date: 5-11-93
Originating Party: Stuart Kent	Other Parties: David Shoemaker
NMED - Superfund	Site Mgr - Moly Corp

Subject:

Discussion:

+ 2 domestic wells located near Columbine Creek, south of Red River. [Depth to water is ~30']

+ Domestic well near the Moly Corp Tunnel is no longer operational.

+ Water level in the new underground mine workings continues to rise since pumping ~~is no longer~~ is not occurring at current time.

+ Water level is 7,337 feet which is below Red River.

Stuart Kent

Signed

Reference 17

The State will do its best to insure that effective transportation controls and road maintenance will be adhered to during implementation of whichever remedy is selected by EPA. If you have any further questions or need additional information, please call Randy Merker of my staff at (505) 827-0078.

Sincerely,

Bruce King
Governor

BK:JME:dmd

Enclosure

cc: Senetor Pete Domenici
Senator Jeff Bingamin
Representative Joe Skeen
Joe Winkle (6A), U.S. EPA, Acting Regional Administrator

SOUTH PASS RESOURCES, Inc.
8669 East San Alberto Drive, Suite 101
Scottsdale, Arizona 85258
Telephone: 602-948-7171
Fax: 602-948-7205

RECEIVED
JUL 15 1993
GROUND WATER BUREAU

PRELIMINARY INVESTIGATION of the POTENTIAL IMPACT of the REWATERING of MOLYCORP'S DEEPER UNDERGROUND MINE on the RED RIVER near QUESTA, NEW MEXICO

REGISTERED GEOLOGIST
CERTIFICATE NO.
27158
JOHN C.
KEPPER
Date Signed 7/14/93
ARIZONA, U.S.A.

prepared for
Mr. David Shoemaker
Molycorp, Inc./Questa Div.
P.O. Box 469
Questa, NM 87556

prepared by
South Pass Resources, Inc.
(formerly The GeoWest Group, Inc.)

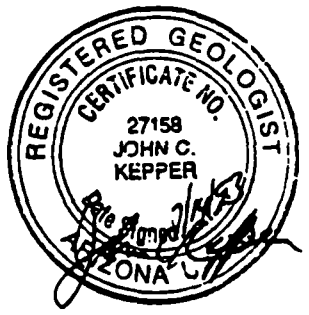
July 14, 1993

TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1
2.0 GEOLOGY	3
2.1 General Geologic Setting	3
2.2 Rock Units	3
2.3 Structure	3
2.4 Mineralization	4
3.0 HYDROGEOLOGY	6
3.1 Hydrogeological Units	6
3.2 Ground-Water Recharge	7
3.3 Discussion of Ground-Water Recharge Issues	8
3.4 Water-Table Configuration	9
3.5 Rate of Rise for the Water Table	10
3.6 Water Chemistry In and Near the Mined Area	10
3.7 Ground-Water Transport	12
4.0 RECOMMENDATIONS	15
5.0 REFERENCES	17

LIST OF APPENDICES

Appendix A. WATER-TABLE CONFIGURATION



LIST OF FIGURES

Figure 1. LOCATION MAP
Figure 2. GENERALIZED GEOLOGIC MAP
Figure 3. APPROXIMATE CROSS-SECTION LOCATIONS
Figure 4. CROSS-SECTION B-B'
Figure 5. CROSS-SECTION A-A'
Figure 6. POSTULATED WATER-LEVEL ELEVATION SURFACES
Figure 7. CROSS-SECTION OF CAVED AREA
Figure A-1. LIMITING CONFIGURATIONS FOR A GAINING STREAM

1.0 INTRODUCTION

The Molycorp/Questa molybdenum mine is located on the western slope of the Taos Range of the Sangre de Cristo Mountains, Taos County in north-central New Mexico (Figure 1). State Highway 38 runs along the north side of the Red River and connects the mine and mill area with the Town of Red River (6 miles to the east) and the Town of Questa (6 miles to the west).

Mining History

The Questa Molybdenum mine was initially developed by Molycorp in the 1920's (Schilling, 1956). This underground mining operation consisted of the development of numerous adits and drifts between the elevation of 8864 feet (Old Glory hole) and 7764 feet at the deepest level. The mine portals were along Sulphur Gulch, an intermittent tributary to the Red River. An adit (Moly tunnel) extended south from about the 8000-foot level to an elevation of 7969 feet near the Red River. The elevation of the Red River segment opposite the mined area ranges from about 7700 feet to 7950 feet.

In the late 1950's, the underground mining was replaced by an open-pit operation which removed much of the upper part of the old underground workings. A deeper-level mineralized zone was identified in 1975, and underground mining by the block-caving method began. The deepest level in the new workings is the Haulage level (elevation 7120 feet), above which is the Grizzly level and the Undercut level (elevation 7310 feet). The service shaft (No. 1 shaft) is located about 800 feet north of the Red River and extends from a surface elevation of 8090 feet to the Haulage level. Shaft No. 2 lies north of No. 1 and extends from a surface elevation of 8270 feet to the Haulage level. A caved area developed above the new workings along Goat Hill Gulch. The caved zone extends from the surface (approximate elevation of 7975 feet) to a depth of approximately 795 feet (elevation of 7180 feet).

The mine is currently on standby status until economic conditions improve for the molybdenum market. With an increase in demand/price for molybdenum, the mine will be dewatered and operations resumed.

Purpose of This Investigation

Pre-mine measurements for water-level elevations (from which flow direction and hydraulic gradient could be measured) are unknown for the area, as are most of the other hydrogeological parameters (such as hydraulic conductivity for the fractured and mineralized bedrock and pre-mine ground-water chemistry). Springs close to the elevation of the Red River and accretionary studies along the river (pre- and post-deep underground mining) indicate that the river is a

gaining stream and that ground water supplies some of the flow. The primary questions to be addressed in this study focus on any potential impact of the mine waters, during the rewatering phase, on the Red River.

Natural recharge (through the mine workings and the fractured bedrock) will cause the mine's water-level to rise until it reaches about the natural (pre-mine) water table that extended across the area north of the Red River. An early question to be considered is the probable configuration of this pre-mine water-table surface. Some of the recharge is being captured by a seepage barrier system located near the toes of the upper mine waste dumps and is being drained into the underground workings through the caved area in Goat Hill Gulch. Given the present rate of recharge into the mine opening, the questions that must be addressed are:

- What will the post-mine water table look like (in terms of configuration, elevation, and gradient)?
- When will this post-mine water table configuration be reached?
- What are the critical levels in the underground mined area at which flow might move toward the river?
- How long would it take mine water to discharge to the Red River?
- What would be the impact of the mine water on the chemistry of the river?
- Are there critical elevations for the rising water level at which measures should be taken to prevent mine water from reaching the river?
- What measures might be undertaken to control or prevent the flow of mine waters to the river?

2.0 GEOLOGY

2.1 General Geologic Setting

The major sources of geological data for the Questa Mine area are Schilling (1956), Rehrig (1969), Lipman (1981), Bookstrom (1981) and numerous unpublished maps, cross-sections, and reports by Molycorp geologists. A common thread to all of these geological studies is that the mineralization at Questa was related to Tertiary magnetism and hydrothermal solutions focused along an east- to northeast-trending structural zone. This structural zone is variously interpreted as part of a graben (Schilling, 1956); as a zone of intense faulting (called the *Red River Structural Zone* by Rehrig, 1969); and the southern part of the outer ring fracture zone that formed the outer wall of the Questa caldera (Lipmann, 1981; Bookstrome, 1981).

The development of the caldera and the associated volcanic and intrusive rocks was a late Oligocene to Middle Miocene event (27.2 million years to 22 million years before present) that overlapped in time and space with the regional rifting associated with the Rio Grande Rift System. The range-bounding high-angle fault along the west side of the Sangre de Cristo Mountains (about 5 miles west of the mine) is related to regional extension across the Rio Grande Rift and the uplift of the range in Mid-Tertiary time. At least the later movements along this range-front fault are younger than the caldera structure because the outer ring fracture zone is truncated by the range-front fault.

2.2 Rock Units

The oldest rock units exposed in the vicinity of the mine are Precambrian amphibolites, quartz-biotite schists, metaquartzites, granite gneisses, and intrusive quartz monzonites. These units are overlain by an Early Tertiary conglomerate and sandstone unit followed by a complex sequence of Oligocene and Miocene rhyolitic to quartz latitic ashflow tuffs, breccias, and lava flows and a sequence of basalt/andesite lava flows. These volcanics are intruded by a number of dikes and small stocks or plutons that range widely in composition (quartz latite, rhyodacite, rhyolite, granite porphyry, and aplite). At the Questa mine, most of the molybdenum mineralization is found in the outer parts of the Mine Aplite (22 million years before present) and adjacent volcanic units.

2.3 Structure

Geological maps of the Questa mine area (Figure 2) all show a northeast- to east-trending structural zone along which intrusions of granitic rock and mineralization have occurred. This zone more or less parallels the Red River in the vicinity of the mine, but swings to the

southwest, away from the river, farther to the west. The structural zone is believed to be the southern part of the outer ring fracture zone (outer wall or rim) for the Questa Caldera. The zone is characterized by a swarm of east-trending dikes, elongated intrusions, and mineral veins that were emplaced in fractures developed parallel to the caldera rim.

South of the structural zone, northeast- and northwest-trending high-angle faults extend throughout the Precambrian block (Precambrian rocks and some pre-caldera volcanic rocks). Some of these faults are truncated by the caldera wall. North of the structural zone, the geology is more complex. Fault-bound blocks of Precambrian rocks, pre-caldera volcanics, and younger caldera-related volcanics occur throughout the area. These structural blocks and the outer fracture zone along the caldera wall became the plumbing system through which granites intruded (e.g., Mine Aplite) and the later mineralizing hydrothermal waters migrated.

A variety of fractures developed throughout the caldera block. These include:

- high-angle joints (called sheeting in the aplite) and fracture cleavage;
- contact conformable fractures between the intrusions and the volcanic units;
- high-angle northeast-, north-, and northwest-trending faults;
- low-angle faults both within the Mine Aplite (west-dipping) and as structural contacts between various Tertiary units.

The low-angle faults are illustrated on cross-sections located on Figure 3 and shown on Figures 4 and 5. These are probably related to listric (concave-up fault planes), normal faults developed along the caldera boundary, and/or large slide blocks derived from the walls of the caldera. Some of the northerly-trending high-angle faults extend to the caldera boundary near the Red River truncating the easterly structures.

2.4 Mineralization

The mineral deposit consists of quartz/molybdenite (molybdenum sulphide) vein fillings in east- to northeast-striking, nearly vertical fractures in the Mine Aplite and in the immediately adjacent andesitic flow rocks intruded by the Aplite. Pyrite (iron sulphide) is fairly abundant in the quartz veins (with or without molybdenite) and in the clay gouges that fill some of the fault zones. Calcite, fluorite, and biotite are commonly associated with the vein minerals. The major alteration mineral in the volcanics outside of the veins is chlorite. Field photographs by Rehrig (1969) indicate that many fractures and small faults are barren of mineralization.

Schilling (1956) described intense zones of alteration associated with hydrothermal pipes (i.e., steeply inclined breccia structures) that probably formed at fault/fracture intersections in the volcanic rocks overlying the intrusion. The alteration minerals in these pipes consist of pyrite, chalcopyrite, quartz, kaolinite, sericite, and carbonates. Subsequent descending oxidizing ground-waters reacted with the pyrite and carbonate minerals to form limonite (iron oxide), jarosite (hydrous iron/potassium sulphate), and gypsum (hydrated calcium sulfate) creating the yellow- and red-colored hydrothermal scars common throughout the area. Schilling (1956) reported that iron-enriched mine drainage waters precipitated limonite near the portal to Z tunnel (old underground workings) and that pre-mine alluvial deposits cemented by limonite occur in the upper Sulphur Gulch drainage above the older workings. This indicates that the natural oxidation processes of the past continue today in the mine area.

3.0 HYDROGEOLOGY

3.1 Hydrogeological Units

The ground-water hydrology of a region is best discussed by grouping the numerous geologic formations into units of hydrogeologic significance. A basic division universally used is aquifer and aquitard. Various geologic units are then assigned to one of these categories, commonly in some kind of stratigraphic and/or structural relationship (e.g., upper volcanic aquifer or lower crystalline aquitard, etc.). Where possible, groupings are based on rock and structural descriptions of the rocks and on aquifer tests or other tests for hydrologic characteristics. Lacking site-specific tests, hydrogeologic properties may be estimated from values published on studies of similar rocks elsewhere. At the Questa Mine area, the identified hydrogeologic units are:

- Precambrian Aquitard,
- Tertiary Aquifer, and
- Hydrothermal Alteration ("Scar") Aquitard.

Precambrian/Tertiary: The Precambrian metamorphic and intrusive rocks and the stock-like Tertiary intrusives (Mine Aplite) form a hydrogeological basement or a regional aquitard analogous to the regional lower clastic (Precambrian/Cambrian quartzites) aquitard identified by Winograd and Thordarson (1975) in central and eastern Nevada. While shallow fracture systems (and in some cases, major through-going faults) allow for some movement of ground water, these rocks are characterized by low hydraulic conductivity and serve as barriers to deep circulation of ground water. Schilling (1956), in characterizing the vertical fracture system in the Mine Aplite, noted that these fractures pinch out downward into the main intrusive mass. These fractures (along with numerous small faults) are also mineralized in the ring fracture fault zone.

Tertiary Aquifer: The Tertiary volcanics and sedimentary rock units are highly fractured and faulted throughout the caldera block north of the river. The major structural features are high-angle northwest-, north- and northeast-trending faults and low-angle faults, either parallel to the intrusive/volcanic contact (contact conformable fractures) or along unit contacts. Joints related to some combination of tectonic and volcanic processes are also present in the volcanic units. Although mineralization and/or clay gouge along faults has sealed some of the fractures, not all are sealed and fracture flow does occur throughout the area. The Tertiary volcanic rock then represents the aquifer in the area and has highly variable hydraulic conductivity depending

on the fracture orientation, fracture spacing, and the openness of the fracture system below the water table.

Hydrothermal Alteration ("Scar") Aquitard: The hydrothermal scars scattered across the ridges above the mined area are composed of pyrite, clay, quartz, and carbonates altered to iron oxide, gypsum, jarosite, plus residual quartz and clay resulting from near-surface oxidation processes. These masses of altered material may principally be located above the natural water table, but they likely have very low hydraulic conductivity and serve to retard infiltration to the fractured aquifer system. Several 90-foot deep boreholes drilled by Molycorp into the "scar" material were either dry or produced over time very small flows (on the order of less than 1 gpm). Because masses of fractured rock are located within the hydrothermal "scars," some of this flow may have been from local perched zones. Where the altered material extends below the water table, the altered rock might locally create semi-confined conditions.

3.2 Ground-Water Recharge

River accretion studies by the U.S. Geological Survey (base flow measurements in late Fall 1965 and 1988) were referenced by Smolka and Tague (1988) of the New Mexico Health and Environment Department and in unpublished data by Vail (1989). Vail used the USGS data to calculate accretion for the Red River at nine locations from the Zwergle Dam site a few miles upstream from the Town of Red River to the Bear Canyon area. The segment of the Red River from the Molycorp Mill downstream to Bear Canyon (near the Questa Ranger Station) shows an accretion of 6.6 cubic feet per second (cfs). Of this, 5.0 cfs comes from Columbine Creek, which leaves 1.6 cfs related to recharge from seeps and springs along both sides of the river. These discharges at or close to river level are believed to be ground-water discharge and indicate that the Red River is a gaining stream (is recharged in part by ground water).

The 1.6 cfs accretion could be divided equally between the north and south sides of the river (0.8 cfs each). The more recent dewatering of the underground mine located beneath Goat Hill Gulch produced about 250 gpm (0.55 cfs). Thus, the mine dewatering removed about 69 percent of the total ground-water recharge (0.8 cfs) available to this segment of the river. According to Smolka and Tague (1988), over the 24-year period (between 1965 and 1988) of the USGS accretion study, there was a slight but insignificant increase in accretion along the Red River. These accretion studies were made over the same period of time that the mine was dewatering and, therefore, it appears that the decline in water level across the mined area did not impact the river (did not reduce accretion to the river).

3.3 Discussion of Ground-Water Recharge Issues

The issues concerning ground-water recharge to the Red River are:

1. The fracture system in the mineralized zone north of the river may be fairly well sealed (vein and fault zone mineralization). This could cause a low hydraulic conductivity condition within the mineralized zone and, during dewatering, a steep-sided depression in the water table may have been the result. A ground-water divide likely developed within the 800 to 1000 feet between the underground mine and the river.

2. If mine dewatering removed 0.55 cfs from storage beneath the mined area, how was accretion maintained in the segment of the Red River adjacent to the mine?

The mine waste dumps that cover fractured bedrock between the mill and the mine office were largely derived from the open-pit operation and, therefore, were in place prior to the deeper underground workings. These dumps are composed of non-mineralized, weakly-altered overburden and are not a source of acidic, metal-enriched water. Because these dumps may have higher rates of infiltration and store large amounts of water, these areas may be a source of recharge to the ground-water system adjacent to the river. Such a local increase in recharge could have offset some portion of the losses in stored water due to the mine dewatering. Mine waste dumps at higher elevations may have increased the surface discharge to the river as a further offset to accretionary losses due to dewatering, but much of this water is currently discharged to the caved area on Goat Hill Gulch.

It is also possible that the recharge to the river is not evenly divided between the two sides of the river. A Maxey and Eakin (1949) approach to drainage basin recharge, based on studies of ground-water basins throughout Nevada, estimates that 25 percent of the annual precipitation over the drainage area above all of the mine workings (i.e., open-pit and all underground workings) could contribute to recharge. Schilling (1956) indicates that the annual precipitation is about 21 inches. Twenty-five percent of the annual precipitation corresponds to 5.25 inches which, if distributed across the drainage area, is equal to 1.45 cfs. Although this would reduce the percentage of recharge captured by the mine, the volume of water needed to balance recharge lost to the mine during dewatering would not change (the 0.55 cfs would still have to be replaced to maintain accretion to the river). Bedrock beneath the drainage area on the south side of the river is part of the aquitard (e.g., Precambrian metamorphics and intrusive rocks) and may supply a lesser amount of ground-water recharge to the Red River.

The river bed is on or not far above the hydrogeological basement, and a significant volume of ground-water recharge from these crystalline rocks is not likely. However geologic cross-

sections show several north-dipping, low-angle faults within the overlying volcanics that intersect the Red River at or close to river level. If these fractures were open and there was sufficient gradient, these might be an additional avenue for recharge to reach the river.

3.4 Water-Table Configuration

Based on Molycorp data, dewatering inflow for the older underground workings and for the open pit ranged from 15 to 30 gpm. These are very low flow rates. If these areas were below the water table, such rates could only be explained by very tight rock conditions in which virtually all the fractures were sealed. Schilling (1956) and Rehrig (1969) descriptions of the fracture systems and field examination of rock exposures in the same area indicate that open fractures exist (some fracturing can be related to mine activities). It is more likely that these low flow rates can be attributed to perched fracture water above a regional water table. The deeper underground workings dewatered at 250 gpm, which is also quite low. For comparison, Newmont's Gold Quarry Mine in Nevada is in fractured sedimentary rock and dewaters at 50,000 gpm (Carillo, 1993). However, if the fractures in the mineralized zone were largely sealed by mineralization/clay gouge, then 250 gpm, even below the water table, would not be unreasonable. It is possible that the open pit and most of the older underground workings near Sulphur Gulch (down to 7800 to 7900 feet) were above the regional water table and that the inflows were from perched fracture water. Currently, this inflow from the open pit and the older underground mine drains though a borehole into the deeper mine workings.

If the gaining stream model is used with the "normal" (versus the "acute") contour configurations (Appendix A) and with the dewatering data, it appears that the "normal" contour surface (Figure 6) would allow for most of the old workings and the pit to be relatively dry and above the regional water table. The Moly Tunnel (7960 adit) would be right at the water table at an elevation of 8000 feet. Construction of the 7960 adit did not produce much water, and therefore, the 8000-foot water-level contour might have curved more to the north. The "normal" water-table surface would have a southwesterly gradient of 0.036 foot/foot in this very simplified configuration. In contrast, the "acute" water table configuration would place most of the old workings and part of the open pit below the pre-mine water table.

We can use the simplified "normal" water-table surface to estimate the elevation of the water table in various areas of the underground workings. For example, the water level would continue to rise in the caved area above the underground workings in the Goat Hill Gulch area to an elevation of approximately 7840 feet. At Shaft No. 1, the elevation would be about 7820 feet and at Shaft No. 2, it would be closer to 7850 feet. With respect to the old Moly Tunnel (7960 adit), a conservative position would place it just below the water table at about 8000 feet.

Another element in the water-table surface configuration is the additional recharge from seepage barriers to the mine through the caved area. This currently amounts to about 70 gpm

captured by the seepage barriers constructed on Capulin and Goat Hill Gulches. An additional 30 gpm drains from the open pit through a borehole in the old underground mine to the deeper workings. These seepage water amounts are occasionally augmented by surface water related to storm discharge. How much of this water actually reaches the caved area is unknown since it is a surface discharge and a certain amount must be lost to evaporation or infiltration to the vadose zone. (In the vadose zone, the water would be bound by surface tension in intergranular voids or micro-fractures.) It is possible that the additional recharge might cause some mounding of the water table surface, particularly in the caved area, and locally a slightly steeper gradient.

3.5 Rate of Rise for the Water Table

The water level in the mine workings is currently at 7370 feet (5/21/93). According to Molycorp records, the caved area began to fill by October 20, 1992. Using the elevation of the bottom of the caved area (7226 feet) and the time since filling began (183 days), the rate of rewatering is 0.78 foot/day. (Over time, the rate of rise will change as a balance between less available space to fill [increases the rate] and the decline in gradient driving the water into the mine workings as the original water-table depression flattens out [decreases the rate].) However, if we use 0.78 foot/day as the rate, it would take 1.16 years for the water level to rise to the downgradient elevation (7700 feet) of the Red River (this assumes a southwestern gradient based on the normal contour configuration in the caved area at Goat Hill Gulch (Figure 7). In other words, after 1.16 years (from May, 1993), there would be a slight gradient from the cave area toward the river. Using the same rate of 0.78 feet/day, it would take 1.65 years to reach the postulated water-table elevation of 7840 feet in the caved area. In the case of the Moly tunnel (7960 feet), it would require 2.21 years for the water level to reach 8000 feet and begin to flow down to the adit.

3.6 Water Chemistry In and Near the Mined Area

Table 1 compares the water chemistry from the seepage barrier system (in the upper parts of Capulin and Goat Hill Gulches), the underground mine (shaft No. 1), the Red River above the mined area, and two production wells. Chemistry for this table is derived from unpublished Molycorp data and from Vail (1989, 1993). All concentrations are expressed in milligrams per liter (mg/L).

(Table 1) is acidic, considerably lower than the more alkaline mine water. Aluminum and iron concentrations in the Red River well are significantly above mine water concentrations. Manganese, zinc and copper are higher in the Red River well and copper is higher in the Columbine well. The mine water does contain higher levels of sulphate and TDS than either well. The mine water has about the same pH as the Red River water sample, but concentrations are higher for the remaining constituents.

Schilling (1956) mapped limonite (iron oxide) cemented alluvial and mudflow deposits flanking some of the drainages across the mined area. These Quaternary age deposits represent evidence for acidic, metal-bearing surface and near-surface recharge water in the area long before mining began.

Figure 7 illustrates the relationship between the deep underground mine including the caved area, the postulated water table surface, and the Red River. The underground mine would be on the order of 530 feet below the water table and 390 feet below river level. For the deep mine water to impact the Red River, there would have to be sufficient head to move the ground water upward principally along preferred pathways. These pathways could consist of the low-angle northward- and westward-dipping faults and north-south high-angle faults that intersect the mine workings. Based on the lack of impact on the Red River by the mine dewatering, these structures do not appear to be efficient conduits between the mine and the river.

The most likely source of mine-affected ground water is from the upper part of the caved area. There are two reasons for this area being a source of higher sulfate/TDS water:

- The broken rock (with a greater surface area) in the cave area is more reactive to oxygenated ground water than the fractured bedrock, and

- Seepage barrier water from Capulin and Goat Hill Gulch mine waste dumps is discharged to the caved area.

3.7 Ground-Water Transport

The mine workings are in a mineralized zone where fractures and faults are completely, or at least partially, sealed by mineral deposits, clay gouge, and intrusive material in the form of dikes. The structural trend of the mineralized zone is east to northeast, roughly normal to the postulated water-table elevation contours, or parallel to the southwesterly flow direction. If these fractures were open to any great extent, then they would be a significant pathway for recharge to the Red River. The lack of any known impact of the mine dewatering on accretion to the Red River suggests that there is a poor hydraulic connection between the east-trending structures and the river. Based on Molycorp maps, some north-trending, high-angle faults intersect the

mineralized zone and extend to the river. Where such faults were cut by the mine workings, in some cases, inflows of ground water occurred (no measured discharge data are available). If ground water that is influenced by the mine water reaches the river, it would more likely be along a few preferential pathways related to the north-trending high-angle faults and/or the low-angle north-dipping faults that intersect the surface near the river. Mapping of springs and seeps along the river combined with rock units and structure as well as water chemistry would help to identify potential pathways.

With the currently available information, it is not possible to make meaningful quantitative estimates for the velocity of ground water through the fractured bedrock. Tracer tests in sets of nearby boreholes would probably allow the best estimate of fracture-related, ground-water velocity. These tests need to be well planned in terms of distances between boreholes and their relationship to mapped fractured systems.

Seepage velocity formulas are based on advection in granular material, not fractured rock. Using the caved area (located on Goat Hill Gulch) above the deep underground workings as a source and published values for hydraulic conductivity and porosity for fractured rock (Freeze and Cherry, 1979), rough estimates of travel time from the mine to the river can be made. According to Freeze and Cherry (1979), the range of hydraulic conductivity for fractured igneous and metamorphic rocks is 10^{-1} to 10^{3} gallons/day/ft^2 and for permeable basalt 1 to 10^{5} gallons/day/ft^2. The porosity range for fractured crystalline rock is 0 to 10%, and for fractured basalt 5 to 50%.

The seepage velocity formula is:

$$V = \frac{KI}{7.5n_e}$$

where: V = seepage velocity, in feet/day
K = hydraulic conductivity, in gallons/day/square foot
I = hydraulic gradient, in feet/feet
n_e = porosity,a percent.

$$\textit{Travel Time} = \frac{\textit{Distance from Source to River}}{\textit{Velocity}}$$

The hydraulic gradient (0.036 foot/foot) and the down-gradient distance to the river from the caved area (3500 feet) are based on the "normal" water-table configuration map (Figure 6). Seepage velocity was estimated by using a hydraulic conductivity equal to 10 gallons/day/ft^2 and

a porosity of 10%. These values are in the mid- to upper range of values for fractured igneous and metamorphic rocks and in the lower range for permeable basalt. The resulting seepage velocity is 0.48 foot/day and the travel time from the caved area to the river is 19.97 years. High-angle faults that cut across the structure of the mineralized zone and the low-angle north- and west-dipping faults may represent preferential pathways for flow to the river at rates less than the calculation indicates. However, without field data based on tracer tests applied to the local fracture system, estimates of seepage velocity and travel time calculated from formulas *derived from granular or matrix flow* are likely to be in significant error.

Another approach to estimating hydraulic conductivity and travel time is to use the dewatering rate for the mine, 0.55 cfs, as the quantity of water that could be available for recharge to the river from the underground mine area. Using the equation for discharge:

$$Q = KAI$$

where Q = discharge (recharge to river), in gallons/day
K = hydraulic conductivity, in gallons/day/square foot
A = cross-sectional area, in square feet
I = hydraulic gradient,in feet/feet,

it is possible to estimate K. To calculate a cross-sectional area, it is assumed that the springs just above river level and any water that moves up along low-angle faults beneath the river bed would be within a zone of about 50 feet in thickness and that the length of the recharge zone down gradient of the mined area is about 6000 feet.

Q = 355,449.6 gallons/day (equals 0.55 cfs)
A = 300,000 feet^2
I = 0.036 foot/foot

The calculation gives an estimated hydraulic conductivity (K) of 33 gallons/day/ft^2. If the estimated value for K is substituted in the seepage velocity formula, the resulting velocity is 1.58 feet/day. The higher K value results in a travel time of 6.06 years from the caved area to the river.

In summary, the two different approaches to travel time indicate that mine water in the caved area, after the water table stabilizes, could reach the river in a time period ranging from 6.06 to 19.97 years. It would take about 6 months (using 0.78 foot/day rate) for the water level to rise from the projected river level to the water-table surface in the caved area (Figure 7). Although there would be gradients toward the river during this period of time, given the travel time estimates at maximum gradient (e.g., at the stable water table), this period is too short to be used in estimating when mine-related water could reach the river. If the time to reach the stable

water table (1.58 years) is added to the above figures, it would take from 7.64 to 21.55 years for mine water to reach the river from the position of the caved area.

4.0 RECOMMENDATIONS

There are at least three approaches to controlling the flow of ground water from a mined area to a gaining river:

- gradient control through a pumping or dewatering program;
- chemical precipitation of metals and sulphate; and
- grout sealing of preferential pathways.

Gradient Control: For gradient control, pumping (from the shaft and/or decline facility) partially dewaters the mined area. The effect of the dewatering is to create a gradient away from the Red River preventing mine waters from influencing the recharge. The Questa Mine is on standby status and, depending on improving economic conditions, the underground mine would be reactivated. Dewatering of the mine to resume operations would prevent mine water, including that in the caved area, from reaching the river.

At some future date, when the ore reserves are exhausted, a pumping program for gradient control can be implemented. Initially, the gradient reversal created by the pumping program would focus on developing a water table depression across the caved area such that the water level elevation was at least just below the projected river level (Figure 7). This condition could likely be accomplished at pumping rates below those required to dewater the mine (250 gpm). Pumping at Shaft No. 1 or No. 2 at underground mine depths (7100 to 7300 feet) should withdraw enough water to reduce the water level in the caved area to below the projected river level elevation. The rate of decline of the water level and the water-level elevation could be monitored at the decline or at a non-pumping shaft as is presently done. The deeper mine workings would not have to be dewatered in this initial effort. Dewatering for gradient control will place the Moly tunnel (7960 adit) above the water table. The tunnel has a cement plug such that fracture water (draining from higher levels and not drained to the deep mine) does not access the river.

The rate of rise, as well as the elevation of the water level in the mine area, are currently being monitored. Both should continue to be monitored on a monthly basis to aid in verifying conclusions in this report regarding the time to reach a stable water-table surface. The monthly monitoring data will be used to evaluate seasonal and any longer term changes in the rate of rise of water-level that might shorten or lengthen the time before the initiation of a pumping program.

A conservative position for initiating a pumping program to control the gradient across the caved area would be 4 years (October 1996) from the date when the water began to rise in the caved structure (October 1992). This would allow some time to adjust pumping rates to develop the appropriate water-table depression. This position is conservative to allow for variations in the travel time approximations and to recognize the potential for structures with down-gradient orientations to conduct ground water at higher rates than the surrounding rock. Variations in travel time calculations result from: (1) lack of site-specific hydraulic conductivity values, and (2) the possibility that the water-table surface may slope more directly toward the river with a steeper gradient and a shorter travel time. However, the "normal" water table configuration, for reasons already discussed, is believed to be not far off from the true surface.

Water withdrawn from the mine area, based on the chemistry in Table 1, would need to be discharged to the tailings pond facility near Questa.

Chemical Precipitation and Grout Sealing: Sealing of open fractures by chemical precipitation or grouting methods faces a formidable problem because of the large number of low-and high-angle fractures throughout the area. To find and seal all of the potential recharge pathways and to develop a monitoring program that can detect shifts from sealed to open fractures is not a feasible option at this site.

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July 20, 1993

Ms. Karen McCormack
Water Resource Specialist
Ground Water Section
State of New Mexico
Environmental Department
P.O. Box 26110-Runnels Bldg.
1190 St. Francis Drive
Santa Fe, New Mexico 87502

RECEIVED
JUL 22 1993
GROUND WATER BUREAU

Ms.McCormack:

Molycorp/Questa sent some corrections to the cadmium, lead, and copper concentrations listed for the seepage barrier water and the mine water in Table 1, page 11 of the July 14, 1993 Mine Rewatering report. Three copies of the revised Table 1 are included with this letter. Please replace page 11 in the July 14, 1993 report with the corrected Table 1.

Should you have any questions about the corrections, please call Jack Kepper at (602) 948-7171.

For South Pass Resources, Inc.

Jack Kepper

Jack C. Kepper
Associate Geologist

JCK:ds

Enclosures

001-02C1.PRT

5.0 REFERENCES

Bookstrom, A.A., 1981. "Tectonic Setting and Generation of Rocky Mountain Porphyry Molybdenum Deposits", in W.R. Dickenson and W.D. Payne (eds.), *Relations of Tectonics to Ore Deposits in the Southern Cordillera.* Arizona Geological Society Digest, Vol. 14, p. 215-226.

Carrillo, F.U., 1993. "Activities in Mining - 1992". Mining Engineering, Vol. 45, p. 474.

Drever, J.I., 1982. *The Geochemistry of Natural Waters.* Prentice-Hall, Englewood Cliffs, New Jersey, 388 p.

Freeze, R.A. and Cherry, J.A., 1979. *Groundwater.* Prentice-Hall, Englewood Cliffs, New Jersey, 603 p.

Lipman, P.W., 1981. "Volcano - Tectonic Settings of Tertiary Ore Deposits, Southern Rocky Mountains", in W.R. Dickenson and W.D. Payne (eds.), *Relations of Tectonics to Ore Deposits in the Southern Cordillera.* Arizona Geological Society Digest, Vol. 14, p. 199-213.

Maxey, G.B. and Eakin, T.E., 1949. *Ground Water in the White River Valley: White Pine, Nye and Lincoln County Nevada.* Nevada State Engineers, Water Resources Bulletin, No. 8, 59 p.

Rehrig, W.A., 1969. *Fracturing and Its Effects on Molybdenum Mineralization at Questa, New Mexico.* Unpublished PhD dissertation. University of Arizona, Tucson, Arizona, 194 p.

Schilling, J.H., 1956. *Geology of the Questa Molybdenum (Moly) Mine Area, Taos County New Mexico.* State Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology Bulletin, No. 51, 87 p.

Smolka, L.R. and Tague, D.F., 1988. *Intensive Survey of the Red River, Taos County, New Mexico, August 18-21, 1986.* New Mexico Environmental Improvement Division, Surveillance and Standards Section, Surface Water Quality Bureau, Sante Fe, New Mexico, 55 p.

Vail Engineering, Inc., 1989, 1993. Unpublished Accretion and Chemical Data on the Red River; for Molycorp, Inc., Questa Division, work in progress.

Winograd, I.J. and Thordarson, W., 1975. *Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site.* U.S. Geological Survey Professional Paper, 721-C, 126 p.

APPENDIX A

WATER-TABLE CONFIGURATION

APPENDIX A

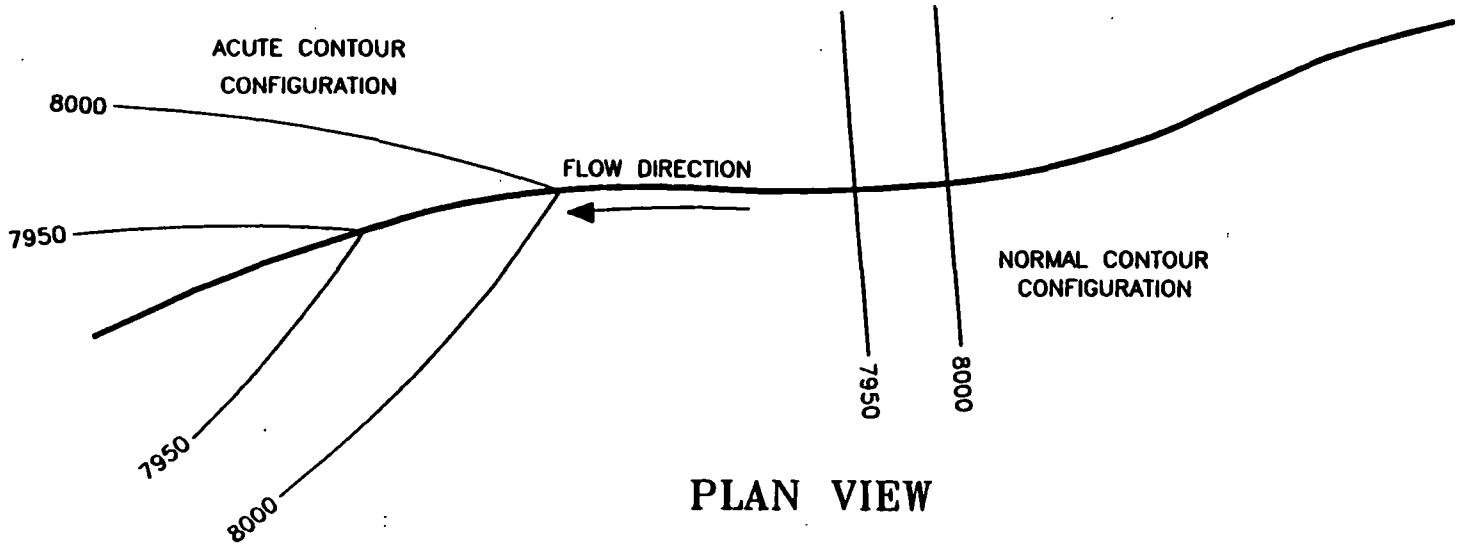
WATER-TABLE CONFIGURATION

The accretion studies were made under base flow conditions which means, because accretion occurs along the entire stretch of the Red River included in the study, ground water flows directly to the river. Therefore, the river can be classified as a gaining stream. Where water-level elevation contours cross a gaining stream, the contours point or "V" in an up stream direction. This is because the river as the lowest topographic element in the drainage basin intersects the water table resulting in any particular contour extending from that point on the river in a downstream direction, but flaring out at some angle beneath the floodplain or bedrock valley walls in this case.

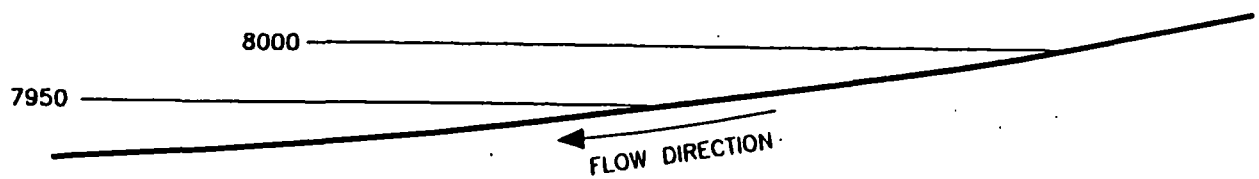
There are limiting angular positions for these contours with respect to the river channel. These positions range from a contour normal to the river channel (i.e., "normal contour pattern") to an acute angle configuration in which the contours are nearly parallel to the channel and the acute angle points up stream (i.e.,"acute contour pattern") as illustrated in Figure A-1. One elevation for any of these contours is fixed by elevations along the river channel.

The "normal" configuration was drawn by simply extending a series of parallel contours from their respective elevations along the river. The "acute"pattern was drawn by connecting the appropriate elevation of the Red River with a corresponding elevation on the deepest and farthest down gradient tributary gulch (Goat Hill Gulch) in the mine drainage area. This represents an extreme configuration because, if it existed, there would be natural springs along the bottom of the gulch wherever the water table was intersected.

The absence of such springs indicates the water table is deeper than the bottom of Goat Hill Gulch, but for the purpose of indicating a maximum condition this configuration will be used. To test these two extreme configurations water level contours can be evaluated based on existing information on water levels drawn in this case from dewatering information associated with the mining operations.



PLAN VIEW



PROFILE VIEW

FIGURE: A1	The GeoWest Group Inc.				LIMITING CONFIGURATIONS FOR A GAINING STREAM Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 7-14-93	AUTHOR: JCK	DRAWN BY: M.O'M.	

Reference 18

August 7, 1993

Don Rauch, Executive Director
Southwest New Mexico Council of Governments
P.O. Box 2157
213 N. Bullard
Silver City, New Mexico 88082

Dear Don:

Thank you for your comments on the proposed remedy, Alternative 5, outlined in the Proposed Plan for the Cleveland Mill Superfund site. I regret that the Southwest New Mexico Council of Governments does not agree with the remedy preferred by the State which consists of excavation of all contaminated surficial materials and off-site treatment through reprocessing and reclamation of beneficial metals. The New Mexico Environment Department (NMED) and the U.S. Environmental Protection Agency (EPA) have conducted an exhaustive assessment of a wide range of alternatives and have determined Alternative 5 to be the most permanent and protective of human health and the environment.

EPA and NMED have re-analyzed transportation issues in response to concerns expressed by Grant County and Silver City officials regarding truck traffic through the community during implementation of the preferred alternative. EPA provided details to the City and County in a letter of June 1, 1993 as to how transportation issues might be addressed by engineering and planning (copy enclosed). Implementation of all the alternatives, with the exception of taking no action at the site, will cause an increase in truck traffic in the short term. Alternatives 3 and 5 both include mitigation of short term risks by using engineering controls and by working closely with the City and County to develop a transportation plan. EPA has also assured the City and County that the costs of repair of any road that is damaged during implementation of the remedy will be included in the overall cost of the project. Given that both Alternatives 3 and 5 will include similar truck traffic and saftey problems, it is my hope that County, City, EPA and NMED technical staffs will work together to formulate a well engineered transportation plan.

U.S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
ROOM 115, FEDERAL BUILDING
SANTA FE, NEW MEXICO 87501

SEEPAGE INVESTIGATION

RIO GRANDE BASIN

Red River - Zwergle damsite to regular gage near Questa, New Mexico.

Reach--From discontinued gage "below Zwergle damsite near Red River" (08264500) to regular gage "near Questa" (08265000).

Previous Investigations--1959, 1963, 1966.

Date-- October 25, 1988.

Summary--Weather clear with no precipitation. No ice effect. Conditions at the sites through the reach were as follows:

Red River near Questa (station 08265000)-discharge remained practically constant from 0900 to 1630 hours.

South ditch near Questa diversion at mile 9.3 - no change in diversion.

Molycorp, Inc. diversion at mill at mile 15.4 - no change in diversion.

Results of this investigation are rated fair to good. This seepage investigation was conducted in conjunction with a water quality survey of the Red River by the New Mexico Environmental Improvement Division. Results of the survey are available from this agency.

Red River Mile	Location	Time	Discharge, cubic feet per second: Main Stream	Tributary or diversion
24.1	Red River below Zwergle damsite near Red River (discontinued gaging station 08264500)	0915	11	
23.7	Goose Creek at mouth	1005		+1.8
	Bobcat Creek at mouth	1020		+0.1 est.
	Placer Creek at mouth	1025		No flow
	Bitter Creek at mouth	1030		No flow
	Mallette Creek at mouth	1035		+0.4 est.
-	Pioneer Creek above Arrowhead Lodge at Red River	1100		+0.78
	Wastewater treatment plant discharge at Elephant Rock Campground near Red River			+0.35[a]
17.6	Red River at Elephant Rock Campground, below treatment plant, 20 ft below footbridge to Fawn Lakes, SW¼NE¼, sec.33, T.29 N., R.14 E. near Red River.	1140	16	
15.7	Red River above Molycorp mill near Red River, SE¼SE¼, sec.31, T.29 N., R.14 E.	1315	20	
	Molycorp diversion at mill	1340		0.00[b]
13.2	Red River 300 ft above mouth of Columbine Creek	1430	19	
13.1	Columbine Creek at mouth	1420		+6.0
			25	

— 4.? cfs

Red River Mile	Location	Time	Discharge, cubic feet per second: Main Stream	Tributary or diversion
10.3	Red River 0.2 miles above mouth of Bear Canyon near Questa	1545	29	
9.3	South ditch			-0.3 est.[b]
9.0	Red River near Questa, (regular gaging station 08265000) NE¼SE¼, sec.32, T.29 N., R.13 E.	1615	30[c]	

a Average discharge provided by treatment plant operator.

b No changes in diversion for duration of investigation.

c Discharge decreasing very gradually; stage fell 0.02 ft during investigation.

Reference 19

BEAR CREEK TAILINGS

PINOS ALTOS, NEW MEXICO

SCREENING SITE INSPECTION REPORT

July 30, 1993

CERCLIS # NMD986676906

Darren Padilla
Superfund Section
Ground Water Protection & Remediation Bureau
New Mexico Environment Department

TECHNICAL REPORT NO. 12

State of New Mexico
State Engineer Office
Santa Fe, N. Mex.

GROUND-WATER CONDITIONS AND GEOLOGY OF SUNSHINE VALLEY AND WESTERN TAOS COUNTY, NEW MEXICO

By

I. J. Winograd

U.S. Geological Survey

1959

TABLE OF CONTENTS

	Page
Abstract	1
Introduction	2
Location and extent of the area	2
Purpose and scope of the investigation	3
Previous investigations	3
Acknowledgments	3
Well-numbering system	3
Geography	5
Climate	5
Physiography	5
Sangre de Cristo Mountains	7
Lava-capped plateau	7
Piedmont alluvial plains	8
Irrigation	10
General geology	11
Stratigraphy	11
Geologic history	12
Proterozoic era	12
Paleozoic era	12
Mesozoic era	12
Cenozoic era	12
Structure	12
Faulting	12
Unconformities	13
Rock formations and their water-bearing characteristics	13
Precambrian system	13
Pennsylvanian and Permian systems	14
Sangre de Cristo formation	14
Tertiary system	14
Volcanic complex	14
Tertiary and Quaternary systems	15
Santa Fe group	15
Alluvial sediments	15
Andesite-basalt	16
Lake deposits	18

PAGE

Quaternary system 18
Recent series 18

Subsurface geology 18

Surface waters 21
Rio Grande 21
Mountain streams 21
Irrigation canals and ditches 22

Ground-water resources 22
Sunshine Valley 22
Water in alluvial sediments 22
Occurrence 22
Well characteristics 24
Chemical quality of the water 26
Water in andesite-basalt 26
Occurrence 26
Well characteristics 27
Chemical quality of the water 28
Relation of water in alluvial sediments to water in andesite-basalt 28
Recharge 30
Movement and discharge 32
Lava-capped plateau 34
Occurrence of ground water 34
Well characteristics 36
Recharge and discharge 37
Ground water at Tres Piedras 37
Ground-water accretion to the Rio Grande and the Red River 38
Effects of ground-water withdrawals in Sunshine Valley upon spring flow into the Rio Grande and the Red River 40

Summary 42

Literature cited 43

ILLUSTRATIONS

Index map of Taos County, N. Mex., showing area covered by report and major physiographic features ..... FRONTISPIECE

PLATE		FOLLOWING PAGE
1.	Generalized geologic map of Sunshine Valley and vicinity, Taos County, N. Mex.	4
2.	Water-table contour map of Sunshine Valley and vicinity, Taos County, N. Mex.	4
3.	Generalized geologic section across Sunshine Valley, Taos County, N. Mex.	16

FIGURE		PAGE
1.	System of numbering wells in New Mexico	4
2.	Rio Grande Canyon at the Dunn Bridge crossing	6
3.	Rio Grande Canyon and Cerro Chiflo	6
4.	East wall of Rio Grande Canyon, 2 miles north of the confluence with the Red River	7
5.	Sunshine Valley and Ute Mountain viewed from Guadalupe Mountain	9
6.	One of six vertical diesel pump units used in Sunshine Valley	11
7.	Map showing water-table contours and location of deep wells in western Taos County, N. Mex.	17
8.	Map of southwestern Sunshine Valley illustrating dip of the buried andesite-basalt lava flows and thickness of deposits formed within a lake during Quaternary time	19
9.	Modes of occurrence of ground water in Sunshine Valley, Taos County, N. Mex.	25
10.	"Arsenic" Springs	35
11.	Profile of Rio Grande from Red River, N. Mex., to Colorado-New Mexico line	41

TABLES

TABLE		PAGE
1.	Average monthly precipitation, and temperature, at weather stations in the Sunshine Valley area, Taos County, N. Mex.	45
2.	Discharge of Costilla Creek, Latir Creek, and Llano ditch, Sunshine Valley, Taos County, N. Mex., 1948-55	45
3.	Tests conducted on Chiflo dam-site test hole R-1 and Costilla dam-site test hole 1	46
4.	Accretion to the Rio Grande between Lobatos, Colo., and Cerro, N. Mex., in the month of least runoff at Lobatos, 1948-55	46
5.	Records of irrigation wells in Sunshine Valley, Taos County, N. Mex., and Costilla County, Colo., 1955 and 1956	47
6.	Records of stock wells, domestic wells, and dam-site test holes in the Sunshine Valley area, Taos County, N. Mex., and Costilla County, Colo., 1955 and 1956	50
7.	Logs of wells and dam-site test holes in the Sunshine Valley area, Taos County, N. Mex., and Costilla County, Colo.	57
8.	Chemical analyses of ground water in the Sunshine Valley area, Taos County, N. Mex., and Costilla County, Colo.	70

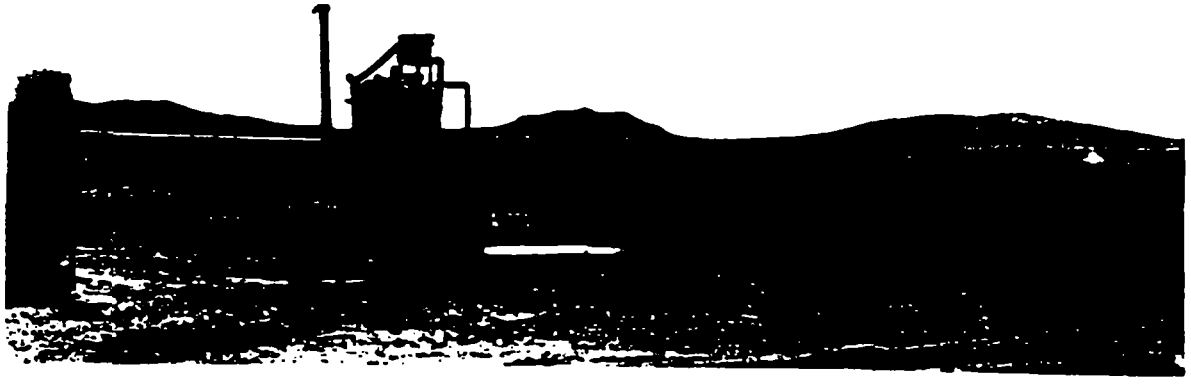


FIGURE 6. One of six vertical diesel pump units used in Sunshine Valley. A vertical crankshaft eliminates the need for a gear box to connect the drive shaft to the pump. The three mountains in the background are, left to right, Guadalupe Mountain, Cerro Chiflo, and Cerro de la Olla. View is southwestward.

GENERAL GEOLOGY

The Sunshine Valley area is geologically a re-entrant between two prongs of the Southern Rocky Mountains. These mountains were formed in late Cretaceous and early Tertiary time by compression of the earth's crust, which deformed the rocks exposed at and underlying the earth's surface. Renewed uplift of these mountains occurred during Miocene time, and this uplift is apparently continuing to the present day. Uplift of the area during the Miocene took place unevenly, and a trough formed between two highland prongs. This depression, referred to as the Rio Grande trough, includes the area covered by this investigation. In the trough were deposited materials eroded from the bordering highlands and lava emitted from numerous volcanoes in the region. The occurrence, movement, and quality of ground water are closely related to the structure and distribution of the valley-fill materials, for it is within these materials, known collectively as the Santa Fe group, that most ground water in the region is found. In the course of this investigation it was therefore necessary to examine the distribution, structure, composition, texture, and subsurface relations of the materials composing the valley fill, or associated with it, particularly insofar as these materials affect the occurrence of ground water.

STRATIGRAPHY

The rocks that crop out in the Sunshine Valley area are of sedimentary, igneous, and metamorphic origin and range from Precambrian to Recent. Most of the area is directly underlain by valley fill and lava of late Tertiary and Quaternary age. The areas of outcrop of the sedimentary, igneous, and metamorphic rocks in the vicinity of Sunshine Valley are shown on plate 1. The oldest rocks exposed in the area are Precambrian. These rocks crop out largely within the Sangre de Cristo Mountains and as isolated hills protruding through the surface of the lava-capped plateau. The Paleozoic rocks are represented by the Sangre de Cristo formation, which crops out in small areas on the mountain range of the same name and is considered to be of Pennsylvanian and Permian age. The middle Tertiary rocks are volcanic rocks of varying composition which compose much of the Sangre de Cristo Mountains and several of the isolated hills found on the lava-capped plateau. Valley fill and lava of late Tertiary and Quaternary age compose the Santa Fe group, which crops out in most of the region and uncomformably overlies the Precambrian and middle Tertiary rocks except where they protrude above the general surface of the tableland. Alluvial sediments of Recent age are found along stream courses.

GEOLOGIC HISTORY

Previous studies of outcrops by many geologists and the examination of well logs during the investigation have revealed much of the geologic history of the area. The following discussion is taken largely from Bryan (1938, p. 204-226) and McKinlay (1956, p. 25-26).

Proterozoic Era

The granite, schist, gneiss, and quartzite, which form much of the Sangre de Cristo Mountains, the granitic hills at Tres Piedras, and the quartzite forming Cerro Azul have been assigned in the literature to the Proterozoic era. The lack of fossils and the deformation undergone by these rocks make any attempt at deciphering the geologic history of the era most difficult. Folding, faulting uplift, metamorphism, weathering, and inundation occurred repeatedly during the era.

Paleozoic Era

The Paleozoic era was marked in New Mexico by the encroachment of a sea from the south. This sea did not inundate northern New Mexico until Devonian(?) time, for rocks of early Paleozoic age are missing in the northern half of the State. During Devonian(?), Mississippian, Pennsylvanian, and Permian time the sea submerged at least parts of Taos County, and the Magdalena group, now exposed atop the Sangre de Cristo Mountains in the southeast quarter of the county, was deposited. Some uplift of the Sunshine Valley area earlier than Permian time is indicated by the conglomeratic nature of the Sangre de Cristo formation (McKinlay, 1956, p. 25), which crops out in the mountains east of the valley.

Mesozoic Era

No sedimentary rocks of Triassic, Jurassic, or Cretaceous age are known in Taos County; consequently, the geologic events that occurred in this region during the Mesozoic era cannot be deciphered. The great thickness of marine sediments deposited in neighboring parts of the State during the Cretaceous age had led Just (1937, p. 15) to believe that the Picuris area in the southern Taos County must have been buried by Cretaceous marine sediments. If this is so, then the absence of sedimentary rocks in the region can be interpreted to indicate deposition followed by active erosion, rather than nondeposition during the Cretaceous period. Similarly, rocks of Triassic and Jurassic age also may have been deposited in the area and then eroded away.

The Mesozoic era closed with the Laramide revolution. During this revolution, or deformational epoch, the Rocky Mountain system was formed. The revolution was characterized by compression of rocks into great folds and thrust faults and was attended by much volcanism. The lines of crustal weakness outlining the basin or trough through which the Rio Grande presently flows may have originated during this revolution, although it is believed generally that the actual trough was formed after the large-scale volcanic activity of Miocene time.

Cenozoic Era

The Laramide revolution is considered generally to have begun in late Cretaceous time and early Tertiary time. During middle(?) to late(?) Tertiary time volcanic activity was renewed on a large scale. The San Juan Mountain region in southwestern Colorado, immediately to the northwest of Sunshine Valley, was one of the major volcanic centers of the period. The aggregate thickness of the several groups of lavas and tuffs emitted from the San Juan region is more than 33,000 feet. Uplift of the Sangre de Cristo and Conejos prongs along fault zones took place in late(?) Tertiary (Miocene?) time and localized the present outcrops of the middle(?) Tertiary volcanic rocks. A Miocene landscape topographically similar to the present landscape was thus created, and deposition of valley fill into the downfaulted areas ensued.

After Miocene time the deposition of alluvial sediments and lava and the uplift of the highland prongs continued in an almost cyclical fashion. The continued uplift of the highlands maintained the depositional trough formed in the Miocene, and accompanying subsidence of the trough preserved great thickness of alluvial sediments and lava flows, composing the Santa Fe group. During Miocene and Pliocene time the deposition of alluvial sediments appears to have been dominant. In late(?) Pliocene and early Pleistocene time, extrusion of andesite-basalt on a large scale began. Guadalupe Mountain, Cerro de la Olla, San Antonio Peak, and Ute Mountain erupted intermittently, spewing lava in all directions and constructing a vast lava plateau. The intermittent nature of the volcanic activity resulted in an interbedding of lava flows and alluvial sediments near the highlands. Uplifts of the Sangre de Cristo Mountains and depression of portions of the valley and the deposition of rock waste into the lowlands is continuing at present.

STRUCTURE

Faulting

Faulting was the major diastrophic process in the Sunshine Valley area after the middle Tertiary. It created the highlands from which the alluvial sediments were derived, and maintained the physiographic outline of the Rio Grande trough.

The effects of faulting since the middle Tertiary are seen in many places in Taos County and in Sunshine Valley. In the vicinity of Pilar, and elsewhere in southern Taos County, the Santa Fe group has been downfaulted and is now in direct contact with Precambrian rocks. Elsewhere the lava flows have been upfaulted. The bold western face of the Sangre de Cristo Mountains and, in particular, the evidence of triangular facets, fault scarplets, and landslides indicate that these mountains owe their present relief to faulting. McKinlay (1956, p. 21) estimates that east of Sunshine Valley the Sangre de Cristo Mountains were raised 7,000 feet and tilted eastward in Pliocene and Pleistocene time.

The lava flows that cap San Pedro Mesa, both in Sunshine Valley and in Colorado, are believed by Upson (1941, p. 536) to be upfaulted portions of the andesite-basalt lavas that underlie the plateau and the piedmont alluvial plains. The difference in altitude between the lava buried beneath the piedmont alluvial plain west of the mesa and the top of the mesa is an indication of the amount of uplift in the region. The top of the lava that caps San Pedro Mesa north of Cañon Cedro (pl. 1) is at an approximate altitude of 9,400 feet. Chiflo dam-site test hole R-8, 1.73.29.241 (pl. 2), is the well closest to the mesa for which a log is available and which penetrated lava. In this well the upper surface of the lava is at an altitude of 7,287 feet, 287 feet below the land surface. Assuming that this lava flow did not dip eastward and that this same flow caps the mesa, the minimum uplift along the mountain front must have been about 2,100 feet. This uplift probably has occurred since the cessation of volcanic activity.

Evidence of continuing uplift along the front of the Sangre de Cristo Mountains is offered by a fault scarplet formed in the alluvial fan at the mouth of Cañon Cedro. This scarp is about a mile west of the mountain front and a quarter of a mile east of State Highway 3, from which it is clearly visible; it trends slightly east of north and is 1.5 miles long. Near its center it attains a height of about 30 feet above the surrounding land, but tapers off rapidly to the north and south. The scarp need not mark the surficial trace of a fault that extends downward into bedrock, as it may lie at some distance from the master fault, and may have originated from tensions set up in the alluvial fan by movement along the major fault zone. The sharp relief of the scarp testifies to its youth, for it could not have lasted long, geologically, in unconsolidated sediments.

The isolated hills of Precambrian rocks such as Cerro Azul and the hills at Tres Piedras (frontispiece) may represent splinter faulting of the basement rock, or may indicate that the basement was a region of great relief when downfaulted.

Unconformities

The andesite-basalt lavas of the Santa Fe group unconformably overlie Precambrian rocks at Tres Piedras. The lavas similarly are unconformable on rocks composing the volcanic complex of middle(?) Tertiary age.

The unconformable relation of the plateau lavas to the andesite of middle(?) Tertiary age composing Cerro Chiflo is well exhibited on the cliff cut by the Rio Grande into the plunging east flank of that mountain. When viewed from the east rim of the canyon, the dark-brown andesite-basalt flows are clearly seen to overlap the lighter colored distorted andesite.

The unconformable relation between the lavas and the volcanic glasses of middle(?) Tertiary age composing No Agua Mountains (frontispiece) is indirectly indicated in a cut along U. S. Highway 285 immediately west of the village of No Agua. At this exposure, reworked volcanic glasses are buried beneath a lava flow.

ROCK FORMATIONS AND THEIR WATER-BEARING CHARACTERISTICS

PRECAMBRIAN SYSTEM

Precambrian granite, gneiss, schist, and quartzite occur mainly in the Sangre de Cristo Mountains. Materials derived from these rocks compose much of the valley-fill sediments found in the Rio Grande trough in Taos County. Precambrian rocks also compose several buried hills which protrude through the sea of lava underlying the plateau. The village of Tres Piedras derives its name from the three granitic hills that rise above the surface of the plateau. Cerro Azul (Blue Hill), near the southern extremity of the plateau, is composed of bluish quartzite. Thickness and extent of the Precambrian rocks composing Cerro Azul and the hills at Tres Piedras are not known because of their partial burial beneath the thick andesite-basalt lavas of the Santa Fe group.

The Precambrian rocks generally are highly fractured, having undergone multiple periods of deformation during their long geologic history. However, the fractures are usually tightly closed at depth, and these rocks should generally be considered as aquicludes — that is, non-water-bearing rocks. Locally, at Tres Piedras small quantities of water are derived from wells dug into granite. These

wells, which appear to act as cisterns and to derive their water from alluvium overlying the granite, usually go dry in early summer and in late fall or early winter.

PENNSYLVANIAN AND PERMIAN SYSTEMS

Sangre de Cristo Formation

The Sangre de Cristo formation of Pennsylvanian and Permian age crops out in isolated patches high in the Sangre de Cristo Mountains. The formation is described by McKinlay (1956, p. 11) as "well cemented, reddish arkosic shales, sandstone, and conglomerates . . . composed of Precambrian debris." Because of its limited occurrence at high altitudes, this formation is not important with regard to the occurrence of ground water in the Sunshine Valley area.

TERTIARY SYSTEM

Volcanic Complex

A volcanic complex, consisting of andesite, rhyolite tuffs and flows, basalt, granite, and some interbedded sedimentary rocks, forms part of the Sangre de Cristo Mountains and San Pedro Mesa. These rocks, considered to be of middle(?) to late(?) Tertiary age, are the source of much of the detritus composing the valley fill. Cerro Chiflo and No Agua Mountain, two partly buried hills which protrude above the surface of the lava-capped plateau (frontispiece), are composed respectively of andesite and volcanic glasses. These rocks are considered to be equivalent in age to the rocks composing the volcanic complex.

With regard to the occurrence of ground water in the Sunshine Valley area, only the rocks composing Cerro Chiflo and No Agua Mountain, by virtue of their presence within the Rio Grande trough, assume importance. The description and discussion of these rocks, which follow, are based largely upon the available literature, maps, logs of test holes and water wells, and observations made in the field.

The andesite composing Cerro Chiflo is hard, fine grained, and largely gray but mottled and banded with pink. Flow lines and fractures in the andesite are well exhibited on the cliff cut by the Rio Grande into the plunging east flank of the mountain. Subordinate amounts of rhyolite occur with the andesite, and the log of test hole 29.12.-17.434 indicates that volcanic ash is present beneath or within the andesite at a depth of 166 feet.

The volcanic glasses composing No Agua Mountain are presently being strip mined for use in the production of cinderblock. Locally, these volcanic glasses have been referred to as perlite, a term which, under a broad industrial classification, includes all expansible volcanic glasses. However, the several specimens that have been examined do not exhibit a perlitic structure. The texture of one sample resembles that of pumice and consists largely of interlocking crystal-clear glass fragments and fibers. Other specimens, much denser than the pumice-textured sample, exhibit a well-defined flow structure consisting of alternating buff and bluish-gray bands. Many of the flow structures are highly distorted and exhibit numerous types of miniature folds. Much of the rock forming the mountain is fractured to such an extent that little blasting is needed to aid removal of the rock by bulldozers. Some of the visible fracturing undergone by the volcanic glasses may be due to erosional load relief, which has resulted in parting of the rock along flow lines.

The thickness and extent of the andesite composing Cerro Chiflo and the volcanic glasses composing No Agua Mountain are not known, because of their partial burial beneath the thick andesite-basalt lavas of the Santa Fe group which form the tableland west of the Rio Grande.

The ability of the andesite and the volcanic glasses to transmit water appears to be poor. The grains of these rocks, like those of most igneous rocks, are interlocking and provide little or no pore space. The movement of ground water through such rocks necessarily depends upon the extent of the fracturing undergone by the rocks either during or after their solidification. In contrast to the andesite-basalt lavas of low viscosity, the andesite and volcanic glasses both were derived from a moderately to highly viscous lava. The high viscosity of the lava probably limited the areal extent of the individual flows, and they are believed to have accumulated upon one another in thick, randomly distributed layers interbedded with ash. Logs and exposures indicate that these rocks are fractured, as a result of flow in the fluid state, contraction cooling, or post-solidification stresses. The thickness of the flows and their limited areal extent, however, probably restricted the development of extensive open-fracture systems such as those which developed in the tabular plateau lavas. It is believed by the author that both the andesite and the volcanic glasses are not as permeable as the andesite-basalt flows beneath which they are buried, and they probably form barriers to the movement of ground water beneath the plateau.

Three Chiflo dam-site test holes (29.12.16.133, 29.12.17.422, and 29.12.17.434) which were drilled to explore the water-bearing properties of the andesite were drilled into that rock to a depth below the water table in the surrounding andesite-basalt flows. No mention was made in the drillers' logs of the occurrence of ground water in two of these test holes; however, the third hole (29.12.17.434) encountered water under sufficient hydrostatic pres-

sure to produce a flowing well. Well 23.9.16.200, buried beneath U. S. Highway 285 immediately west of No Agua Mountain, reportedly was drilled to a depth of 700 feet without encountering water. The cuttings removed during the drilling of this well are reported by longtime residents as having consisted of a white sand, which probably was crushed volcanic glass. However, this dry hole does not necessarily prove that the volcanic glasses composing No Agua Mountain are not water bearing for the regional water table, as indicated by figure 7, is probably below the altitude of the bottom of this well.

TERTIARY AND QUATERNARY SYSTEMS

Santa Fe Group

The valley-fill materials which have accumulated to a great thickness in the Rio Grande trough since middle(?) Miocene time are collectively called the Santa Fe group* in the Santa Fe area. Equivalent rocks occur within the Rio Grande depression from the north end of the San Luis Valley to and beyond El Paso, Tex. In the Sunshine Valley area they consist largely of alluvial sediments and andesite-basalt lava flows, and some lake deposits. These rocks are not all of one age, for, obviously, the valley fill deposited in middle(?) Miocene time is older than the detritus removed from the slopes of the highlands during Pleistocene(?) time. Nevertheless, they are grouped together because all were deposited in a common trough. They have a common mode of occurrence and they are all younger than middle Tertiary.

The Santa Fe group is the major ground-water reservoir in Taos County. The alluvial sediments, andesite-basalt flows, and lake deposits, which compose this group in the Sunshine Valley area, differ greatly from each other in their lithology and in their water-transmitting characteristics. The three units are discussed below.

Alluvial sediments

Alluvial sediments underlie most of the piedmont alluvial plains and are interbedded with the andesite-basalt flows of the plateau. They are composed of detritus or rock waste washed down from mountains into the Rio Grande trough. Most of the alluvial sediments forming and underlying the piedmont alluvial plains were derived from the Sangre de Cristo Mountains, although small amounts were contributed by Ute Mountain and Guadalupe Mountain. The alluvial sediments underlying and interbedded with the lavas of the plateau were probably derived both from the Sangre de Cristo Mountains and from the highlands bordering the plateau on the west.

*Spiegel, Zane, and Baldwin, Brewster, Geology and water resources of the Santa Fe area, N. Mex.: U. S. Geol. Survey rept. in preparation.

The thickness of the alluvial sediments beneath the valley is estimated by McKinlay (1956, p. 21) to be about 3,000 feet. However, the alluvial sediments, deposited since the last period of volcanic activity, thin out toward the west, and near the contact with the eastward-dipping lava flows they are only a few feet thick (pl. 3). The thickness of the alluvial sediments underlying the lavas capping the plateau is not known. The greatest thickness of alluvial sediments penetrated by a well (1.73.32.122) is 535 feet. The surface distribution of these sediments in Sunshine Valley is shown on the geologic map (pl. 1).

Examination of the walls of irrigation ditches, and of gravel pits along State Highway 3, reveals the heterogeneous character of the alluvial sediments. These sediments, commonly buff to dark brown, are composed of materials ranging in size from clay particles to cobbles 8 inches long. The individual pebbles and cobbles are recognizably derived from the granite, schist, gneiss, and volcanic rocks composing the Sangre de Cristo Mountains, and they range in color from black to gray-green to red.

Usually the alluvial sediments are unsorted, but locally they are fairly well sorted, and contain lenses of gravel, sand, or clay. Well logs show that the horizontal and vertical variability of the alluvial sediments as seen in pits and ditches is also characteristic of the rock at depth.

The presence or absence of sorting and the wide variation in lithology of the detritus composing the alluvial sediments may be attributed largely to the varying load capacities of, and the frequent channel shifting by, the streams that emerged from the highlands to deposit the sediments. During periods of heavy flood, the streams are able to transport materials of all sizes, including boulders. The large boulders and cobbles, usually deposited near the mouths of canyons at the foot of the mountains, may thus be carried some distance from the canyon and dropped over finer sediments laid down on the plains during a minor flood. The character of the sediments covering these boulders and cobbles will in turn depend largely on the stream velocities of succeeding floods. During periods of moderate stream discharge, coarse materials previously deposited may deflect the stream so that its load may overlap the finer sediments deposited at the mouth of a smaller neighboring canyon. In such a manner, heterogeneous alluvial fans and cones were built at the mouth of every canyon at the foot of the mountain range. As these fans grew and expanded laterally they coalesced, forming piedmont alluvial plains.

Most of the domestic and stock wells, and all the irrigation wells, in Sunshine Valley derive their water principally from the alluvial sediments. The water-bearing characteristics of these sediments are of necessity as varied as their lithology. Beneath the

water table all the voids or pore spaces between the individual grains are filled with water: that is, the sediments as a whole are saturated. The ground water is continually moving slowly through the void spaces in the rock, toward natural outlets or wells that are being pumped. The rate of ground-water movement through the void space of these sediments is dependent in part upon the degree of sorting of the grains through which it moves. For example, coarse-grained, well-sorted sand permits movement of ground water much more readily than gravel that is thoroughly mixed with sand and clay. In the gravel stratum the spaces between the pebbles are filled with sand grains, and the spaces between sand grains in turn are filled by clay particles: movement of water through this stratum consequently is comparatively slow. The well-sorted, coarse-grained sand would offer relatively less resistance to the passage of water.

The rate of movement of water through well-sorted materials also varies directly with the coarseness of the grains. Thus, a well-sorted sand will not transmit water as readily as a well-sorted gravel: water moving through the sand would have to overcome a greater amount of friction than would be encountered in the gravel. Stated in another manner, the ratio of the surface area of a given volume of water occupying a void, to the volume of the void, is greater in small voids than in large voids. Small voids therefore offer more resistance to the movement of water than large voids.

Owing to the large range in possible degrees of sorting and coarseness of the alluvial sediments, the rate of ground-water movement through this material varies greatly. Deep wells tapping these sediments, however, generally yield large quantities of water, because in most places they tap some strata of well-sorted material in addition to penetrating zones of "tight" clayey or poorly sorted material. The yields of irrigation wells tapping the alluvial sediments generally range from 600 to 1,200 gpm, although one yield as large as 3,000 gpm has been reported (table 5).

Andesite-basalt

Andesite-basalt lavas underlie most of the plateau in western Taos County (pl. 1) and are known to exist beneath, and to be interbedded with, the alluvial sediments composing the piedmont alluvial plains east of the Rio Grande. Ute Mountain, San Antonio Peak, Cerro de la Olla, Cerro Negro, and other volcanoes in the region were the probable sources of these vast lava flows, although some of the flows may have issued from fissures. The flows range in composition from basalt to andesite and will be referred to hereafter as andesite-basalt lavas, or simply as lavas.

The individual andesite-basalt lava flows are generally less than 50 feet thick and are locally interbedded with thin strata of volcanic ash. In the northern half of the plateau, the logs of wells 29.11.-14.410, 31.9.10.320, and 30.10.8.444 show that the lava and associated volcanic ash and cinder beds reach thicknesses of 485, 575, and 600 feet, respectively. In the southern half of the plateau the thickness of the lava ranges from 45 feet, north of Tres Piedras, to 280 feet, 5 miles north of Taos Junction (logs 28.9.11.200, 26.10.6.200, and 25.10.4.222, table 7). Approximately 670 feet of lava is exposed in the canyon at the Taos Junction bridge.

The andesite-basalt flows were derived largely from molten lavas of low viscosity; hence they were able to spread out over the plateau in tabular sheets, often of large extent. The sheets were cut by numerous vertical fractures which formed during the cooling of the lava. The rapid chilling of the tops and bottoms of individual flows, and later erosion, resulted in a rugged contact between the lava strata. In addition, the chilled and broken crusts of the flows probably were often rolled under the advancing front of the lava, and as a result permeable brecciated zones may at times have been formed at the base of individual flows. In such a manner, both horizontal and vertical passages were developed in this rock. Although some of the andesite-basalt lava is very dense, most of the specimens collected contain vesicles or bubbles formed by gases escaping from the cooling lava. The vesicles usually occur near the top of the lava flows. Typically, they are spherical or cellular in outline, but many are tubular. The vesicles range in diameter from the size of a pinpoint to 0.5 inch and are not well interconnected.

Although the lava ranges in color from jet black to brownish red, most specimens are gray on the fresh surface. The rock commonly weathers to a black, brown, or cream color. The texture of the flows generally is so fine that the individual grains cannot be distinguished with the naked eye, although some samples are sufficiently coarse textured to permit such distinction. The coarse-textured samples may represent the middle portions of thick flows. Most specimens exhibit a fine-grained, smooth fracture. The lava normally weathers into a clayey soil, on which travel by auto during and after a rainstorm is a painstaking, and at times a hazardous, process.

Most of the stock wells in the northern half of the lava-capped plateau obtain their water from the andesite-basalt. The ability of this rock to transmit water — that is, its permeability — depends largely upon the extent of its fracturing. Unlike alluvial sediments which generally have void spaces between individual grains through which ground water may move, the grains or crystals composing a lava are usually interlocked, thus leaving little or no interconnected void space. Ground water in lava

flows, therefore, moves only through fractures in the rock or along the rough contacts separating the individual flows. Vesicles do not seem to be an important medium for ground-water movement through the lava.

Because of dependence upon fractures to transmit water, andesite or basalt lavas are often described as having a low rock permeability but a high formational permeability. That is, though small portions of a lava flow are commonly impermeable, the lava flow as a whole is capable of transmitting large quantities of ground water. Stock wells on the plateau which tap the lava have reportedly yielded 25 to 30 gpm during bailing tests. The great depth to water in the lava beneath the plateau and the availability of shallower water in Sunshine Valley from the alluvial sediments has precluded drilling in the lavas for irrigation water.

Lake deposits

Logs of numerous wells show that deposits of clay or sandy clay occur beneath the alluvial sediments in the southwestern quarter of Sunshine Valley. These deposits, which are believed to have been formed in an ancient lake, range in thickness from several feet to 166 feet. Most logs describe these sediments as "clay, brown, sandy," "clay, red," "clay, dense, brown, sticky." Several logs list strata in which sand and gravel occur in a matrix of brown clay. The determination of the lithologic characteristics of these deposits is based, of necessity, upon descriptions in well logs, for the deposits have been buried beneath younger alluvial sediments.

Although the lake sediments are generally fine grained, indicating deposition in relatively quiet waters, coarse, well-sorted deposits could have formed along the eastern border of the lake as a result of reworking of the flanking alluvial sediments. The permeability of the lake deposits is usually low because of their predominantly fine-grained texture. Consequently, wells drilled into these deposits will yield relatively small quantities of water.

The origin and extent of the lake in which these deposits formed are discussed under "Subsurface geology."

QUATERNARY SYSTEM

Recent Series

Stream deposits, predominantly sand and gravel, crop out along the banks of creeks in the area. These deposits generally are fairly well sorted. Wells dug along Costilla Creek derive their water largely from floodplain sediments deposited by this creek. The thickness and extent of these deposits are not known.

SUBSURFACE GEOLOGY

Owing to the different water-bearing capacities of the alluvial sediments, the andesite-basalt lavas, and the lake deposits, the subsurface relations between these rocks directly affect the rate and direction of ground-water movement. The relations of these rocks to each other are therefore discussed with special reference to the subsurface geology of Sunshine Valley.

Beneath the lava-capped plateau, the lava flows and associated ash beds accumulated one upon another to thicknesses ranging from 45 to more than 600 feet. These overlie the alluvial sediments, and there is no evidence of interbedding of the sediments and the lava beneath the plateau.

East of the Rio Grande the lava flows have been buried beneath alluvial sediments and are locally interbedded with them. During periods of volcanic activity the alluvial sediments derived from the Sangre de Cristo Mountains were partially buried beneath vast sheets of lava derived from the west. With the cessation of volcanic activity the lava flows were in turn buried beneath detritus. In such a manner the lava flows and the alluvial sediments, which largely compose the Santa Fe group, were interbedded along the mountain front. This interbedding is clearly seen in the Rio Grande Canyon at Dunn Bridge (fig. 2). To the north, opposite Sunshine Valley, only lava flows are seen in the canyon. Well logs (table 7) show, however, that the lava and alluvial sediments are interbedded east and southeast of Ute Mountain.

Since the last period of volcanism the lavas east of the Rio Grande Canyon have been largely buried beneath the alluvial sediments that underlie the piedmont alluvial plains. In Sunshine Valley, the lava crops out in a narrow strip, half a mile to a mile wide (pl. 1), which borders the Rio Grande Canyon on the east. Elsewhere in the valley the lava is buried beneath the alluvial sediments.

Knowledge of the extent of the lavas beneath the valley is derived from the logs of wells and damsite test holes. Figure 8 is a structure contour map, prepared from logs, showing the altitude of the uppermost lava flow encountered during the drilling of wells and test holes in the southwest quarter of the valley. The structure contours clearly show that the lava strikes nearly north-south and dips eastward. The plain, under which the lava is buried, slopes westward; consequently, the depth to the lava increases toward the Sangre de Cristo Mountains. The lava was encountered at a depth of 102 feet below land surface in test hole 30.12.33.220, 1.5 miles east

streams also head in the Sangre de Cristo Mountains but, unlike the above-mentioned streams (Costilla Creek, Latir Creek, Rio del Medio, Rio Primero, and Cañada Piñabete), they flow in a valley incised 100 to 200 feet below the surface of the piedmont alluvial plain rather than upon the surface of the plain. Red River shows an appreciable gain in flow, in large part from springs on the north and south banks, between its mouth and a point about 7 miles upstream, at the junction with Cabresto Creek. In its lower reaches Cabresto Creek also receives part of its flow from ground water. The accretion to Red River is discussed more fully under the section in this report on ground-water accretion to the Rio Grande and Red River.

IRRIGATION CANALS AND DITCHES

Acequia Madre, Cerro Canal, Cerro community ditch, and Llano ditch (pl. 2) are the major irrigation watercourses that divert water from the perennial mountain streams. The first two divert water from Costilla Creek; the Cerro community ditch intercepts water from Latir Creek, Rio del Medio, and Rio Primero; and Llano ditch diverts from Cabresto Creek. Numerous minor ditches (not labeled on pl. 2), including Mesa ditch, Middle ditch, Alire ditch, and the New Mexico branch of the Cerro Canal, divert water from the ditches named. Within the State the network of ditches is largely limited to the northeastern and southeastern corners of the valley. In Colorado surface water is applied to much of the land in the vicinity of Garcia and Jarosa. The quantity of water flowing in the ditches depends upon the season of the year and the amount of water released from storage in Cabresto and Costilla Reservoirs. During the 1955 irrigation season (May-September), Acequia Madre, Cerro Canal, and Llano ditch transported respectively about 4,600, 11,700 and 2,000 acre-feet of water past their points of intake. The flow in these ditches during the winter is negligible. The flow in the Cerro community ditch during the 1955 irrigation season was greater than the 3,200 acre-feet diverted from Latir Creek by the amount of unmeasured intake from Rio Primero and Rio del Medio. The flow of Latir Creek is diverted into this ditch the year round. None of these ditches are lined to prevent the loss of water through seepage. The ditches are commonly floored with sand and gravel and serve as excellent sources of artificial recharge to the ground-water reservoir.

GROUND-WATER RESOURCES

SUNSHINE VALLEY

Ground water beneath Sunshine Valley occurs within the alluvial sediments that largely underlie the piedmont alluvial plain, and within lava flows that underlie and are interbedded with the alluvial sediments. Most wells derive their water from the alluvial sediments that floor the valley. Ground water within these sediments is generally found at depths ranging from 2 to 90 feet in the southern half of the valley and from 50 to 271 feet in the northern half. Several dam-site test holes and several irrigation wells have been drilled into the lava, and the wells derive all or part of their water from that rock. Water within the lava is tapped by wells at depths ranging from 90 to 231 feet below the land surface.

Wells dug along the banks of Costilla Creek derive their water chiefly from the alluvium of Recent age deposited by this creek.

Water in Alluvial Sediments

Occurrence

The alluvial sediments form the principal aquifer within the valley. They underlie most of the valley (see pl. 1) and contain large quantities of ground water of excellent quality. For many years prior to the recent development of ground water for irrigation, water within these sediments was used for stock and domestic purposes. The quantity of water pumped from this aquifer for irrigation now greatly exceeds all other uses.

The depth to water within the alluvial sediments varies considerably in different parts of the valley. In the southern half of the valley, water levels are relatively shallow, ranging from 2 to 90 feet below land surface. In T. 30 N., R. 12 E., the water table is within 50 feet of the land surface. It nearly parallels the land surface throughout this township, and consequently the depth to water does not increase toward the east despite the rise of the land surface in that direction. Plate 3 shows the relation of the water table to the land surface across the center of this township. In secs. 1, 14, 15, and 23 the land surface and water table converge, the upper surface of the zone of saturation approaching to within 2 feet of the land surface. The water table in these sections is at the land surface in several places where watering holes have been dug. One of these holes or pits, in the NW¼ sec. 1, served as a watering hole in stagecoach days.

In the immediate vicinity of Cerro, and southward to Questa, water levels range from 60 to 157 feet below the land surface. In this area the land surface rises toward the mountains and toward the low topographic divide separating the two villages at a gradient greater than that of the water table, resulting in greater depths to water in those wells

may be expected from several feet of highly fractured saturated lava. The pressure tests conducted on the test holes show clearly, however, that a large variation exists in the water-transmitting capacity of the lava. In Costilla dam-site test hole 1, for example, several zones, ranging from 10 to 20 feet in length, accepted no water under pressures of 100 pounds.

The possibility of obtaining from the lava sufficient water for irrigation has not yet been determined adequately by drilling but appears to depend directly upon the extent of fracturing encountered by a well. A well penetrating several hundred feet of saturated lava might tap several highly fractured zones capable of yielding large quantities of water. The yields of adjacent wells might differ considerably, however. Sufficient water from the lava for stock and domestic needs is considered a certainty. Stock wells on the lava-capped plateau west of the Rio Grande, which derive their water from saturated lava, reportedly were tested with a bailer at 25 to 30 gpm.

Chemical quality of the water

Ground water within the lavas is of satisfactory chemical quality for all usual purposes and closely resembles that within the alluvial sediments. Table 8 lists the chemical analyses of water samples from three springs that issue from lava in the Rio Grande and Red River Canyons and from a stock well on the lava-capped plateau. The hardness of the samples ranged from 63 to 100 ppm.

Relation of Water in Alluvial Sediments to Water in Andesite-Basalt

Ground water has been shown to occur in both the alluvial sediments and the andesite-basalt lavas. The absence of springs at the surficial contact of the alluvial sediments and the lavas, plus the similarity in chemical composition of the water in the lava to that in the overlying alluvial sediments, indirectly indicates that water from the sediments moves into the underlying lava.

Water is heard running or cascading constantly into wells which have penetrated both saturated alluvial sediments and lava flows. This phenomenon is exhibited in irrigation wells drilled east and southeast of Ute Mountain. Well 1.74.24.244a, for example, was drilled through a lava flow, between 276 and 290 feet, then into more alluvial sediments to a depth of 475 feet, where lava was again encountered. The water level in this well on July 12, 1955, was 197.9 feet below the ground. Water is always heard cascading into this well. Irrigation well 1.-74.24.244, 320 feet north of well 1.74.24.244a, was drilled through alluvial sediments to a depth of 276 feet and was completed at the top of a lava flow. The depth to water in this well on the same date was 195.9 feet below the land surface. Water is not heard running into this well. A difference of 2.3 feet exists in the altitude of the ground surface at the two wells; when referred to the same datum the water level in the 475-foot well was 4.3 feet below that in the shallower well. On the date of measurement water was entering the deep well at a depth of 193.6 feet and cascading to a depth of 197.9 feet. Other irrigation wells, among them wells 2.74.2.222, 2.74.12.121, 2.74.12.122, and 31.12.35.123, exhibit this phenomenon.

Although many of the dam-site test holes penetrated both alluvial sediments and lava, water is not heard cascading into these holes. This is because the water within the alluvial sediments is sealed off from the water in the lava through the utilization of double casings.

The water levels often drop sharply within the casings after the drill has penetrated lava. This was best exhibited in irrigation well 30.12.2.444 and in test hole 30.12.23.122. The irrigation well was drilled through 137 feet of alluvial sediments and 62 feet of lake deposits before encountering lava at 199 feet. Water in the alluvial sediments was at a depth of 18 feet. The lava was penetrated to a depth of 250 feet. During drilling to this depth the water level within the casing dropped sharply and water cascaded into the well from the 18-foot level. This led the driller to believe that all water had been lost into cavities within the lava. The hole was then cemented back to the 199-foot level. The water level in this well on August 31, 1955, was 20 feet below land surface.

Test hole 30.12.23.122 first encountered ground water within the alluvial sediments 11 feet below ground level. At a depth of 110 feet lake deposits were encountered, and at a depth of 212 feet lava was encountered (see log, table 7). Between 232 and 240 feet, while the drill was still in lava, the water level in the casing dropped from 11 to 45 feet and water began cascading into the well from saturated sediments above the 45-foot level. No water is now heard running into this well, as the water within the alluvial sediments has been cased off.

The above-described phenomena reflect a difference in head between the water in the alluvial sediments and that in the underlying lava. The hydrologic environment and the probable cause of this head difference are discussed below with reference to figure 9, which generalizes conditions encountered in several dam-site test holes.

Part C of figure 9 illustrates a test hole in which ground water was encountered under water-table conditions within the alluvial sediments and was completed just above a lava stratum. The fractures in the top of the lava stratum are filled with sediments. Ground water within the alluvial sediments

moves to the left toward a point of discharge not shown on the diagram. Within the lava stratum a zone of saturation exists in which water also moves to the left toward a point of discharge. Water within the lava is under subnormal head, for the water levels in wells tapping this rock stand below the water table within the alluvial sediments. Consequently, water moves downward from the sediments into the lava. This downward movement is retarded by the upper portion of the lava flow where the fractures have been filled by clay, sand, and gravel. Where the lava is directly overlain by the lake deposits, as in the western two-thirds of T. 30 N., R. 12 E., these deposits assume importance in retarding downward percolation. Although downward movement of water from the upper zone of saturation into the lavas occurs, ground water within the alluvial sediments moves laterally also, toward points of lower altitude.

The upper body of water within the alluvial sediments, illustrated in figure 9C, is considered to be semiperched with respect to the lower body within the lava. No unsaturated rock is present between them and each is considered part of the same zone of saturation. The upper portion of the lava stratum, whose fractures have been filled with sediments and which in effect separates the two saturated zones by retarding the movement of water between them, may be called a negative confining bed or stratum. The concept of a lava flow serving as a negative confining bed appears somewhat ambiguous in the light of previous references to the high permeability of the rock. However, the upper portions of the numerous fractures in a flow have been filled with clay, sand, and gravel upon burial beneath the alluvial sediments, and it is understandable that the permeability of this rock is reduced locally. If the surface of the lava has been exposed to the elements for a length of time, the clayey weathering product of this rock also reduces its permeability somewhat. Where lake deposits overlie lava they also function as negative confining strata. Meinzer (1923, p. 40) defines such a stratum as "one that prevents or retards downward movement of ground water where the overlying water has sufficient head to produce a resultant downward pressure."

The amount of downward leakage through the negative confining beds must be appreciable to maintain constant saturation of the underlying zone. If the negative confining stratum were impermeable, the water in the lower zone of saturation, if not recharged from another source, would drain to the level of its outlet: this would produce a zone of aeration between the upper and lower saturated rocks and the water in the alluvial sediments would be perched. Usually such a condition does not exist in the valley. The generalized hydrologic conditions discussed, and illustrated by figure 9C, exist within the valley wherever saturated lava underlies or is interbedded with saturated alluvial sediments.

If the well shown in figure 9C were deepened and drilled through the negative confining bed into the lower saturated zone within the lava, the water in the casing would drop below its original level (fig. 9D). Water flowing through casing slots into this well from the upper level would then cascade inside the casing to a lower level. In effect, the well would represent a large artificial fracture cutting the negative confining layer that separates the upper zone of saturation from the lower. Drainage from the upper to the lower zones in the vicinity of the well would immediately take place through the well casing at a rate much greater than that occurring under natural conditions through the negative confining layer. The amount of drop in water level in the wells is proportional to the difference in head between the two zones of saturation and their relative permeabilities. Examples of wells that exhibit the conditions portrayed by figure 9D were cited at the beginning of this discussion.

The situation illustrated in figure 9E shows the manner in which a double casing was used in test holes to isolate the water within the lava from that within the alluvial sediments. It should again be noted that the water level within the lava stands within the casing at a point above the top of the lava but below the water table within the alluvial sediments (and also below the level given by fig. 9D). The significance of this is threefold: (1) No zone of aeration exists between the upper and lower saturated zones. If such a zone existed the water level in the lava would be beneath the bottom of the confining strata. (2) The water in the lower zone of saturation is under hydrostatic pressure, for the water level stands above the bottom of the confining layer. (3) The head of the water in the lava is less than that within the alluvial sediments and therefore constitutes a subnormal pressure head.

Difference in head between the water within the alluvial sediments and that within the lavas is attributed to a difference in the permeability of these rocks, to the existence of a confining layer, and in part to the low outlet level of the water in the lava. The movement of ground water through lava is predominantly by way of fractures and through passageways along bedding planes. The fractures are comparatively large and when open offer little impediment to ground-water movement. The gradient or head difference required to transmit water through the lava is therefore small. Ground water moves in the alluvial sediments through small spaces between the individual grains and consequently meets much resistance. A steeper gradient is re-

quired to move an equal quantity of water through such a stratum. It is therefore apparent that the subnormal pressure head within the lava is due primarily to the greater permeability of that rock, which is reflected by the low gradients under which the ground water moves. The steeper ground-water gradients within the alluvial sediments reflect the lower permeability of this rock.

Not every well that pierces a lava stratum beneath saturated alluvial sediments contains water under subnormal pressure head. Well 2.74.11.222, for example, was drilled through two lava flows, 35 and 45 feet thick, sandwiched between alluvial sediments. No water is heard cascading into this well nor did the water level reportedly drop in the casing below the depth at which it was first encountered. The apparent absence of semiperched conditions at this locality probably indicates that the lava flows penetrated were not fractured to an extent sufficient to transmit water rapidly. Where the alluvial cover is thin and the discharge point within the lava is nearby, as in the vicinity of well 30.12.21.111, the downward seepage of water is insufficient to saturate the lava and a zone of aeration separates the two aquifers. Most wells and test holes penetrating lava beneath saturated alluvial sediments, however, have exhibited a drop in water level in the casing and a resulting cascade, provided the semiperched water has not been cased out.

The relation of the water within the alluvial sediments to that within the lavas may be summarized as follows. Beneath the water table, within the zone of interbedding of alluvial sediments and lava, downward movement of ground water from the alluvial sediments to a zone of saturation within the lava takes place through a negative confining layer represented by sediment-filled cracks in the upper part of the lava or by lake deposits. This downward movement is in response to a difference in head between water within the alluvial sediments and that within the lava. Movement through the negative confining layer occurs at a rate not fast enough to drain the overlying alluvial sediments completely but sufficient to saturate the lava. Two main zones of saturation result, one above the retarding stratum or negative confining layer, the other below. The upper zone is semiperched with respect to the lower. Wells drilled through the confining layer and open to both zones accelerate the downward movement of the semiperched water by giving it free access to the underlying zone of saturation. The water levels in such wells usually drop after the confining layer is penetrated and water cascades into the well from the semiperched water body.

Recharge

Recharge to the ground water in Sunshine Valley is derived from the perennial streams and related irrigation ditches, arroyo flood flows, direct infiltration of precipitation, and infiltration of water pumped for irrigation.

Recharge to the ground-water body from surface water is well illustrated in the vicinity of the villages of Costilla and Cerro, N. Mex. Here water levels in wells dug or drilled along the banks of creeks and ditches fluctuate widely with the quantity of surface-water runoff and consequently with the season of the year. The depth to water in wells along the banks of Costilla Creek is in many places within 20 feet of the land surface during the summer, when more than 71 percent of the runoff occurs at the gaging station 2 miles southeast of the village. During the winter the water levels lower rapidly and many shallow wells go dry. The seasonal fluctuations of water level in several of these wells is reportedly in excess of 10 feet. Surface-water losses apparently supply the water to wells dug along this creek.

The shape of contours on the water table around Costilla (see pl. 2) is a further indication that Costilla Creek recharges the ground-water body. The contours adjacent to the creek are convex downstream, as is common with a "losing" or "influent" stream. The elevation of the water table, as shown by the contours, is highest adjacent to the creek and progressively lower in a westerly direction, indicating that the ground water is moving westward away from the creek. Most of the recharge from the creek probably takes place in New Mexico and the area just north of the State line, for, owing to diversions, the creek is often dry a few miles north of the Colorado-New Mexico line. Recharge from Costilla Creek is principally to the alluvium of Recent age which underlies and borders the creek, but it eventually reaches the underlying alluvial sediments. Recharge to the ground-water body from the other perennial streams in the region occurs in a manner similar to that from Costilla Creek.

Ground-water recharge from losses from irrigation ditches in the Costilla area is illustrated by the fluctuations of water level in well 1.73.10.431, on the north side of Cerro Canal. The water level in this dug well in July 1955 was 33 feet below the land surface at an altitude of 7,760 feet, higher than the water levels in adjacent wells, indicating a ground-water mound or ridge or possibly a perched or semiperched zone beneath the canal in the vicinity of the well. Water must be lost from the canal. Furthermore, this well reportedly goes dry after the growing season, presumably in response to a decrease of flow in the canal. Sufficient wells to delineate the extent of the ground-water mound beneath the ditch were not available. Loss of water

from the gravel-floored canal probably takes place along its entire length.

Recharge from irrigation ditches occurs in the vicinity of Cerro also. The water levels in several of the wells visited here reportedly fluctuate widely with the season; some of these wells go dry during the winter. Well 29.13.18.111 is within a few hundred feet of Cerro community ditch. The water surface in this well in August 1955 was 17 to 62 feet higher than water levels in surrounding wells, suggesting a ground-water mound beneath this well created by seepage from the Cerro community ditch and a nearby ditch. The altitudes of the water table at this and several nearby wells served to delineate approximately the extent of this area of high water levels. This mound is outlined on plate 2 by the configuration of the 7,500-foot contour. Because of the rapid response of water levels in wells bordering the ditches to the quantity of water flowing through the ditches, the extent of this ground-water mound will vary widely with the season.

The amount of water lost from the perennial creeks and the irrigation ditch network in the region is probably great. A series of measurements made on Cerro Canal by the New Mexico State Engineer in the early 1930's (1932, p. 88) showed that 83 percent of a flow of 8 cubic feet per second (cfs) was lost before the water reached the irrigated land. The length of the ditch gaged was not given. This loss, of course, consisted of seepage loss plus evaporation. It would seem that the ditches and canals lose a larger percentage of water through seepage than do the creeks. The flow in many of the ditches is intermittent, being regulated by the season and by allotments. Whenever water is diverted to a ditch or canal after a period of nonuse, the silt is flushed out and the permeability of the bottom of the water-course is thus increased. The creeks, on the other hand, probably have a fine sand and silt layer flooring their beds which hinders seepage most of the time. This is more likely true of Costilla Creek than of the other perennial creeks in the region, for its gradient, within the region studied, is much less than the others.

Some recharge from ephemeral creeks to the alluvial sediments at the foot of the Sangre de Cristo Mountains also must occur during the summer, after heavy rainfall.

Practically all the recharge surface water from the sources discussed replenishes the alluvial sediments and alluvium of Recent age, as these rocks underlie most of the areas traversed by the creeks and ditches. Recharge to the lava aquifer by surface water occurs at infrequent intervals, when the runoff in Costilla Creek and Cerro community ditch is of sufficient magnitude to reach the western extremity of the valley, where the lavas are exposed at the surface.

The discharge of Latir Creek, Llano ditch, and Costilla Creek (see table 2) at their points of entrance into the valley indicates the magnitude of potential recharge from surface water to the ground-water body beneath the valley. The combined average discharge of the creeks and ditch for the period 1948-55 is 31,300 acre-feet per year. The surface-water flow over the valley exceeds this quantity by the ungaged flow of Rio Primero, Rio del Medio, and Cañada Piñabete and that occurring in the small canyons after heavy summer rains. The discharge of Cabresto Creek, except that diverted by Llano ditch, is largely carried beyond the confines of the valley and therefore is not included within the 31,300 acre-feet. The total runoff from the sources enumerated is usually completely consumed within the confines of the valley through infiltration, evaporation, and transpiration, although some runoff occasionally reaches the Rio Grande through Cerro community ditch and Costilla Creek. The runoff that seeps through the alluvial sediments to the water table may be conservatively estimated to be about one-third of the total runoff, or about 10,000 acre-feet per year. It appears unlikely that surface-water losses attributable to infiltration would exceed half the surface flow. If the ungaged flows of Rio Primero, Rio del Medio, Cañada Piñabete, and other tributaries also are considered, the total annual recharge from surface flows is probably more than 10,000 acre-feet.

Recharge also occurs directly from precipitation. This recharge is derived principally from snowfall, which constitutes 30 to 40 percent of the annual precipitation, as most of the rainfall occurs during the summer when evaporation, transpiration, and soil-moisture deficit are greatest. Local ponding of runoff from summer rains, however, should also be considered as a potential source of recharge.

Ute and Guadalupe Mountains are composed largely of highly fractured andesite-basalt lava, and a significant part of the precipitation on these volcanoes probably percolates to the ground-water body. The volcanoes rise respectively 10,151 and 8,735 feet above sea level and approximately 2,600 and 1,200 feet above the adjacent valley floor, and undoubtedly induce greater precipitation upon their flanks and peripheries than the 13 inches recorded within the valley at Cerro.

An approximation of the amount of recharge derived from precipitation on the valley floor and on the slopes of the volcanoes can be made on a basis similar to that used in studies by Theis (1937, p. 564-568) of the Llano Estacado portion of the southern High Plains. Estimates by Theis of the annual recharge from precipitation were based on

three different quantitative approaches and ranged from about 0.1 to 0.7 inch where the mean annual precipitation was about 16 inches. His estimates were derived largely from geologic and hydrologic data collected in Roosevelt and Lea Counties, N. Mex. The average annual temperature in these counties is approximately 15° F higher than at Cerro. The evaporation opportunity on the plains accordingly is much greater than that in Sunshine Valley. In addition, the percentage of precipitation occurring as snowfall is negligible in the southern counties but is about 30 to 40 percent in Sunshine Valley. The snow which intermittently blankets the valley during the winter is conducive to a greater rate of recharge than that afforded by rainfall, for melting of a snow cover simulates a continuous downpour of rain, which is not dissipated immediately by evapotranspiration. Finally, recharge in the two southern counties is greatly hindered by the presence of a continuous highly impermeable caliche zone beneath the surface. No such zone exists in the alluvial sediments of Sunshine Valley. Recharge from precipitation in Sunshine Valley is therefore considered to be appreciably greater than that in Lea and Roosevelt Counties and probably averages at least 1 inch annually.

If the annual recharge in Sunshine Valley is 1 inch, every 12 acres will receive an acre-foot of recharge annually. The valley, Guadalupe Mountain, and Ute Mountain cover an area of approximately 110,000 acres. Annual recharge from precipitation on the valley and on the two extinct volcanoes may therefore approximate 10,000 acre-feet. This estimate of recharge, like that of recharge from surface waters, was arrived at inferentially and therefore indicates only the order of magnitude.

Some ground-water recharge must occur also from irrigation ditches and from irrigated land. Return of well water, the magnitude of which is unknown, is not natural recharge and in effect represents a decrease in pumpage.

In summary, recharge to the ground water beneath Sunshine Valley is derived primarily from water losses from perennial creeks and related irrigation ditches and from precipitation, the total being of the order of 20,000 acre-feet a year. The recharge from surface waters is estimated to be in excess of 10,000 acre-feet annually, and recharge from precipitation is estimated to be not less than 10,000 acre-feet. The recharge is primarily to the ground-water body within the alluvial sediments which are at the surface over most of the valley. Recharge to the lavas within the valley occurs predominantly through leakage from the overlying saturated alluvial sediments, and to a lesser extent from precipitation on Ute and Guadalupe Mountains.

Movement and Discharge

Ground water in Sunshine Valley generally moves from areas of higher elevation, the main areas of recharge being at the base of the Sangre de Cristo Mountains on the east side of the valley, to those of lower elevation, the discharge areas along the Rio Grande. The ground water initially moves in a westerly direction through the alluvial sediments, which underlie most of the areas receiving recharge, and discharge into the lava. It then moves through the lava and discharges into the Rio Grande as spring flow. The gradients under which the water moves through the sediments range from only a few feet to 100 feet to the mile; the steepest gradients occur beneath the recharge areas and east of Ute Mountain, but in most of the valley the gradients are less than 50 feet to the mile.

The gradient and direction of ground-water movement within the alluvial sediments are altered in the northwestern quarter of the valley, around the periphery of Ute Mountain. East and southeast of this volcano the alluvial sediments and lava flows are interbedded. There is no evidence of lake deposits. As the ground water moves westward from the areas of recharge and approaches the contact between the alluvial sediments and the lava flows, its gradient increases sharply. The contours on the water table (pl. 2) show that within a zone of 1 mile to 1½ miles wide along the east periphery of Ute Mountain the water table drops from an altitude of 7,450 feet in the alluvial sediments to an altitude of 7,325 feet in the lava flows. The sharp change in slope represents a change in the hydrologic conditions under which the ground water occurs. Within the zone of interbedding, ground water in the alluvial sediments drains into the underlying lava. The amount and rate of downward movement of the water probably increases greatly toward the base of the volcano, for the percentage of lava in the zone of interbedding increases as the volcano is approached. Eventually all the water in the alluvial sediments drains into the lava. The increase in slope of the water table along the periphery of the volcano thus reflects ground-water drainage from the alluvial sediments toward lower levels within the lava flows.

The direction of ground-water movement in the vicinity of the volcano also is influenced by subsurface conditions. Movement of ground water from the recharge areas is principally westward. However, along the periphery of Ute Mountain, the contours representing the altitude of the upper surface of the zone of saturation (pl. 2) curve around this volcano, indicating that the water within the alluvial sediments is moving toward Ute Mountain from the north, northeast, and southeast as well as from the east. The direction of movement is practically at

right angles to the contact of the lava and the alluvial sediments, as is shown by the similarity in the shape of the water-table contours surrounding the mountain and the geologic contact of the lava and sediments shown on plate 1. Ute Mountain thus appears to serve essentially as a huge infiltration gallery. Water within the alluvial sediments drains toward this mountain from the north, east, and south and is discharged into the lava.

Guadalupe Mountain also appears to act as an infiltration gallery. The 7,450-foot contour of the water table in the alluvial sediments east and northeast of this extinct volcano indicates that ground water within the sediments moves directly toward this mountain.

In the southern half of the valley the gradient of ground water within the alluvial sediments is not noticeably altered by semiperched conditions. Water moves westward from the areas of recharge toward the Rio Grande. No significant change in gradient occurs within the alluvial sediments above the lava flows. In the western two-thirds of T. 30 N., R. 12 E., lake deposits overlie much of the lava and are themselves overlain by partly saturated alluvial sediments. Here the negative confining layer, separating the zone of saturation within the alluvial sediments from that within the lavas, is represented not only by sediment-filled fractures in the upper part of the lava flows but also by lake sediments of low permeability. Downward leakage of ground water from the alluvial sediments into the lava is consequently retarded to a greater extent here than in the northwestern quarter of the valley; therefore, the gradient of the water table within the alluvial sediments above the lava does not increase westward even though semiperched conditions exist.

West of the geologic contact of the alluvial sediments and the lavas in T. 30 N. (pl. 1), the water table is within the lava at an altitude nearly the same as that of the Rio Grande. (See pl. 3.) East of this contact, water in the alluvial sediments which has not drained into the lavas probably cascades into the lava at or near its contact with the alluvial sediments. This is indicated by the absence of springs in the box canyons tributary to the Rio Grande Canyon.

Although the lavas in the valley serve as the principal means of discharge for ground water from the alluvial sediments, some ground water also discharges from these sediments in the south-central part of the valley through evapotranspiration. Within a narrow strip 5 miles long and a quarter to half a mile wide in the south-central part of the valley, the water table is within 2 to 20 feet of the surface. This strip trends north-south and extends through sections 1, 11, 12, 14, 23, and 26 of T. 30 N., R. 12 E., encompassing an area of approximately 3 square miles. The water table in several watering holes in this zone is only 2 to 3 feet below the ground surface. The proximity of the water table to the surface is conducive to discharge of ground water through evaporation and transpiration. Evaporation occurs directly from the surfaces of the watering holes and from the capillary fringe, and transpiration occurs through use of the ground water by vegetation. The magnitude of the evapotranspiration in this zone is not known.

Wells into which water cascades also may be considered as points through which ground water discharges from the alluvial sediments or as sources of artificial recharge to the lava. If numerous wells with casings perforated in the sediments were to pierce the negative confining stratum, drainage into the lava would be increased and water levels in the semiperched water body in the alluvial sediments would be lowered.

Water that seeps into the lava from sediments moves in various directions toward the Rio Grande, into which it discharges (fig. 10). In the southern half of the valley and beneath Guadalupe Mountain ground water in the lava moves westward and southwestward toward the Rio Grande, which has incised its bed below the water table. Ground water moves through the lava under gradients ranging from 10 to 100 feet to the mile. The range in gradients apparently is due largely to the profile of the river. The lowest gradients, 10 to 25 feet to the mile, occur in T. 30 N., R. 12 E., through which the river flows under a gradient ranging from less than 10 to nearly 20 feet to the mile. Opposite Guadalupe Mountain the gradient of the river ranges from about 15 to 100 feet to the mile and the slope of the water table toward the river and accretion to the river are greater. This increase in gradient represents an adjustment to the lowering of the discharge point. A similar increase in the gradient of the water table occurs west of the river.

Ground water within the lava in the northern half of the valley moves under very low gradients. Between the proposed State line dam site (4½ miles north of the Colorado-New Mexico line) on the north and about 2 miles downstream from the proposed Ute Mountain dam site on the south, and in a strip 4 to 5 miles wide on either side of the canyon, the water table in the lava is below river level. At the proposed State line dam site the water table is 66 feet below the river (Sloan, 1938, p. 516) and at the proposed Costilla dam site, about 40 feet. East of Ute Mountain ground water within the zone of interbedding of the lava and alluvial sediments is respectively 50 and 31 feet below river level in wells 1.74.15.224 and 1.74.23.222. The shape of the water table where it lies below river level is that of a

broad, flat trough, as is indicated by the 7,325-foot contour (pl. 2).

About 2 miles downstream from the proposed Ute Mountain dam site the river intercepts the water table and springs appear in the canyon. Ground water moves through the lava toward this point of initial discharge from the east, west, and north under low gradients. Because of the low gradient of the water table in the lava, it was necessary to change the contour interval in order to represent the water table within this rock on plate 2. Between the 7,335-foot contour in Colorado and the 7,325-foot contour in New Mexico, the water table slopes 2.5 feet per mile in a southerly direction. Between the 7,325-foot contour and test hole 31.12.31.140 the southward slope of the water table along the Rio Grande is 2 feet to the mile. In the same stretch the gradient of the river exceeds 8 feet to the mile. These low gradients of the water table and the highly fractured nature of the lava are indicative of the relatively high permeability of the lava.

The wide, troughlike shape of the water table around Ute Mountain indicates that the rocks underlying this area are of relatively high permeability. It would appear that the peripheral zone rather than the core of the mountain has the greater permeability. In addition to the fractures that formed in the lava during solidification of the rock composing this volcano, each eruption would of itself shatter and fracture the solidified flows around the periphery of the vent(s) through which the molten rock reached the surface, thereby increasing the permeability of the peripheral rocks. The water levels in wells 1.74.23.222 and 1.74.15.224 east of the volcano, test holes 1.74.6.400 and 1.74.7.111 northwest of the mountain, and wells 32.11.28.430 and 31.11.16.333 west of the volcano are at practically the same altitude, showing that ground water moves through at least the periphery of this volcano with little impedance.

Ground water similarly moves through the peripheral zone, if not the core of Guadalupe Mountain. The water levels in three of the proposed Chiflo dam-site test holes (29.12.21.114, 29.12.21.411, and 29.12.21.441), drilled about half a mile apart on the western slope of the mountain, encountered the water table at altitudes differing by only 2 feet. The 7,150-foot contour east of the Rio Grande essentially represents the altitude of the water table encountered in these holes. As movement of ground water normally is at right angles to the contours, in the downslope direction, ground water apparently is moving through this volcano in a southwesterly direction. However, because of the irregularity of fractures in lava, the movement of ground water through these volcanoes at a particular place may not be exactly at right angles to the contours as drawn, and, although direct information on the water conditions near the center of the mountain is lacking, the possibility that the water moves in a circuitous route, possibly through the periphery of the volcano, should not be overlooked.

By way of summation, ground water within the alluvial sediments moves from the recharge areas along the east side of the valley toward the west. In the zone of interbedded alluvial sediments and lava most of the ground water in the sediments is slowly discharged into the underlying lava. Some discharge occurs also through evapotranspiration in the south-central part of the valley where the water table is very shallow. Ground water within the lava moves from the areas of recharge, which underlie saturated alluvial sediments, toward the Rio Grande, into which it discharges as spring flow.

LAVA-CAPPED PLATEAU

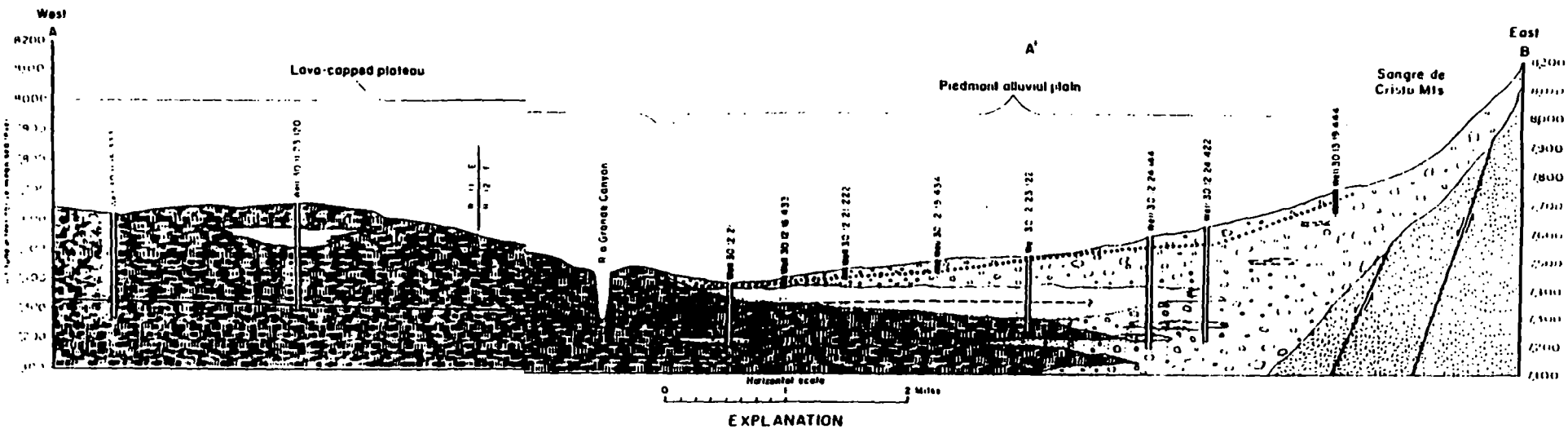
The lava-capped plateau lies west of the Rio Grande. Beneath the plateau, ground water occurs within the lava and the alluvial sediments at depths ranging from about 250 to 750 feet below the land surface. There are also isolated shallow, perched ground-water bodies, generally within 40 feet of the surface. Wells that penetrate these perched water bodies are usually assured of a water supply for only short periods each year.

Occurrence of Ground Water

Owing to the small number of wells drilled and dug into the tableland, knowledge of the occurrence of water is limited, and is almost wholly confined to the northern half of the plateau (fig. 7).

Perched ground-water bodies — that is, bodies of water separated from the major water table in the region by a zone of aeration — at present provide a limited source of well water for stock and domestic purposes. The perched bodies commonly are in arroyos which are cut into the lava surface and floored with clay, sand, and gravel. During periods of surface-water runoff, generally following spring snowmelt or summer rains, the alluvium filling the draws is temporarily saturated and will supply water to wells dug into these arroyo floors. With cessation of the spring snowmelt and summer rains, the alluvium filling the draws is no longer replenished and the accumulated water drains into the underlying lava. The water levels in wells dug into these arroyos then recede and the wells often go dry. This situation appears generally to hold for shallow wells dug into the alluvium flooring Arroyo Aguaje de la Petaca (fig. 7). One resident reported that when the clay that floors the arroyos is dug through, all the shallow perched water percolates downward.

It seems probable that ground water is occasionally perched also by strata of volcanic ash, which in



EXPLANATION

Alluvial sediments. Detritus composed of sand and gravel and some clay and silt

Lake deposits. Predominantly clay and sandy clay

Andesite - basalt. Composed of numerous lava flows, generally less than 50 feet in thickness, derived largely from the west. Includes volcanic ash, cinders, and thin clay strata

Granite, gneiss, and associated rock

Well for which log and water - level measurement are available

Well for which water - level measurement is available.

Water table in alluvial sediments. Semiperched where underlain by saturated andesite basalt. Perched in vicinity of test hole 30 12 21 111

Water table in andesite - basalt. Solid line indicates water table; dashes indicate piezometric surface of water confined in andesite - basalt under subnormal artesian pressure. Water in alluvium is semiperched from about well 30 12 16 433 to a point east of well 30 12 23 122; perched from about well 30.12.16 433 to a point west of well 30 12 21 111

Plate 3. - Generalized geologic section across Sunshine Valley, Taos County, N. Mex. Location shown on plates 1 and 2.

Plate 3

Reference 20

LIST OF FIGURES

FIGURE 1: Bear Creek Tailings site location map.

FIGURE 2: Site layout of Bear Creek Tailings site.

FIGURE 3: Sample location map of Bear Creek Tailings site.

LIST OF TABLES

TABLE 1: Summary of amalytical results of samples collected from on-site tailings piles and soils.

TABLE 2: Summary of analytical results of samples collected from Bear Creek and associated drainage channels.

TABLE 3: Summary of analytical results of sample collected from private water wells.

LIST OF APPENDIXES

APPENDIX A: Selected photographs taken during the November 18, 1992 site inspection of Bear Creek Tailings site.

APPENDIX B: Xerox copy of New Mexico State Highway and Transportation Department aerial photograph of Bear Creek Tailings site on May 1, 1962.

APPENDIX C: XRF Survey of Bear Creek Tailing site, November 18, 1993.

Water Availability & Water Quality

Taos County, New Mexico

Phase A Report: Basic Data on Geography, Climate, Geology, Surface Water Ground Water, Water Rights, Water Use, Water Supply and Water Quality

by

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TABLE OF CONTENTS

Section		Page
	EXECUTIVE SUMMARY	[illegible]
I.	INTRODUCTION	I-1
II.	GEOGRAPHY	II-1
III.	CLIMATE	III-1
	Air Masses	III-1
	Topography	III-1
	Data Sources	III-2
	Temperature	III-2
	Precipitation	III-3
	Evaporation and Consumptive Use	III-5
	Other Climatic Aspects	III-6
IV.	GEOLOGY	IV-1
	Age and Distribution of Rocks	IV-1
	Structural Evolution	IV-2
	Resources and Hazards	IV-3
V.	SURFACE WATER	V-1
	Gaging Station Records	V-2
	Average Flows	V-3
	Time Trends	V-4
	Seasonal Patterns	V-4
	Drought and Flood Flows	V-6
	Runoff Forecasting	V-7
	Storage and Diversion Projects	V-8
	Summary	V-10
VI.	GROUND WATER	VI-1
	Some Principles of the Occurrence of Ground Water	VI-1
	Data Sources	VI-3
	Well Records	VI-4
	Well Numbering System	VI-5
	Area Summaries	VI-5
	Penasco	VI-7
	Pilar-Ojo Caliente Area	VI-8
	Taos Area	VI-9
	Valdez Area	VI-14
	Mountains	VI-16
	Tres Piedras	VI-17
	Sunshine Valley	VI-20

TABLE OF CONTENTS
(Continued)

Section		Page
VII.	WATER SUPPLY AND WATER RIGHTS	VII-1
	Existing Water Use	VII-1
	Future Water Use	VII-1
	Irrigation Water Use Budget	VII-2
	Water Rights Laws and Regulations Affecting Irrigation and Other Transfers	VII-3
	State Water Policy	VII-3
	Detailed Information on Irrigation Water Use and Water Rights	VII-9
	Domestic Water Use	VII-11
	Community Water Organizations: Laws and Regulations	VII-11
	Community Water Rights	VII-13
	Inventory of Community Water Systems	VII-14
	Other Water Use and Water Rights	VII-15
VIII.	WATER QUALITY	VIII-1
	Regulations and Standards	VIII-1
	The Impact of Water Quality Regulations	VIII-3
	Pollution Sources	VIII-3
	Data	VIII-6
	Existing Water Quality	VIII-6
	MolyCorp and the Red River	VIII-8
	Water Quality of the Rio Hondo	VIII-9
IX.	REFERENCES CITED	IX-1

LIST OF TABLES

Table 1.	Statistical and Related Information, Taos County, New Mexico	I-3
Table 2.	Natural Units of Taos County	II-2
Table 3.	Taos County Weather Stations, and Mean Precipitation and Temperature Data	III-7
Table 4.	Temperature - Taos County	III-8
Table 5.	Mean Monthly and Annual Precipitation, Taos County	III-9
Table 6.	Mean Monthly and Annual Snowfall, Taos County	III-10
Table 7a.	Miscellaneous Information on Precipitation Regimes in Red River and Taos, N.M.	III-11

TABLE OF CONTENTS

Section		Page
	EXECUTIVE SUMMARY	iv
I.	INTRODUCTION	I-1
II.	GEOGRAPHY	II-1
III.	CLIMATE	III-1
	Air Masses	III-1
	Topography	III-1
	Data Sources	III-2
	Temperature	III-2
	Precipitation	III-3
	Evaporation and Consumptive Use	III-5
	Other Climatic Aspects	III-6
IV.	GEOLOGY	IV-1
	Age and Distribution of Rocks	IV-1
	Structural Evolution	IV-2
	Resources and Hazards	IV-3
V.	SURFACE WATER	V-1
	Gaging Station Records	V-2
	Average Flows	V-3
	Time Trends	V-4
	Seasonal Patterns	V-4
	Drought and Flood Flows	V-6
	Runoff Forecasting	V-7
	Storage and Diversion Projects	V-8
	Summary	V-10
I.	GROUND WATER	VI-1
	Some Principles of the Occurrence of Ground Water	VI-1
	Data Sources	VI-3
	Well Records	VI-4
	Well Numbering System	VI-5
	Area Summaries	VI-5
	Penasco	VI-7
	Pilar-Ojo Caliente Area	VI-8
	Taos Area	VI-9
	Valdez Area	VI-14
	Mountains	VI-16
	Tres Piedras	VI-17
	Sunshine Valley	VI-20

TABLE OF CONTENTS
(Continued)

Section		Page
VII.	WATER SUPPLY AND WATER RIGHTS	VII-1
	Existing Water Use	VII-1
	Future Water Use	VII-1
	Irrigation Water Use Budget	VII-2
	Water Rights Laws and Regulations Affecting Irrigation and Other Transfers	VII-3
	State Water Policy	VII-3
	Detailed Information on Irrigation Water Use and Water Rights	VII-9
	Domestic Water Use	VII-11
	Community Water Organizations: Laws and Regulations	VII-11
	Community Water Rights	VII-13
	Inventory of Community Water Systems	VII-14
	Other Water Use and Water Rights	VII-15
VIII.	WATER QUALITY	VIII-1
	Regulations and Standards	VIII-1
	The Impact of Water Quality Regulations	VIII-3
	Pollution Sources	VIII-3
	Data	VIII-6
	Existing Water Quality	VIII-6
	MolyCorp and the Red River	VIII-8
	Water Quality of the Rio Hondo	VIII-9
IX.	REFERENCES CITED	IX-1

LIST OF TABLES

Table 1.	Statistical and Related Information, Taos County, New Mexico	I-3
Table 2.	Natural Units of Taos County	II-2
Table 3.	Taos County Weather Stations, and Mean Precipitation and Temperature Data	III-7
Table 4.	Temperature - Taos County	III-8
Table 5.	Mean Monthly and Annual Precipitation, Taos County	III-9
Table 6.	Mean Monthly and Annual Snowfall, Taos County	III-10
Table 7a.	Miscellaneous Information on Precipitation Regimes in Red River and Taos, N.M.	III-11

LIST OF TABLES
(Continued)

		Page
Table 7b.	Miscellaneous Information on Precipitation Regimes in Red River and Taos, N.M.	III-11
Table 8.	Storm Rainfall Estimates, Taos County	III-12
Table 9.	Consumptive Water Use and Irrigation Requirement for Major Crops, Taos County, N.M.	III-13
Table 10.	Prevailing Wind Directions for Stations in Taos County, N.M.	III-14
Table 11.	Generalized Description of Rock Units in Taos County	IV-5
Table 12.	Drainage Features of Taos County	V-11
Table 13.	Gaging Station Records, Taos County, "Minor Stations".	V-12
Table 14.	Gaging Station Records, Taos County, "Major Stations".	V-13
Table 15.	Selected Low and High Flow Records, Taos County, New Mexico	V-15
Table 16.	Stream Gaging Stations Used in Regional Flood Frequency Analysis	V-16
Table 17.	Penasco Area: Summary of Well Records on File at SEO, Santa Fe.	VI-24
Table 18.	Selected Stratigraphic Logs for Selected Wells in the Penasco Area, Taos County, New Mexico	VI-25
Table 19.	Summary of Well Observations in Penasco Area Made During 1977 Field Study.	VI-26
Table 20.	Data on Mutual Domestic Wells in the Penasco Area.	VI-27
Table 21.	Pilar-Ojo Caliente area: Summary of Well Records on File at SEO, Santa Fe	VI-28
Table 22.	Selected Stratigraphic Logs for Selected Wells in the Pilar-Ojo Caliente Area, Taos County, New Mexico	VI-30

LIST OF TABLES
(Continued)

		Page
Table 23.	Summary of Well Observations in Pilar-Ojo Caliente Area Made During 1977 Field Study.	VI-31
Table 24.	Taos area: Summary of Well Records on File at SEO, Santa Fe.	VI-32
Table 25.	Selected Stratigraphic Logs for Selected Wells in the Taos Area, Taos County, New Mexico	VI-39
Table 26.	Summary of Well Observations in Taos Area Made During 1977 Field Study	VI-41
Table 27.	Valdez Area: Summary of Well Records on File at SEO, Santa Fe	VI-42
Table 28.	Selected Stratigraphic Logs for Selected Wells in the Valdez Area, Taos County, New Mexico	VI-47
Table 29.	Summary of Well Observations in Valdez Area Made During 1977 Field Study.	VI-49
Table 30.	Two Logs for Well 26.12.25.4122 (DH-TP-2).	VI-50
Table 31.	Mountain Area: Summary of Well Records on File at SEO, Santa Fe.	VI-51
Table 32.	Selected Stratigraphic Logs for Selected Wells in the Mountain Area, Taos County, New Mexico.	VI-53
Table 33.	Summary of Well Observations in the Mountain Area Made During 1977 Field Study.	VI-54
Table 34.	Tres Piedras Area: Summary of Well Records on File at SEO, Santa Fe.	VI-55
Table 35.	Selected Stratigraphic Logs for Selected Wells in the Tres Piedras Area, Taos County, New Mexico	VI-56
Table 36.	Summary of Well Observations in Tres Piedras Area Made During 1977 Field Study	VI-58
Table 37.	Sunshine Valley Area: Summary of Records on File at SEO, Santa Fe.	VI-59
Table 38.	Selected Stratigraphic Logs for Selected Wells in the Sunshine Valley Area, Taos County, New Mexico	VI-66

LIST OF TABLES
(Continued)

Page

Table 39. Summary of Well Observations in Sunshine Valley Area Made During 1977 Field Study. VI-68

Table 40. Water Use in Taos County, 1975 . . . . . .VII-17

Table 41. A Possible Water Use Budget for Taos County in the Next 50-100 Years VII-18

Table 42. Typical Water Use Budget for Irrigation Near Cerro VII-19

Table 43. Summary of Irrigation Water Use and Water Rights Survey, Taos County. VII-20

Table 44. Irrigation Water Use and Water Rights Survey, Taos County VII-23

Table 45. Urban Water Budget VII-45

Table 46. Conservation Budget. VII-46

Table 47. Taos County Water Rights - Non-Agricultural. VII-47

Table 48. Water Use Survey: Taos County, New Mexico VII-49

Table 49. Information on Community Water Systems in Taos County VII-51

Table 50. Withdrawal Rates and Total Dissolved Solids (ppm) for Selected Locations in Taos County. . . .VII-53

Table 51a. Published Comments Regarding Water Supply or Sanitation Needs of Communities in Taos County Which Do Not Now Have a Community System VII-54

Table 51b. Private Water Systems in Taos County Serving the General Public, Based on EID Records VII-54

Table 52. Stream Standards Which Apply in Taos County. . . . VIII-11

Table 53. Major Requirements of the Interim Primary Drinking Water Regulations VIII-12

Table 54. Ground Water Quality Standards of the New Mexico Water Quality Control Commission VIII-13

Table 55. Standards for Point Source Discharges in Taos County VIII-14

LIST OF TABLES
(Continued)

Page

Table 56. STORET Records for the Rio Grande near Lobatos, Colorado; Red River at Fish Hatchery near Questa; and Rio Grande Below Taos Junction B. VIII-16

Table 57. STORET Records for U.S.Forest Service Mountain Stations, 1975-1976. . . . . .VIII-19

Table 58. Result of EID Monitoring of Rio Hondo, 1974-1975. . . . . .VIII-20

Table 59. Results of Monitoring of Red River, Part A 1971-1972; Part B 1976-1977 . . . . . .VIII-26

Table 60. Miscellaneous Data on Surface Water Quality in Taos County VIII-27

Table 61. Water Quality of Public Water Systems. VIII-29

Table 62. Data for Taos and Cerro Units of San Juan-Chama Project VIII-65

Table 63. Chemical Analyses of Ground Water in the Sunshine Valley Area, Taos County, New Mexico and Costilla County, Colorado VIII-68

Table 64a. Miscellaneous Data on Ground Water Quality in Taos County. VIII-69

Table 64b. Spring Records and Auger Holes in Taos County. . . .VIII-70

LIST OF FIGURES

Page

Figure 1. Location Map I-4

Figure 2. Natural Units Map. II-3

Figure 3. Normal Annual Precipitation III-15

Figure 4. Rainfall Dispersion Diagram of Monthly Means from Taos County Weather Stations III-16

LIST OF FIGURES
(Continued)

		Page
Figure 5a.	Average Annual Precipitation, Taos County, N.M., 1910-1974	III-17
Figure 5b.	Moving Ten Year Average of Precipitation, Taos County, N.M.	III-18
Figure 6.	Average Annual Precipitation vs. Elevation, Taos County, N.M.	III-19
Figure 7.	Gross Annual Lake Evaporation	III-20
Figure 8.	Monthly Distribution of Average Annual Lake Evaporation, North Central New Mexico	III-21
Figure 9.	Geology	IV-7
Figure 10a.	Generalized Geologic Structure	IV-8
Figure 10b.	Schematic West-East Geologic Cross-Section Through Central Taos County	IV-9
Figure 11.	Surface Drainage Features	V-17
Figure 12.	Gaging Stations	V-18
Figure 13.	Average Annual Water Yield, in Inches	V-19
Figure 14.	Surface Hydrology of Taos County	V-20
Figure 15.	Long-Term Precipitation and Runoff at Arroyo Hondo	V-21
Figure 16.	Seasonal Flow Patterns in Taos County: Rio Hondo (Near Valdez); Rio Grande Del Rancho (Near Talpa)	V-22
Figure 17.	Sample Form for Well Permit Information	VI-69
Figure 18.	Taos County Water Resources Study - Well/Spring Schedule	VI-70
Figure 19.	System of Numbering Wells in New Mexico	VI-71
Figure 20.	Areas for Which Ground Water Data are Summarized	VI-72
Figure 21.	Irrigation Water Use Water Rights, June, 1976.	VII-55
Plate 1.	Geologic Map	wall map

Table 9. Storm rainfall estimates, Knox County.

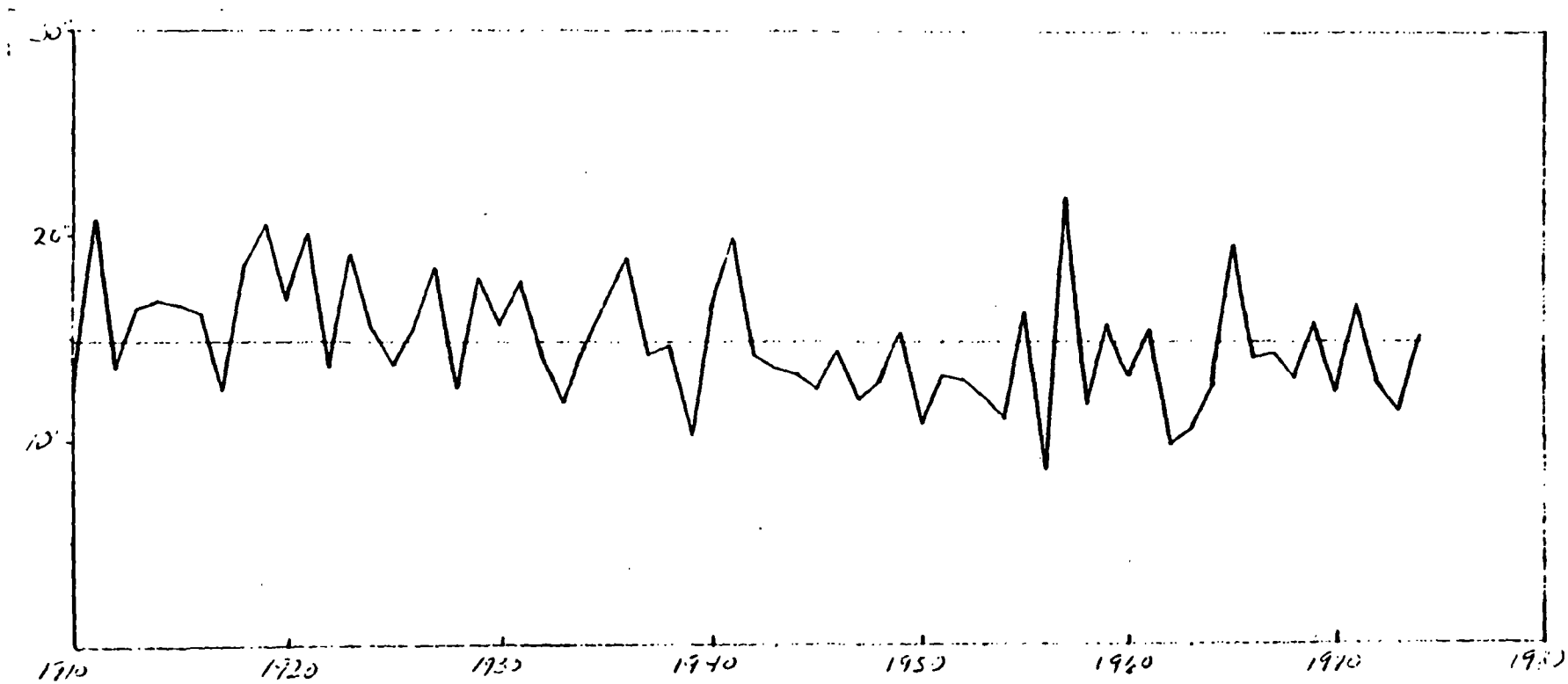
These values are the maximum rainfalls expected to occur in Knox County over a typical period of time. Return period indicates the frequency with which a given storm rainfall is likely to occur. Column 1A gives the 6-hour duration rainfalls for Knox. For example, the 5-year storm (which will occur on the average 20 times every century) brings with it 1.25 inches of rain in six hours. Column 1B gives the range in 6-hour rainfalls for the County, with low values generally occurring in the southwest part of the County, and highs in the northeast corner. Column 2A = 24-hour rainfalls, Knox; Column 2B = 24-hour rainfalls, Countywide. Based on maps, SCS, 1967.

Duration:	1B	1A	2B	2A
Return Period				
2 years	.85 - 1.8	.96	[1.1 - 2.2]	1.20
5 years	1.15 - 2.2	1.25	1.5 - 2.6	1.62
10 years	1.25 - 2.6	1.39	1.7 - 3.0	1.84
25 years	1.55 - 3.0	1.50	1.9 - 3.8	2.28
50 years	1.75 - 3.2	2.00	2.1 - 4.2	2.44
100 years	1.95 - 3.5	2.25	2.5 - [illegible]	2.62

Figure 5a.
Average annual precipitation, Taos County*, N.M., 1910-1974.

LEGEND: average annual precipitation

mean precipitation for the period (14.79")



* Average of Cerro, Red River, Taos, and Tres Piedras for entire period

cubic feet per second (c.f.s.) - unit used to measure water flow (i.e. at a gaging station); equals the rate of flow in a channel with a one square-foot cross-section and velocity of one foot per second. One c.f.s. for a 24-hour period equals 86,400 cubic feet or 1.98 acre-feet. Then 1 CFS/yr = 722.7 acre-feet/yr

1.98 acre-ft/day × 365 days/yr = 722.7 acre-ft/yr

inch - a depth of runoff which produces a certain amount of water per unit of land area; for example, twelve inches of water on one acre equals one acre-foot.

Average Flows. Based on Figure 13 and on the data tables it is evident that almost all runoff in Taos County occurs in mountain streams. For most of the large upland basins the average flow is 3-10 inches/year, measured near the point where the stream enters the Piedmont area. In the Piedmont proper runoff is normally 0.5-2.0 inches/year while in the Taos Plains it is less than 0.5 inches/year. The following list indicates how much water would be produced from one square mile in each of the three natural units:

Mountains:	160-600 acre-feet/year
Piedmont:	25-100 acre-feet/year
Plains:	5- 25 acre-feet/year

The major factor controlling runoff is precipitation, which as discussed previously is closely related to elevation. The following equation permits prediction of average runoff, if average basin elevation is known:

$$Q = \text{Antilog}\left(\frac{0.72E}{1,000} - 6.19\right)$$

where Q is runoff in inches/year, and E is elevation in feet. This equation does not apply if average elevation is above about 10,500 feet.

For the major streams gaged in Taos County, average elevation decreases markedly as basin area increases; therefore discharge can also be predicted as a function of area, a value which is easier to measure than average elevation. The appropriate equation is:

$$Q = 1,580A^{0.64}$$

where Q is runoff in acre-feet/year, and A is basin area in square miles. This applies only to mountain drainages, not lowland arroyos.

The effect of elevation is especially noticeable for the Rio Fernando de Taos. According to Bureau of Reclamation data (Bureau of Reclamation, 1971), above the gaging station this drainage has an average elevation of 9151 feet, and a unit discharge of 54 acre-feet per square mile. The nearby Rio Grande del Rancho is approximately 264 feet higher in average elevation, and has nearly four times the water yield - 204 acre-feet per square mile.

Much of the average flow of the Taos County streams is discharged to the Rio Grande either directly or after recharge to ground water and subsequent ground water inflow to the River. At the point it enters Taos County the Rio Grande carries mostly return flow from irrigation in the San Luis Valley of southern Colorado. This flow is approximately doubled by the time it leaves the County, through the addition of 250,000 - 300,000 acre-feet in a "typical" year, and

Miscellaneous cont.

Number Assigned	Name and Location of Station	Period of Record	Footnotes
#08-2595	New Mexico Branch Cerro Canal, near Jaroso, Colorado (from Cerro Canal)	1944-Present	G
#08-2596	*Cerro Canal at state line near Jaroso, Colorado	1973-1974	
#08-2600	Penasquito Ditch at Costilla, New Mexico (from Costilla Creek)	1955-1961	G
#08-2615	*Alire Ditch at Garcia, Colorado (from Costilla Creek)	1944-1959	G
#08-2620	*Eastdale No.1 Intake Canal (from Costilla Creek)	1944-Present	G
#08-2655	Llano Ditch near Questa, (from Cabresto Creek)	1943-1964	G
	Acequia Madre at Taos, New Mexico (from Rio Pueblo de Taos)	1940-1941	C,H
	Tenorio Ditch near Arroyo Seco, New Mexico (from Rio Lucero)	1935-1950	H
	Indian Ditch near Arroyo Seco, New Mexico (from Rio Lucero)	1934-1950	H
	Seco Ditch near Arroyo Seco, New Mexico (from Rio Lucero)	1934-1950	H
	Juan Manuel Ditch near Arroyo Seco, New Mexico (from Rio Lucero)	1935-1950	H
	Prado Ditch near Arroyo Seco, New Mexico (from Rio Lucero)	1934-1950	H
	Picuris Ditch near Penasco, New Mexico	1936-1941	
#08-2688	Tributary of Rio Grande near Arroyo Hondo, New Mexico	1968-Present	P
#08-2774	Tributary of Rio Grande at Rinconada, New Mexico	1952-Present	P

*Irrigation in Colorado

Table 14. Gaging station records, Taos County, "Major Stations". Information obtained from U. S. Geological Survey.

Number Assigned by U.S.G.S.,	Name and Location of Station	Area (sq.mi.)	Period of Record (water year)	Average Flow Records (acre-feet/year)	CFS	1955-1974 (acre-feet/year)	1955-1974 (inches)	Footnotes
#2515	Rio Grande near Lobatos, Co.	4,760[a]	1889-Present	431,100		242,000	.96	A,B,C,D,E,I
#2525	Costilla Creek above Costilla Dam, N. M.	25.1	1937-Present	N/A		N/A	N/A	A,D,G
#2555	Costilla Creek near Costilla, N. M.	195	1936-Present	50,430		26,750	2.57	C,H
#2630	Latir Creek near Cerro, N.M.	10.5	1937-1970	4,930		N/A	N/A	I
Above Red River #2635	Rio Grande near Cerro, N.M.	5,300[a]	1948-Present	273,900	379	268,800	.92	C
#2650	Red River near Questa, N.M.	115	1910-Present[b]	38,250	52.9	26,150	4.33	C,F,I
#2660	Cabresto Creek near Questa, N. M.	36.7	1943-Present	9,950		8,540	3.34	C
#2670	Red River at Mouth near Questa, N. M.	190	1950-Present	56,220	77.8	54,770	5.40	C
#2675	Rio Hondo near Valdez, N.M.	36.2	1934-Present	25,650		22,240	11.51	I
#2685	Arroyo Hondo at Arroyo Hondo, N. M.	95.0	1910-Present[b]	20,000		14,150	4.33	C
#2690	Rio Pueblo de Taos near Taos, N. M.	50.0	1911-Present[b]	20,350		N/A	N/A	H,I
#2710	Rio Lucero near Arroyo Seco, N. M.	16.6	1910-Present[b]	16,080		N/A	N/A	H,I
#2750	Rio Fernando de Taos near Taos, N. M.	71.7	1910-Present[b]	4,780		N/A	N/A	C
#2755	Rio Grande del Rancho near Talpa, N. M.	53	1952-Present[b]	14,270		14,560	3.28	C
#2756	Rio Chiquito near Talpa, N. M.	37	1957-Present	5,550		N/A	N/A	
#2763	Rio Pueblo de Taos below Los Cordovas, N. M.	380	1957-Present	54,920		N/A	N/A	C,I
Below 15-mile Target Dist. Limit #2765	Rio Grande below Taos Jct. Bridge, near Taos, N. M.	5,730[a]	1905-Present	527,400	730	431,300	1.20	C
#2790	Embudo Creek at Dixon, N. M.	305	1923-Present[b]	37,090		N/A	N/A	C,H
#2795	Rio Grande at Embudo, N. M.	7,460[a]	1889-Present	728,100		481,100	1.22	C
#2890	Rio Ojo Caliente at La Madera, N. M.	219	1952-Present	49,050		40,140	1.30	C

[a] area does not include 2,340 square miles in a closed basin
[b] earlier records partial

Table 27. (continued)

LOCATION	OWNER OF RECORD: RG PERMIT NUMBER AND YEAR COMPLETED	WELL DEPTH	WATER LEVELS	OTHER
27.12 Tr	John Davidson Ranchos de Taos RG27809, 1976	D-75	25' 10/76	Y-4
27.13.13.000 (p)	Robert Peet RG26282, 1972	D-57		
27.13.31.130	Lower Des Montes MDWCA RG16107		180' 1/68	Y-20 C
27.13.31.213	Fritz Law ooc RG18190, 1970	D-55	20' 11/70	
27.13.31.214	Fritz Law ooc RG21163, 1972	D-87	40' 7/72	C
27.13.32 Tr	Alejandro R. Valdez Valdez RG9681, 1964	D-56	26' 3/64	
27.13.32.213	Jose Garcia ooc RG17995, 1970	D-70	40' 9/70	C
27.13.32.212	Joseph R. Apodaca Valdez RG18052, 1970	D-92	39' 10/70	
27.13.32.332	Charles R. Pfeiffer Valdez RG19053, 1970	D-55	20' 10/70	
27.13.32.212	Eva Martinez Valdez RG20535, 1972	D-95	45' 7/72	F
27.13.32 Tr	Peter Blake Arroyo Seco RG26143, 1975	D-165	69' 10/75	Y-10
27.13.33 Tr	Paul C. Hunner ooc RG13539, 1966	D-60	40'	
27.13.33.122	Mr. & Mrs. Gordon Wagner, ooc RG18051, 1970	D-100	70' 10/70	F

Table 27. (continued)

LOCATION	OWNER OF RECORD: RG PERMIT NUMBER AND YEAR COMPLETED	WELL DEPTH	WATER LEVELS	OTHER
27.13.33.111	Tony P. Valdez Valdez RG18120, 1970	D-81	27' 10/70	
27.13.3312	P. Martinez* Taos Cerro Project DH-T11 RG20046, 1972	D-500	60.56' 3/72	S C
28.12.1.000	Manuel Ortega Questa RG123, 1956	D-65	43' 12/56	
28.12.1.100	Feliciano Rael Questa RG10696, 1965	D-175	84'	F
28.12.1.220	Felipe S. Ortega Questa RG11021, 1964	D-52	6' 8/64	U-C C
28.12.1.220	John W. Coward Questa RG17088, 1969	D-115	40' 11/69	C
28.12.1.420	Feliciano Vigil Questa RG17352, 1970	D-200	40' 5/70	F
28.12. 2.422**	Louis B. Ortiz[1] Questa RG10584, 1964	D-71	45' 6/64	C S
28.12. 2.422**	Louis B. Ortiz Questa RG10585, 1964	D-60	35' 6/64	C S
28.12.5.442	Alfredo Duran Questa RG13698, 1968	D-43	21' 4/66	C
28.12.24.144	Abran Ortega Questa RG149, 1957	D-300	Dry	
28.12.28.400	U. S. Forest Service Region #3, ooc RG22147, 1973	D-1183	887' 10/73	Y-2 (860 885) Y-1 (885-895) Y-15 (906-1008) Y-10 (1065-1183) F,S

*Data obtained from special SEO file.
**Location based on field check.
[1]In addition, SEO files show two springs with water level at 7400'.

These sections are immediately south of those with tailings ponds

le 37. (continued)

ATION	OWNER OF RECORD: RG PERMIT NUMBER AND YEAR COMPLETED	WELL DEPTH	WATER LEVELS	OTHER
3.29	Felomeno Vigil Questa RG15727, 1968	D=50	5' 6/68	
3.29	Agustin Rael Questa RG16937, 1970	D=60	8' 9/70	
3.30.311	*	D=130	70'	
3.30.140	State Highway Dept. Questa RG4128, 1961	D=198	98' 10/61	F
3.30.333	Manuel D. Ortega Questa RG9262, 1964	D=52	10' 7/64	
3.30.190	Taos County Board of Education Taos RG10732, 1964	D=210	127' 9/64	F C
3.30.110	Questa Baptist Mission Questa RG12762, 1965	D=200	128' 7/65	
3.30.1211	Village of Questa RG10641-S	D=200	85' 7/64	Y=237 C U-M
3.30.124	Robert C. Bryant Questa RG10179, 1969	D=250	165' 1/69	Y=30 U-C C, F
3.31.114	*	D=55	45'	
3.31.320	John H. Yaple Questa RG1107, 1960	D=103	80' 5/60	

a obtained from special SEO file.

Table 37. (continued)

LOCATION	OWNER OF RECORD: RG PERMIT NUMBER AND YEAR COMPLETED	WELL DEPTH	WATER LEVELS	OTHER
29.13.31.323	*	D=180-200		
29.13.31.341	*	D=267	20'?	
29.13.31.343	*	D=35	33'	
29.13.31.410	*	D=35	16'	
29.13.31.411	Antonio J. Trujillo Questa RG4784, 1960	D=30	6' 6/60	
29.13.31.111	Selimo Rael Questa RG147, 1957	D=136	95' 3/57	F
29.13.31.422	E. J. Valasquez Questa RG4784, 1960	D=30	6' 6/60	
29.13.31.233	Malaquias Rael Questa RG10707, 1964	D=50	6' 6/64	C
29.13.31.422	Charles Gonzales Questa RG10722, 1964	D=50	7' 7/64	
29.13.31.410	Eloisa V. Cisneros Questa RG11271, 1964	D=55	10' 6/64	
29.13.31 Tr	Carlos Martinez Cerro RG11552, 1964	D=50	8' 10/64	
29.13.31.400	Santiago Ortega Questa RG11156, 1964	D=51	10' 6/64	U=C
29.13.31. Tr	Claudio Rael Questa RG13037, 1966	D=62	35' 5/66	F

*Data obtained from special SEO file.

Town of Questa located in 29.13.31

Reference 21

LIST OF FIGURES

FIGURE 1: Bear Creek Tailings site location map.

FIGURE 2: Site layout of Bear Creek Tailings site.

FIGURE 3: Sample location map of Bear Creek Tailings site.

LIST OF TABLES

TABLE 1: Summary of amalytical results of samples collected from on-site tailings piles and soils.

TABLE 2: Summary of analytical results of samples collected from Bear Creek and associated drainage channels.

TABLE 3: Summary of analytical results of sample collected from private water wells.

LIST OF APPENDIXES

APPENDIX A: Selected photographs taken during the November 18, 1992 site inspection of Bear Creek Tailings site.

APPENDIX B: Xerox copy of New Mexico State Highway and Transportation Department aerial photograph of Bear Creek Tailings site on May 1, 1962.

APPENDIX C: XRF Survey of Bear Creek Tailing site, November 18, 1993.

ANALYSIS OF TAILINGS POND SEEPAGE FLOW TO RED RIVER

AT

UNOCAL 76 MOLYCORP, INC.

QUESTA DIVISION

VAIL ENGINEERING, INC.

SANTA FE, NEW MEXICO

SEPTEMBER 24, 1993

ANALYSIS OF TAILINGS POND SEEPAGE FLOW TO RED RIVER

TABLE OF CONTENTS

	Page #
OVERVIEW	1
SURVEY OF RED RIVER	3
DATA BASE	4
Flow in Red River	4
Accretions to Red River	8
Fish Hatchery Diversion	8
Ambient Ground Water Quality	10
Tailings Seepage Water Quality	12
ANALYSIS	12
SUMMARY AND CONCLUSIONS	18

LIST OF TABLES

TABLE 1 Lower Red River Survey 4-12-93	5
TABLE 2 Water Quality Analysis Survey	6
TABLE 3 USGS Stream Flow Data	9
TABLE 4 Ambient Water Quality	11
TABLE 5 Selected Analytical Values	12

VAIL ENGINEERING, INC.

PHONE: (505) 988-3575

1388 SAN MATEO LANE
SANTA FE, NEW MEXICO
87501

ANALYSIS OF TAILINGS POND SEEPAGE FLOW TO RED RIVER

OVERVIEW

Molycorp's tailings dams are located primarily in Sections 35 (Dam Nos. 4 & 5) and 36 (Dam No. 1), of Township 29N Range 12E NMPM, one to two miles west of the Town of Questa, Taos County, New Mexico. Red River flows to the west past the tailings ponds at a distance of approximately one-half mile south of the ponds. Leachate from the tailings ponds seeps to the ground water which flows generally in a southwesterly direction and discharges to Red River.

The seepage from the ponds contains elevated concentrations of sulfates (840± mg/l), molybdenum (2± mg/l), manganese (1.4± mg/l), and total dissolved solids (1700± mg/l). Several other elements are present at moderately elevated but below significant levels. It appears that most of the molybdenum is being absorbed during seepage flow in the vadose zone and along the ground water flow path.

During the 1970's Molycorp excavated trenches and installed french drains to intercept the seepage flow south of Dam No. 1 and southeast of Dam No. 4. These seepage barriers appeared to be fairly effective for some time but recently there has been evidence that an increased amount of seepage from the tailings ponds flows past these barriers. This seepage flow is generally in the shallow alluvium and the fairly high constituent concentrations this area.

It is probable that a large percentage of the seepage from section 35 is transported by the ground water flow in the volcanic formations which underlie most of this pond area. It is believed that most of this ground water flow is discharged to Red River at the numerous springs along the Red River Gorge. The accretion to Red River from spring flow between the head of the gorge to the State fish hatchery is on the order of 18 cfs indicating a large amount of ground water flow in the volcanic formation.

In April 1993 a water quality survey was made along Red River between the State Road 3 highway bridge and the Red River Fish Hatchery. The primary purposes for this survey study were:

(1) Determination of the concentration of significant pond seepage water constituents in the ground water and spring water entering Red River.

(2) Determination of the amount of seepage water contained in the ground water and spring flows along specific reaches of Red River.

(3) Determination of the effect on Red River of the pond seepage discharge.

This study was conducted in conjunction with a ground water study, being prepared by South Pass Resources, Inc., to determine the characteristics of the ground water aquifer south of Dam No. 1 and the distribution and concentration of significant tailings pond water constituents in the ground water immediately down gradient of the pond areas.

Both studies were being conducted to determine the desirability and feasibility of further action by Molycorp to reduce the effect of seepage from the pond areas.

A schematic diagram showing the above distribution of accretion flow and all of the other measured and derived spring and river flows and SO_4 concentrations is included at the end of this report.

SUMMARY AND CONCLUSIONS

At the time of the stream survey (April 12, 1993) the quality of the water in Red River (relative to constituents associated with Molycorp's operations) was better below the fish hatchery than at the State Highway bridge. The sulfate concentration was nearly the same. The concentrations of aluminum, iron, copper, zinc and manganese were all lower at the downstream point. Concentrations of molybdenum, cadmium and lead at both the upstream and downstream ends of this reach, were all below the detection limits for the laboratory methods used. Except for manganese, all constituents analyzed were below drinking water and stream water quality standards. The high manganese concentration are due to concentrations in the river upstream of the tailings pond area.

The quality of the natural ground water in the area is excellent. The average sulfate concentration is low at only slightly more than 20 mg/l.

Except for TDS and SO_4; the seepage flow from the tailings ponds compares favorably with Red River water quality.

The majority of the natural spring flow along the survey reach is intercepted by the fish hatchery water supply system. Analysis of the hatchery water supply indicates a moderate increase in sulfate; however, the concentration (63 - 80 mg/l) is still far below drinking and ground water standards. The maximum SO_4 concentration found for any individual spring was 126 mg/l. (Sampling

points 9 and 10 are believed to be field drainage and shallow alluvium aquifer flow rather than spring flow.)

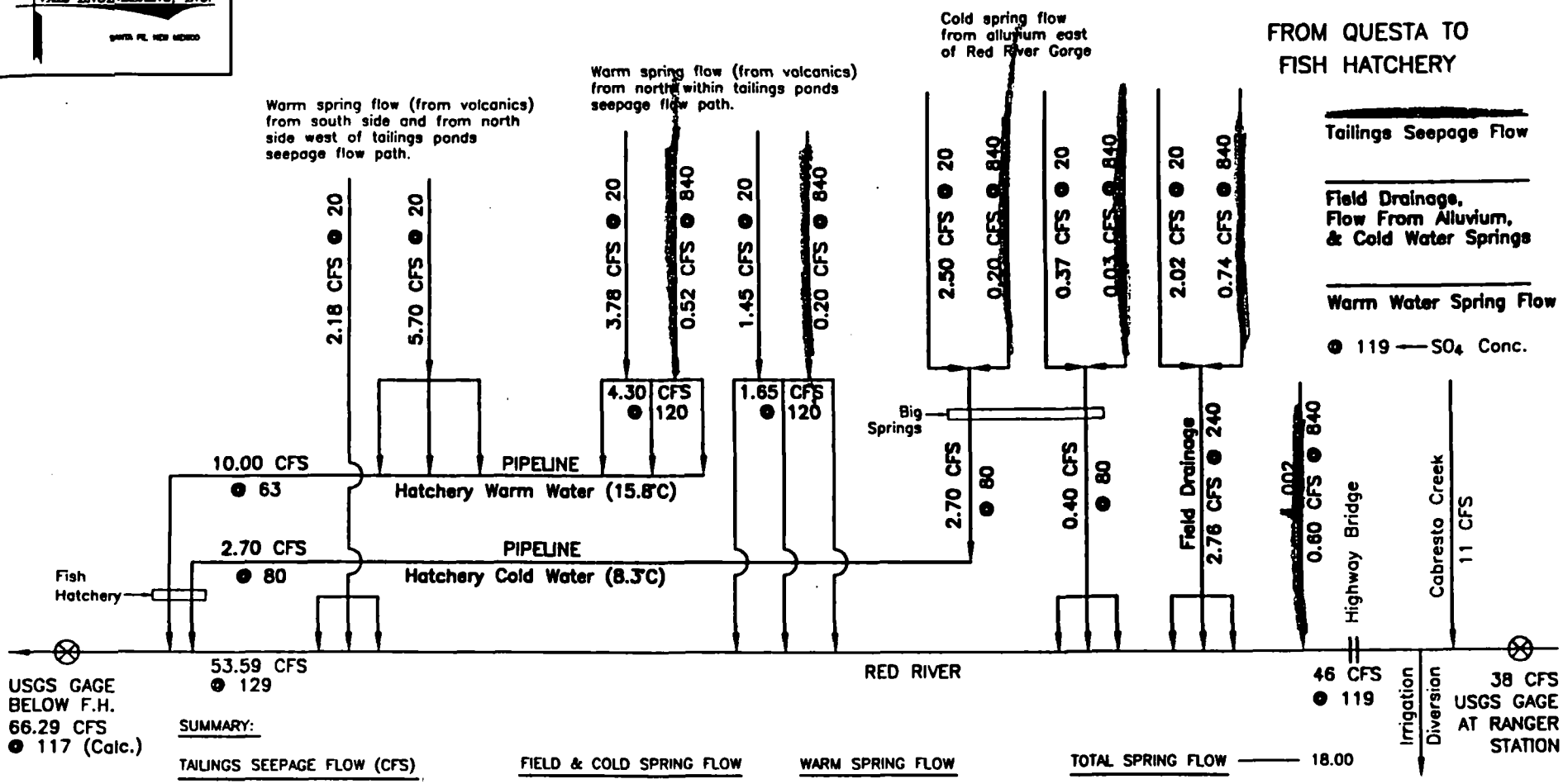
High concentrations of sulfate (660 - 690 mg/l) were found down gradient of the junction manhole from 002 and 003 which is located in the natural drainage channel below Dam No. 1. and about 1/4 mile north of Red River. Other data indicates elevated SO_4 concentrations in some monitor and private wells in and down gradient of this area. The highest SO_4 concentration detected near the river was 504 mg/l at Station No. 9. We believe that the field drainage below Dam No. 1 and 003 is concentrated at this location. Molycorp is presently investigating the feasibility of constructing additional seepage barriers and/or other facilities to substantially reduce the seepage flow down gradient of the tailings ponds in this area.

Data from the stream survey indicates that at that time, the total tailings pond seepage flow entering Red River (including the fish hatchery supply) was about 2.29 cfs (including discharge from 002 and 003). Of this about 0.6 cfs was flowing from 002 and 003. 0.7 cfs were in the field drainage and shallow alluvium aquifer flow east of the volcanic formations. These seepage flows are presumably from the tailings ponds in Section 36 and the easterly part of the tailings ponds in Section 35. An additional seepage flow of about one cfs was indicated to be contained in the cold spring flow at upper end of the gorge and in the warm springs along the gorge. It is believed that this seepage flow is from the west side of the pond area in Section 35 and from the pond area above Dam No. 5. Survey data indicates that the seepage path from these areas extends downstream to within about 1/2 mile east of the fish hatchery.

VAIL ENGINEERING, INC.
SANTA FE, NEW MEXICO

ANALYSIS OF ACCRETIONS TO RED RIVER

FROM QUESTA TO FISH HATCHERY



SUMMARY:

TAILINGS SEEPAGE FLOW (CFS)

002	0.60
Field Drainage	0.74
Big Springs to River	0.03
Big Springs to Pipeline	0.20
Warm Water Springs to River	0.20
Warm Water Springs to Pipeline	0.52
TOTAL	2.29

FIELD & COLD SPRING FLOW

Field Drainage	2.02
Big Springs to River	0.37
Big Springs to Pipeline	2.50
TOTAL COLD	4.89

WARM SPRING FLOW

In Seepage Path	
To River	1.45
To Pipeline	3.78
From South & to West of Seepage Path	
To River	2.18
To Pipeline	5.70
TOTAL WARM	13.11

TOTAL SPRING FLOW — 18.00

RIVER FLOW

Red River ● Ranger Sta.	35.00
Cabresto Creek	11.00
Field & Cold Spring Flow	4.68
Warm Spring Flow	13.11
Tailings Ponds Seepage	2.29
TOTAL	66.29

Reference 22

APPENDIX C

Molycorp, Inc.

Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

union 76
MOLYCORP

March 12, 1987

Amy Childers
Water Resource Specialist,
Ground Water Section
New Mexico Health and Environment Department
P. O. Box 968
Santa Fe, New Mexico 87504-0968

Dear Ms. Childers:

Enclosed is the ground water base data which you requested in your memo to me dated January 28, 1987. Call me at 586-0212 if you require additional data or if I can be of further assistance to you regarding this matter.

Very truly yours,

LeRoy E. Apodaca
Manager, Administrative
Services

RECEIVED
MAR 13 1987
GROUND WATER HAZARDOUS WASTE
BUREAU

FT
987

APPENDIX E

WATER QUALITY SAMPLING LOCATIONS

Within the Guadalupe Mountains/Questa area, there are several localities where water flow or water quality evaluations can be made. These include wells, springs, drain systems, and surface waters. The following is a description of locations where water measurements were made. Sampling points are identified by both their full name and abbreviated names, and the sampling location or occurrence and its use in the investigation are discussed.

BIG ARSENIC SPRING (RG BARSP)

This spring is the largest natural spring in the area. It is located on the Rio Grande, about 1.5 miles upstream from the confluence of the Red River and Rio Grande. The actual spring is a single source located approximately 40 feet above river level. A few much smaller seeps occur a few hundred feet upstream. This spring was used for spring flow staff gauging and was sampled for ambient ground-water quality evaluation.

LITTLE ARSENIC SPRING (RG LARSP)

This spring is a single source that has a relatively high discharge. It is located approximately 0.75 mile upstream from the confluence and originates about 30 feet above river level. This spring was used for visual spring flow gauging and was sampled for ambient ground-water quality evaluation.

CERRO SPRING (RG CERSP)

This spring is an area of about a dozen seeps along the Rio Grande, just below Cerro Canyon. The seeps occur at river level and vary in discharge from a very small trickle to a couple gallons per minute. Proceeding north to south, the seeps are labeled A through L. Cerro C, one of the larger seeps, was used for visual spring flow gauging and was sampled for ambient ground-water quality evaluation.

FISH HATCHERY 1 AND 2 (RR-FH1-SP, RR-FH2-SP)

These springs are an area of broad, relatively high discharge seeps. They are located about 0.75 mile upstream of the Red River Fish Hatchery and occur about 5 to 10 feet above river level. These springs were used for visual spring flow gauging and were sampled for ambient ground-water quality evaluation.

RED RIVER 1 AND 2 (RR No. 1 SP, RR No. 2 SP)

These springs are very small seeps located at river level a few hundred feet downstream from El Aujae Campground. During late summer, these springs sometimes go dry. They were used for visual spring gauging and were sampled for ambient ground-water quality evaluation.

RED RIVER 3, 4, 5, 6, 7, 8, 9, AND 10 (RR-3-SP - RR-10-SP)

This spring complex is located approximately 0.5 mile downstream from the Red River Fish Hatchery. The springs are located at river level and vary in discharge from small seeps to single sources that have moderate discharges. They were used for visual spring gauging and sampled for ambient ground-water quality evaluation.

BLM CHIFLO CAMPGROUND WELL (BLMCHI W and SHEEPX W)

This well is located approximately 0.5 mile southeast of the Chiflo Campground. The well is 415 feet deep and taps the regional basalt aquifer. Samples from this well were used for ambient ground-water quality evaluation, water-level surveys, and aquifer testing. Water samples from this well are collected at the wellhead and at Sheeps Crossing Campground after being piped for approximately 0.5 mile.

BLM HEADQUARTERS WELL (BLMHDQ W and BARSEN W)

This well is located at the BLM Wild and Scenic River Headquarters facility. The well is 546 feet deep and taps the regional basalt aquifer. Samples from this well were used for ambient ground-water quality evaluation, water-level surveys, and aquifer testing. Water samples from this well were collected at the wellhead and at the Big Arsenic Campground after being piped for approximately 0.5 mile.

OUTFALL 001, 002, 003 (FALL001, FALL002, FALL003)

The Outfalls 001, 002 and 003 are the discharge points for the french tile drain system that underlies the current tailings disposal facility. Outfall 001 rarely flows. Discharges from Outfalls 002 and 003 are combined before the sampling point. Samples from these locations were used for leachate chemistry analyses.

MW-1, 2, 3, 4

These monitor wells are less than 50 feet deep and are positioned along the face of the current tailings dam. Water samples were sporadically taken with a bailer and were used for leachate chemistry analyses.

HERRERA WELL (P-1)

This shallow private well is located 0.25 mile south of the current tailings disposal site. Water samples were collected from the household tap and were used for leachate chemistry evaluation.

RAEL WELL (P-4)

This shallow private well is located 0.5 mile south of the current tailings disposal site. Water samples were collected from the household tap and were used for leachate chemistry evaluation.

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

TYP=AMB_GW

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	86	8.03720939	0.27909372	7.30000019	8.69999981	0.03009545	691.200008	0.0778933	3.473
COD	1	0.00000000	.	0.00000000	0.00000000	.	0.000000	.	.
TSS	49	31.00000000	53.26036675	0.00000000	274.00000000	7.60862382	1519.000000	2836.6666667	171.808
TDS	95	198.22105263	70.73732936	91.00000000	428.00000000	7.25749686	18831.000000	5003.7697648	35.686
CN	11	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.000000	0.0000000	.
F	95	0.99157895	0.27892772	0.40000000	1.40000000	0.02861738	94.200000	0.0778007	28.130
CD	74	0.00237838	0.00453317	0.00000000	0.02000000	0.00052697	0.176000	0.0000205	190.599
FE	105	0.59948571	0.98396943	0.00000000	5.30000000	0.09602558	62.946000	0.9681958	164.136
MN	105	0.17517143	0.22981130	0.00000000	1.05000000	0.02242729	18.393000	0.0528132	131.192
MO	105	0.06333333	0.16510874	0.00000000	1.44000000	0.01611296	6.650000	0.0272609	260.698
ZN	105	0.18604762	0.44761197	0.00000000	3.58000000	0.04368246	19.535000	0.2003565	240.59C
PB	82	0.01573171	0.02090723	0.00000000	0.07000000	0.00230882	1.290000	0.0004371	132.89S
CU	82	0.01808537	0.02001475	0.00000000	0.09000000	0.00221026	1.483000	0.0004006	110.66E
AS	13	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.000000	0.0000000	.
HG	11	0.00016364	0.00013508	0.00000000	0.00032000	0.00004073	0.001800	0.0000000	82.54(
SO4	90	38.92111111	45.16512151	0.90000000	172.00000000	4.76082183	3502.900000	2039.8882010	116.04:
BA	10	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.000000	0.0000000	.
CR	11	0.01281818	0.00996813	0.00000000	0.03000000	0.00300550	0.141000	0.0000994	77.76(
NI	10	0.03100000	0.02233582	0.01000000	0.08000000	0.00706321	0.310000	0.0004989	72.05)
CA	10	22.21000000	7.37660717	17.20000000	38.60000000	2.33268801	222.100000	54.4143333	33.21:
AG	10	0.00003200	0.00010119	0.00000000	0.00032000	0.00003200	0.000320	0.0000000	316.22(
CL	10	8.90000000	3.66515120	6.00000000	18.00000000	1.15902258	89.000000	13.4333333	41.18'
AL	10	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.000000	0.0000000	.
MG	10	6.72000000	2.31651079	5.30000000	11.90000000	0.73254503	67.200000	5.3662222	34.47:

4

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

TYP=L_CHEM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	162	7.64135802	0.42959537	5.90000010	9.1000004	0.03375220	1237.90000	0.18455	5.622
COD	116	7.43965517	3.95251993	1.00000000	21.0000000	0.36698226	863.00000	15.62241	53.128
TSS	141	7.88588652	29.16590647	0.00000000	340.0000000	2.45621242	1111.91000	850.65010	369.849
TDS	160	1332.26875000	469.45446356	32.00000000	2165.0000000	37.11363406	213163.00000	220387.49336	35.237
CN	112	0.00249464	0.00208456	0.00000000	0.0114000	0.00019697	0.27940	0.00000	83.561
F	157	1.31337580	0.77543169	0.30000000	2.4000000	0.06188619	206.20000	0.60129	59.041
CD	154	0.00898052	0.00725310	0.00000000	0.0300000	0.00058447	1.38300	0.00005	80.765
FE	174	0.31214943	0.51855575	0.00000000	5.0000000	0.03931161	54.31400	0.26890	166.124
MN	174	0.54620690	0.65024360	0.00000000	2.1700000	0.04929484	95.04000	0.42282	119.047
MO	174	1.06675862	1.06394312	0.00000000	3.5300000	0.08065732	185.61600	1.13197	99.736
ZN	174	0.16637931	0.41697797	0.00000000	3.0000000	0.03161102	28.95000	0.17387	250.619
PB	152	0.05927632	0.03553008	0.00000000	0.2400000	0.00288187	9.01000	0.00126	59.940
CU	152	0.02322368	0.03692846	0.00000000	0.3400000	0.00299529	3.53000	0.00136	159.012
AS	97	0.00917526	0.00276515	0.00000000	0.0100000	0.00028076	0.89000	0.00001	30.137
HG	95	0.00000000	0.00000000	0.00000000	0.0000000	0.00000000	0.00000	0.00000	.
SO4	166	850.24698795	343.32720389	28.00000000	1662.0000000	26.64735898	141141.00000	117873.56893	40.380
BA	0	.	.	.	.	.	.	.	.
CR	0	.	.	.	.	.	.	.	.
NI	0	.	.	.	.	.	.	.	.
CA	0	.	.	.	.	.	.	.	.
AG	0	.	.	.	.	.	.	.	.
CL	0	.	.	.	.	.	.	.	.
AL	0	.	.	.	.	.	.	.	.
MG	0	.	.	.	.	.	.	.	.

5

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

LOC=P-1 W

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	14	7.56428572	0.50475756	7.0000000	8.5000000	0.13490213	105.900000	0.254780	6.673
COD	0	.	.	.	.	.	.	.	.
TSS	3	2.46666667	1.85831465	0.4000000	4.0000000	1.07289846	7.400000	3.453333	75.337
TDS	14	1219.92857143	93.02891551	1102.0000000	1408.0000000	24.86302349	17079.000000	8654.379121	7.626
CN	0	.	.	.	.	.	.	.	.
F	14	0.42142857	0.09749613	0.3000000	0.6000000	0.02605694	5.900000	0.009505	23.135
CD	8	0.00500000	0.00534522	0.0000000	0.0100000	0.00188982	0.040000	0.000029	106.904
FE	14	0.46142857	0.57541767	0.0200000	2.0600000	0.15378684	6.460000	0.331105	124.704
MN	14	0.01642857	0.01277446	0.0000000	0.0400000	0.00341412	0.230000	0.000163	77.758
MO	14	0.08042857	0.03624004	0.0060000	0.1400000	0.00968556	1.126000	0.001313	45.059
ZN	14	0.46571429	0.26267014	0.0900000	0.9500000	0.07020155	6.520000	0.068996	56.402
PB	8	0.05625000	0.03622844	0.0100000	0.1200000	0.01280869	0.450000	0.001313	64.406
CU	8	0.01250000	0.01488048	0.0000000	0.0400000	0.00526104	0.100000	0.000221	119.044
AS	0	.	.	.	.	.	.	.	.
HG	0	.	.	.	.	.	.	.	.
SO4	13	681.30769231	110.25000727	509.0000000	875.0000000	30.57785033	8857.000000	12155.064103	16.182
BA	0	.	.	.	.	.	.	.	.
CR	0	.	.	.	.	.	.	.	.
NI	0	.	.	.	.	.	.	.	.
CA	0	.	.	.	.	.	.	.	.
AG	0	.	.	.	.	.	.	.	.
CL	0	.	.	.	.	.	.	.	.
AL	0	.	.	.	.	.	.	.	.
MG	0	.	.	.	.	.	.	.	.

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

LOC=FALL001

ARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	13	7.69230758	0.68855106	6.69999981	8.8000002	0.19096970	99.999999	0.474103	8.951
COD	13	9.61538462	4.55592035	4.00000000	21.0000000	1.26358496	125.000000	20.756410	47.382
TSS	13	3.92307692	2.01913919	2.00000000	8.0000000	0.56000845	51.000000	4.076923	51.468
TDS	13	1175.23076923	175.67970564	900.00000000	1576.0000000	48.72478360	15278.000000	30863.358974	14.949
CN	13	0.00112308	0.00119802	0.00000000	0.0032000	0.00033227	0.014600	0.000001	106.673
F	13	2.01538462	0.19081472	1.70000000	2.4000000	0.05292248	26.200000	0.036410	9.468
CD	13	0.01076923	0.00862316	0.00000000	0.0200000	0.00239164	0.140000	0.000074	80.072
FE	13	0.24692308	0.12963954	0.00000000	0.4800000	0.03595554	3.210000	0.016806	52.502
MN	13	0.28153846	0.21129940	0.02000000	0.5600000	0.05860391	3.660000	0.044647	75.052
MO	13	0.69615385	0.38293904	0.38000000	1.8600000	0.10620818	9.050000	0.146642	55.008
ZN	13	0.02153846	0.01863963	0.00000000	0.0600000	0.00516970	0.280000	0.000347	86.541
PB	13	0.05307692	0.02250356	0.00000000	0.0800000	0.00624136	0.690000	0.000506	42.398
CU	13	0.04153846	0.09044760	0.00000000	0.3400000	0.02508565	0.540000	0.008181	217.744
AS	13	0.01000000	0.00000000	0.01000000	0.0100000	0.00000000	0.130000	0.000000	0.000
HG	13	0.00000000	0.00000000	0.00000000	0.0000000	0.00000000	0.000000	0.000000	.
SO4	12	842.83333333	68.05456812	672.00000000	932.0000000	19.64566161	10114.000000	4631.424242	8.074
BA	0	.	.	.	.	.	.	.	.
CR	0	.	.	.	.	.	.	.	.
NI	0	.	.	.	.	.	.	.	.
CA	0	.	.	.	.	.	.	.	.
AG	0	.	.	.	.	.	.	.	.
CL	0	.	.	.	.	.	.	.	.
AL	0	.	.	.	.	.	.	.	.
MG	0	.	.	.	.	.	.	.	.

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

LOC=FALL002

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	47	7.51489361	0.22261164	7.0999999	8.1999998	0.03247125	353.200000	0.049556	2.962
COD	43	5.20930233	2.36601070	1.0000000	11.0000000	0.36081325	224.000000	5.598007	45.419
TSS	46	4.45652174	5.31123138	0.0000000	23.0000000	0.78309834	205.000000	28.209179	119.179
TDS	46	1458.69565217	121.57665521	1160.0000000	1811.0000000	17.92549987	67100.000000	14780.883092	8.335
CN	44	0.00174318	0.00094510	0.0000000	0.0040000	0.00014248	0.076700	0.000001	54.217
F	46	2.11086957	0.13371323	1.8000000	2.4000000	0.01971494	97.100000	0.017879	6.335
CD	51	0.00862745	0.00663916	0.0000000	0.0200000	0.00092967	0.440000	0.000044	76.954
FE	53	0.16169811	0.10547942	0.0000000	0.4700000	0.01448871	8.570000	0.011126	65.232
MN	53	1.48377358	0.20631591	1.0800000	2.1700000	0.02833967	78.640000	0.042566	13.905
MO	53	2.47490566	0.38490070	1.5100000	3.5300000	0.05287018	131.170000	0.148149	15.552
ZN	53	0.01830189	0.01717958	0.0000000	0.0700000	0.00235980	0.970000	0.000295	93.868
PB	51	0.06313725	0.03049526	0.0000000	0.1600000	0.00427019	3.220000	0.000930	48.300
CU	51	0.01843137	0.02737682	0.0000000	0.1900000	0.00383352	0.940000	0.000749	148.534
AS	44	0.00909091	0.00290803	0.0000000	0.0100000	0.00043840	0.400000	0.000008	31.988
HG	44	0.00000000	0.00000000	0.0000000	0.0000000	0.00000000	0.000000	0.000000	.
SO4	50	930.28000000	123.08285578	714.0000000	1234.0000000	17.40654439	46514.000000	15149.389388	13.231
BA	0	.	.	.	.	.	.	.	.
CR	0	.	.	.	.	.	.	.	.
NI	0	.	.	.	.	.	.	.	.
CA	0	.	.	.	.	.	.	.	.
AG	0	.	.	.	.	.	.	.	.
CL	0	.	.	.	.	.	.	.	.
AL	0	.	.	.	.	.	.	.	.
MG	0	.	.	.	.	.	.	.	.

TABLES OF INORGANIC DATA-CONCENTRATION IN PPM, pH IN UNITS
AMBIENT GROUND WATER QUALITY, SURFACE WATER, LEACHATE CHEMISTRY
AMB_GW=RG SPRINGS, RR FISH HATCHERY, RR(1-10)SPRINGS, BLM WELLS
L_CHEM=OUTFALLS, TAILDRY, W_DITCH, MW-(1-4), P-1 AND P-4
SUR_WAT=RR AND CABRESTO AND COLUMBINE CREEKS SURFACE LOCATIONS

LOC=P-4____W

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
PH	4	7.95000017	0.38729840	7.40000010	8.30000019	0.19364920	31.80000067	0.15000005	4.872
COD	0	.	.	.	.	.	.	.	.
TSS	1	0.50000000	.	0.50000000	0.50000000	.	0.50000000	.	.
TDS	4	227.75000000	22.06618831	200.00000000	250.00000000	11.03309416	911.00000000	486.91666667	9.689
CN	0	.	.	.	.	.	.	.	.
F	4	0.52500000	0.05000000	0.50000000	0.60000000	0.02500000	2.10000000	0.00250000	9.524
CD	1	0.00000000	.	0.00000000	0.00000000	.	0.00000000	.	.
FE	4	0.10000000	0.03559026	0.05000000	0.13000000	0.01779513	0.40000000	0.00126667	35.590
MN	4	0.01250000	0.01500000	0.00000000	0.03000000	0.00750000	0.05000000	0.00022500	120.000
MO	4	0.00500000	0.01000000	0.00000000	0.02000000	0.00500000	0.02000000	0.00010000	200.000
ZN	4	0.36750000	0.11354148	0.25000000	0.50000000	0.05677074	1.47000000	0.01289167	30.896
PB	1	0.02000000	.	0.02000000	0.02000000	.	0.02000000	.	.
CU	1	0.00000000	.	0.00000000	0.00000000	.	0.00000000	.	.
AS	0	.	.	.	.	.	.	.	.
HG	0	.	.	.	.	.	.	.	.
SO4	3	62.00000000	2.64575131	60.00000000	65.00000000	1.52752523	186.00000000	7.00000000	4.267
BA	0	.	.	.	.	.	.	.	.
CR	0	.	.	.	.	.	.	.	.
NI	0	.	.	.	.	.	.	.	.
CA	0	.	.	.	.	.	.	.	.
AG	0	.	.	.	.	.	.	.	.
CL	0	.	.	.	.	.	.	.	.
AL	0	.	.	.	.	.	.	.	.
MG	0	.	.	.	.	.	.	.	.

Appendix C.5

The following table is a comparison of water quality to maximum concentrations allowed by the New Mexico State Standards. The comparison was developed by subtracting the water quality standard from the water quality parameter value for that sampling. Thus a positive result indicates that maximum allowable concentrations were exceeded.

The format is: sampling location, date and then the comparison of values and state standards. The comparisons are arranged in the following order:

	pH,	COD,	TSS,	TDS,	CN,	F,	Cd,	Fe,	Mn,	Mo,	Zn,	Pb,	Cu,	As,	Hg,	SO4,	Ba,	Cr,	Ni,	Se,	Ag,	Cl,	Al,	Mg
EXCD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

COMPARISON TO NEW MEXICO WATER QUALITY STANDARDS
CONCENTRATIONS IN PPM

OBS	LOC	DAT	EXCD1	EXCD2	EXCD3	EXCD4	EXCD5	EXCD6	EXCD7	EXCD8	EXCD9	EXCD10	EXCD11
189	JUNEBUG	850131	-1.5	.	.	-720	.	-1.1	-0.0100	-0.390	0.1900	-1.000	-9.830
190	JUNEBUG	850228	-1.5	.	.	-802	.	-1.2	-0.0100	-0.680	0.0800	-1.000	-9.960
191	JUNEBUG	850401	-1.9	.	.	-800	.	-1.1	0.0000	-0.400	0.1100	-1.000	-9.950
192	JUNEBUG	850501	-1.1	.	.	-855	.	-1.3	-0.0100	0.640	-0.0800	-1.000	-9.950
193	JUNEBUG	850531	-1.1	.	.	-860	.	-1.2	0.0000	0.830	-0.0700	-1.000	-9.940
197	MW-1	830909	-1.8	.	.	172	.	.	.	-0.680	-0.1400	-0.850	-9.770
198	MW-2	830909	-1.4	.	.	355	.	.	.	-0.210	0.4800	-0.460	-9.950
199	MW-3	830909	-1.7	.	.	473	.	-1.0	.	2.810	0.7600	-0.510	-9.830
201	P-1____W	830128	-0.6	.	.	102	.	-1.0	.	-0.690	-0.2000	-0.940	-9.640
202	P-1____W	830224	-1.7	.	.	150	.	-1.0	.	1.060	-0.2000	-0.940	-9.440
203	P-1____W	830316	-1.1	.	.	128	.	-1.2	.	-0.940	-0.2000	-0.880	-9.060
204	P-1____W	830425	-1.8	.	.	113	.	-1.2	.	-0.510	-0.1900	-0.950	-9.460
205	P-1____W	830527	-1.7	.	.	200	.	-1.1	.	-0.520	-0.1700	-0.930	-9.300
206	P-1____W	830915	-1.8	.	.	156	.	-1.1	.	-0.780	-0.1600	-0.890	-9.520
207	P-1____W	850131	-2.0	.	.	320	.	-1.2	-0.0100	-0.850	-0.1800	-0.890	-9.520
208	P-1____W	850228	-1.9	.	.	211	.	-1.2	0.0000	0.130	-0.1800	-0.950	-9.500
209	P-1____W	850401	-1.7	.	.	200	.	-1.2	0.0000	0.010	-0.1700	-0.930	-9.550
210	P-1____W	850501	-1.5	.	.	408	.	-1.3	0.0000	-0.810	-0.1900	-0.860	-9.050
211	P-1____W	850531	-1.4	.	.	356	.	-1.3	-0.0100	-0.750	-0.1700	-0.800	-9.110
212	P-1____W	850627	-1.7	.	.	272	.	-1.2	0.0000	-0.940	-0.1800	-0.930	-9.910

OBS	EXCD12	EXCD13	EXCD14	EXCD15	EXCD16	EXCD17	EXCD18	EXCD19	EXCD20	EXCD21	EXCD22	EXCD23	EXCD24
189	-0.03	-0.8800	.	.	-527	.	.	.	.	.	.	.	.
190	-0.05	-0.9500	.	.	-521	.	.	.	.	.	.	.	.
191	-0.03	-0.9300	.	.	-528	.	.	.	.	.	.	.	.
192	-0.04	-0.9800	.	.	-571	.	.	.	.	.	.	.	.
193	-0.04	-0.9700	.	.	-577	.	.	.	.	.	.	.	.
197	.	.	.	.	-180	.	.	.	.	.	.	.	.
198	.	.	.	.	-213	.	.	.	.	.	.	.	.
199	.	.	.	.	-143	.	.	.	.	.	.	.	.
201	.	.	.	.	-58	.	.	.	.	.	.	.	.
202	.	.	.	.	-91	.	.	.	.	.	.	.	.
203	.	.	.	.	-4	.	.	.	.	.	.	.	.
204	.	.	.	.	108	.	.	.	.	.	.	.	.
205	.	.	.	.	.	.	.	.	.	.	.	.	.
206	.	.	.	.	-50	.	.	.	.	.	.	.	.
207	-0.03	-1.0000	.	.	100	.	.	.	.	.	.	.	.
208	0.03	-0.9700	.	.	275	.	.	.	.	.	.	.	.
209	0.03	-0.9600	.	.	139	.	.	.	.	.	.	.	.
210	0.01	-1.0000	.	.	207	.	.	.	.	.	.	.	.
211	-0.04	-1.0000	.	.	137	.	.	.	.	.	.	.	.
212	0.07	-0.9900	.	.	14	.	.	.	.	.	.	.	.

Positive # means std has been exceeded

Pb

Reference 23

LIST OF FIGURES

FIGURE 1: Bear Creek Tailings site location map.

FIGURE 2: Site layout of Bear Creek Tailings site.

FIGURE 3: Sample location map of Bear Creek Tailings site.

LIST OF TABLES

TABLE 1: Summary of amalytical results of samples collected from on-site tailings piles and soils.

TABLE 2: Summary of analytical results of samples collected from Bear Creek and associated drainage channels.

TABLE 3: Summary of analytical results of sample collected from private water wells.

LIST OF APPENDIXES

APPENDIX A: Selected photographs taken during the November 18, 1992 site inspection of Bear Creek Tailings site.

APPENDIX B: Xerox copy of New Mexico State Highway and Transportation Department aerial photograph of Bear Creek Tailings site on May 1, 1962.

APPENDIX C: XRF Survey of Bear Creek Tailing site, November 18, 1993.

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HYDROGEOLOGIC STUDIES
for
MOLYCORP/QUESTA

prepared for
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prepared by
The GeoWest Group, Inc.

June 2, 1993

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	GEOLOGIC SETTING	3
3.0	HYDROGEOLOGIC SETTING	5
4.0	MOLYCORP SEEPAGE CONTROLS AND MONITORING SYSTEM	8
5.0	PROPOSED MONITOR WELLS	9
6.0	DISCUSSION	12
7.0	WORK SCHEDULE	13
8.0	REFERENCES	14

LIST OF FIGURES

Figure 1 Location Map
Figure 2 Geologic Map
Figure 3 Monitor Well Cross-Section
Figure 4 Regional Monitor Wells and Direction of Ground-water Flow
Figure 5 Existing and Proposed Monitor Wells
Figure 6 Multiple-Completion Monitor Well
Figure 7 Single-Completion Monitor Well

LIST OF TABLES

Table 1 Comparison of Water Chemistry for Monitor Wells and Outfall 002

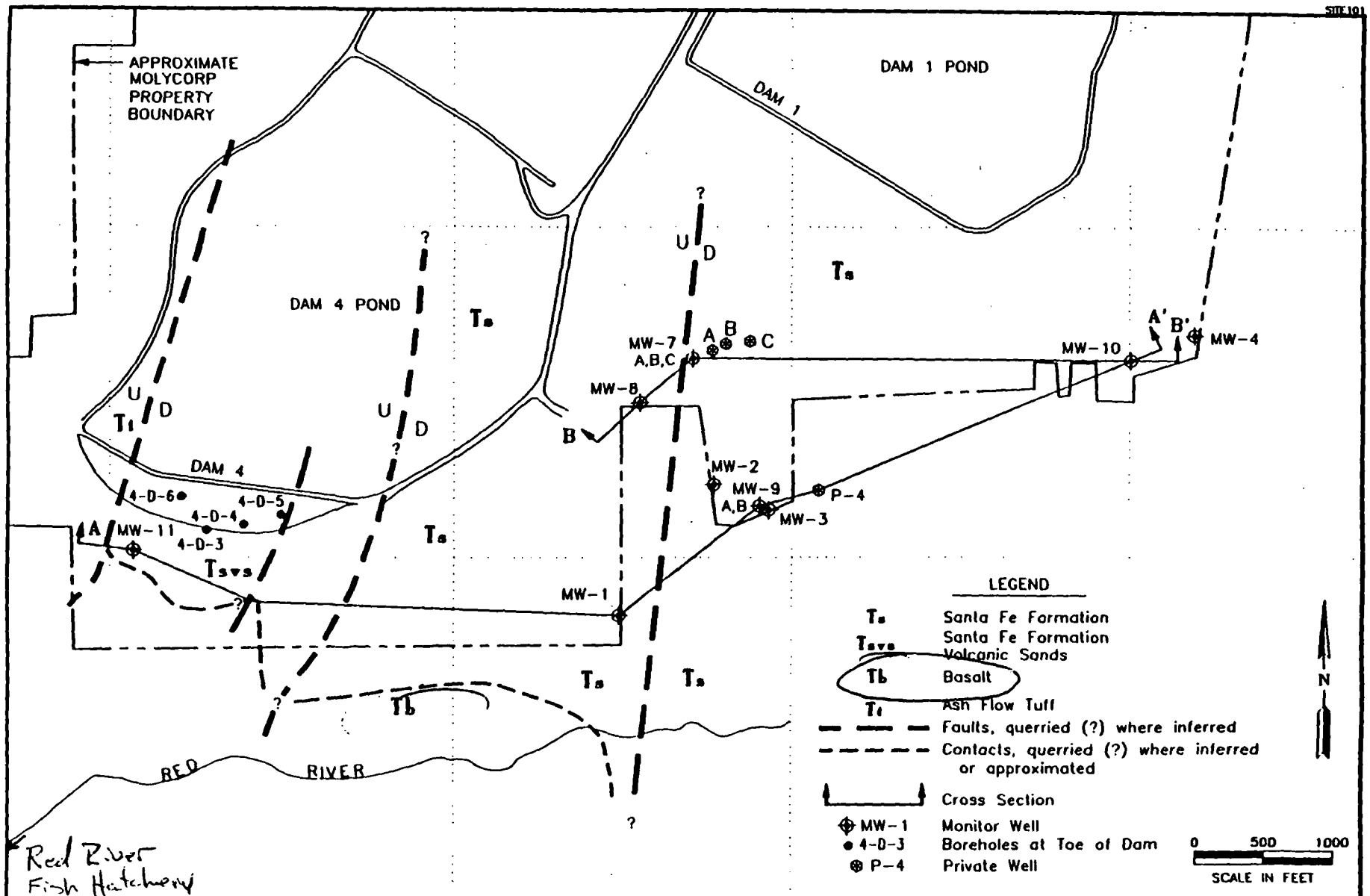


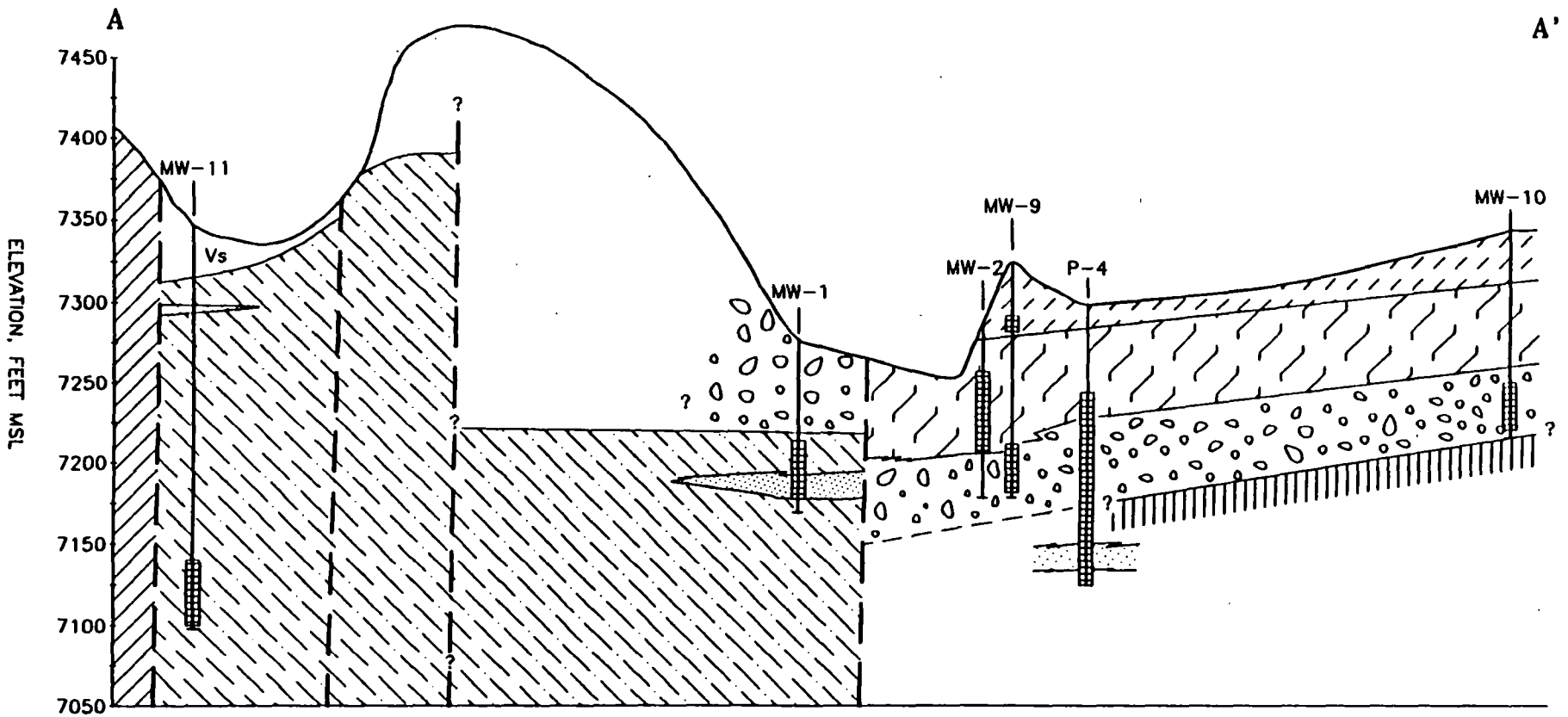
FIGURE: 2

SOUTH PASS RESOURCES, Inc.

PROJECT No.	DATE:	AUTHOR:	DRAWN BY:
[illegible]	9-20-93	[illegible]	M.O'M.

GEOLOGIC MAP – TAILINGS PONDS AREA

Molycorp, Inc.
Questa, New Mexico



LEGEND

- Santa Fe Formation Undivided
- Vs — Volcanic Sands
- Upper Aquifer Unit
- Middle Aquitard Unit
- Lower Aquifer Unit

(Volcanic Sands, Upper Aquifer Unit, Middle Aquitard Unit: Sanata Fe Formation)

- Volcanic Unit
- Gravels within Volcanic Unit
- Volcanic Tuff Unit
- Faults

MW-1 — Monitor Well

Screened Interval

0 500 1000 — HORIZONTAL SCALE IN FEET

0 50 100 — VERTICAL SCALE IN FEET

FIGURE: 4	SOUTH PASS RESOURCES, Inc.				GEOLOGIC CROSS-SECTION A – A' Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 9-15-93	AUTHOR:	DRAWN BY: M.O'M.	

TABLE C-1
MONITOR WELL CHEMISTRY

Boring or Monitor Well #	MW-1	MW-2	MW-3	MW-4	MW-A	MW-C	MW-7A	MW-7B	MW-7C	MW-9A	MW-10	MW-11	CH
pH	7.9	7.7	7.4	7.3	7.4	7.2	7.1	8.9	10.6	7.6	8.1	8.1	7.7
TDS	1051	1553	1393	1021	1115	1940	1046	1220	990	759	191	267	305
Sulfate	540	900	793	543	603	1113	571	651	613	355	54	78	57
Sodium	56	102	72	86	58	117	41	80	81	47	36	32	98
Potassium	3.5	4.7	3.5	1.4	2.4	6.5	1.9	<1.0	157	1.3	1.8	3.1	117
Calcium	169	231	219	155	189	339	185	163	119	130	18	34	30
Magnesium	39	52	48	38	38	61	36	3.1	<1	26	3.3	11	6
Arsenic	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Aluminum	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Cadmium	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005
Chromium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	0.034	<.001	0.002	0.001	0.003
Lead	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	0.006	<.002	<.002	<.002	<.002
Molybdenum	0.08	1.8	<.005	0.21	0.50	2.8	0.04	<.005	<.005	0.02	0.02	0.09	<.005
Iron	0.06	0.06	0.03	0.05	0.20	0.05	<.02	<.02	0.03	<.02	0.03	<.02	<.02
Manganese	0.03	0.58	<.01	<.01	0.05	2.6	<.01	<.01	<.01	1.2	<.01	0.01	<.01
Copper	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Zinc	0.014	0.00	0.00	0.00	0.00	0.00	0.03	0.20	0.008	0.12	0.038	0.014	0.007
Carbonate Alkalinity	<1	<1	<1	<1	<1	<1	<1	10	24	<1	<1	<1	<1
Bicarbonate Alkalinity	148	116	17	18	156	18	134	<1	<1	169	66	81	187
Hydroxide Alkalinity	<1	<1	<1	<1	<1	<1	<1	3	300	<1	<1	<1	<1
Fluoride	0.34	0.92	0.45	0.71	0.37	2.8	0.25	0.19	0.78	0.16	0.65	0.66	1.20

TABLE C-1
MONITOR WELL CHEMISTRY

Boring or Monitor Well #	MW-1	MW-2	MW-3	MW-4	MW-A	MW-C	MW-7A	MW-7B	MW-7C	MW-9A	MW-10	MW-11	CH Bkgr
pH	7.9	7.7	7.4	7.3	7.4	7.2	7.1	8.9	10.6	7.6	8.1	8.1	7.7
TDS	1051	1553	1393	1021	1115	1940	1046	1220	990	759	191	267	305
Sulfate	540	900	793	543	603	1113	571	651	613	355	54	78	57
Sodium	56	102	72	86	58	117	41	80	81	47	36	32	98
Potassium	3.5	4.7	3.5	1.4	2.4	6.5	1.9	<1.0	157	1.3	1.8	3.1	117
Calcium	169	231	219	155	189	339	185	163	119	130	18	34	30
Magnesium	39	52	48	38	38	61	36	3.1	<1	26	3.3	11	6
Arsenic	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Aluminum	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Cadmium	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005
Chromium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	0.034	<.001	0.002	0.001	0.003
Lead	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	0.008	<.002	<.002	<.002	<.002
Molybdenum	0.08	1.8	<.005	0.21	0.50	2.8	0.04	<.005	<.005	0.02	0.02	0.09	<.005
Iron	0.06	0.06	0.03	0.05	0.20	0.05	<.02	<.02	0.03	<.02	0.03	<.02	<.02
Manganese	0.03	0.58	<.01	<.01	0.05	2.6	<.01	<.01	<.01	1.2	<.01	0.01	<.01
Copper	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Zinc	0.014	0.00	0.00	0.00	0.00	0.00	0.03	0.20	0.008	0.12	0.038	0.014	0.007
Carbonate Alkalinity	<1	<1	<1	<1	<1	<1	<1	10	24	<1	<1	<1	<1
Bicarbonate Alkalinity	148	116	17	18	156	18	134	<1	<1	169	66	81	187
Hydroxide Alkalinity	<1	<1	<1	<1	<1	<1	<1	3	300	<1	<1	<1	<1
Fluoride	0.34	0.92	0.45	0.71	0.37	2.8	0.25	0.19	0.78	0.16	0.65	0.66	1.20

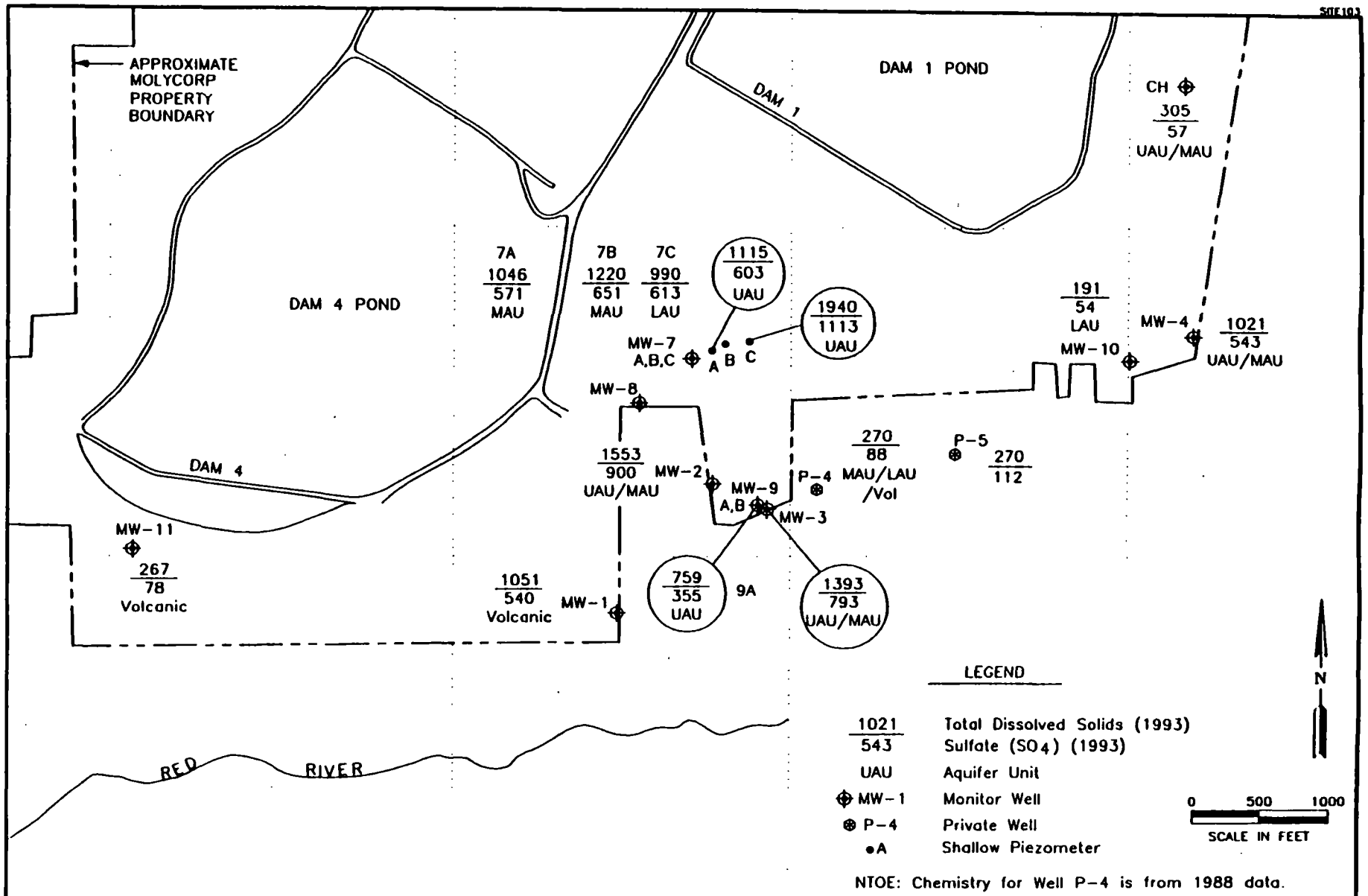


FIGURE: 7	SOUTH PASS RESOURCES, Inc.				MONITOR WELL GROUND-WATER CHEMISTRY Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 9-15-93	AUTHOR:	DRAWN BY: M.O'M.	

Reference 24

Randy Merker
Program Manager

Dale Doremus
Supervisor

Vacant
Geologist 3
Stephen Wust
Env. Spec.
Jeff Walker
WRS 2 (TEMP)

Susan Morris
Supervisor

Maura Hanning
WRS 3
David Trujillo
WRS 2

Laurie Varela
M.C. Operator
Jane Gonzales
Secretary 3
Rachael Tapia
Seasonal

M.A. Menetrey
Supervisor

Darren Padilla
WRS 2
Stuart Kent
WRS 2

RECORD OF TELEPHONE CONVERSATION

Time: 2:30 PM	Date: 11-19-93
Originating Party: Stuart Kent	Other Parties: Dave Shoemaker 586-0212 x3001
NMED - Superfund Program	Molycorp Site Manager

Subject: Switching of wells south of tailings pond to community water supply

Discussion:

+ When I last visited w/ Mr Shoemaker (10-29-93) he spoke of several wells below the ponds which had not been switched to community water

+ Today, he identified these wells:
  P-4 b well - Feliciano Ruel
  P-5 well - Danny Duran
  P-9 well - Delmirina Medina

+ These wells are currently, or have very recently (w/in weeks) being switched to community supply wells.

+ Recent analysis of water from these wells (sampled 9-27-93) show low sulfate, TDS levels

+ Mr. Shoemaker checked with waterboard & found that NO additional private wells are currently used below the tailings dams.

Stuart Kent

Signed

Reference 25

Randy Merker
Program Manager

Dale Doremus
Supervisor

Vacant
Geologist 3
Stephen Wust
Env. Spec.
Jeff Walker
WRS 2 (TEMP)

Susan Morris
Supervisor

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M.C. Operator
Jane Gonzales
Secretary 3
Rachael Tapia
Seasonal

M.A. Menetrey
Supervisor

Darren Padilla
WRS 2
Stuart Kent
WRS 2

RECORD OF TELEPHONE CONVERSATION

Time:	Date: 4-30-93
Originating Party: Stuart Kent	Other Parties: Ben Herrera
NMED - Superfund	Village of Questa Superintendent

Subject: Location of community wells + Public Supply wells in/near Questa

Discussion:

+ There are several community wells near or w/in town limits:

1) Adjacent to Village of Questa offices which is approx. 1 mile north of the cutoff to Red River (i.e. Hwy 38). Serves 10-15 houses

2) n Cerro de Oro (1/2 mile north of village office along Hwy 522); Serves 10-15 Hses

3) at Eagle Rock Lake where the well services ~ 10 trailers

+ The hotel located SW of town at Red River Bridge has its own well

+ All other residences serviced by public well incl. South of Hwy 522, east to Eagle Rock Trailer Park and north along Cabresto Rd to Forest Service Property

+ Town of Cerro has 3 community wells

Stuart Kent

Signed

N/A - Not Applicable
N/Av - Not Available
Est. - Estimated

NM Health and Environment Department
Environmental Improvement Division

Community Water Supply System

Inspection Form

Section A - GENERAL INFORMATION

SS CODE: 268-29	WATER SUPPLY SYSTEM NAME Village of Questa	COUNTY: Taos
		Inspection Date: May15, 1991

System Address/LOCATION P.O. Box 260, Questa, New Mexico 87556

WNER: Village of Questa	OWNER ADDRESS (if different than above) same	PHONE 586-0694

Population Served	# Connections	# Meters	Max. System Production	Average System Production
1644	560	447 meter in use	110-115,000 GPD Poten. [X] Actual [ ]	95,000 GPD

System Source (Check Approp. Boxes) Distribution Only [ ] Well(s) [X] # of Wells 3
Spring(s) [ ] Infiltration Gallery [ ] Surface [ ]

Additional or Qualifying Information:

See attached for water rates.

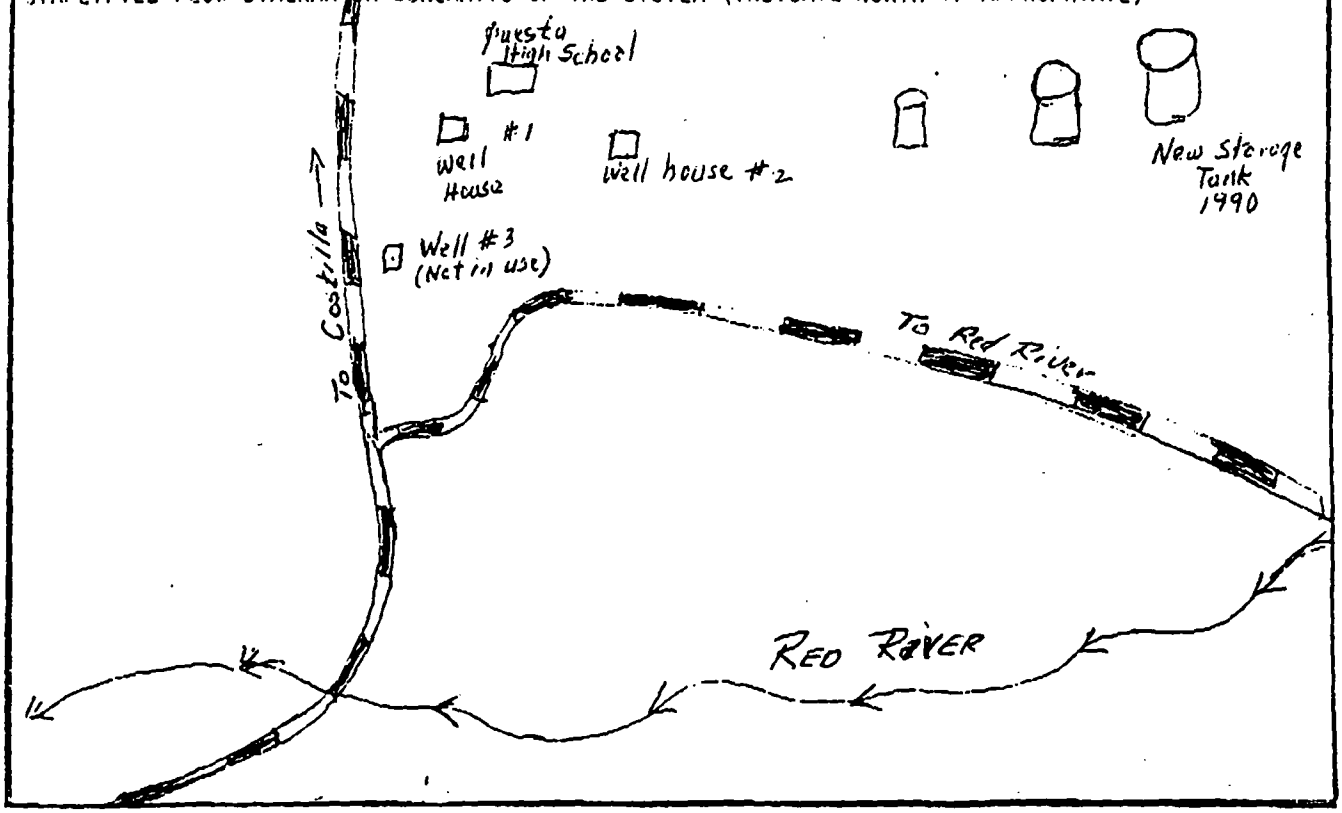
New storage tank installed in 1990.

System Personnel - Name/Classification	Level of Certification Required	Level of Certification Obtained
Lawrence Gallegos, Mayor	N/A	
Frank Rael, Administrator		
~~Michael Cordova,~~ Superintendent		
Lawrence Bailon, Maintenance		
Gloria Martinez, Utility Clerk		

Information furnished by:	Lawrence Bailon	Business Phone: 586-0694
Survey Performed by:	Juan P. Ortega	Business Phone: 758-8808

Section A (Continued)

SIMPLIFIED FLOW DIAGRAM OR SCHEMATIC OF THE SYSTEM (INDICATE NORTH IF APPROPRIATE)



Section B - Source Information

WELL Identification	Well Depth	Pump Depth	Pump Capacity GPM	Well Drawdown feet	Pump Type	Static Water Level	Age of Pump	Date Well Drilled
Well #1	250	200	100	N/Av	subm	N/Av	N/Av	1972
Well #2	400	350	25	N/Av	subm	N/Av	N/Av	1966
Well #3	300	250			subm	N/Av		

Remarks, Deficiencies, and Recommendations

Source	Number (each)	Total Capacity	Remarks, Deficiencies, and Recommendations
rtesian Wells	N/A		
prings	N/A		
nfiltration Galleries	N/A		

Section C - Gravity Storage and Pressure Tank Reservoirs

Gravity Storage Reservoir Indent.	Storage Capacity (gallons)	Date Built	Exterior Condition	Tank Material	Cathodic Protection	Tank Openings Secured	Overflow Screened	Vent Screen
Tank #1	100,000		good	steel	no	yes	yes	yes
Tank #2	50,000		good	steel	no	yes	yes	yes
Tank #3	25,000		good	steel	no	no	no	yes

Pressure Tank I.D.	Volume (gallons)	Age	Exterior Condition	Additional Information

Remarks, Deficiencies or Recommendations

Section D - WATER DISTRIBUTION

Booster Pump Stations	Total Number of Stations 1	Remarks, Deficiencies or Recommendations
Type of Disinfection Facilities		Remarks, etc.
System Pressure	Max. 65 psi Min. 50 psi	Remarks, etc.
Pipe Materials in system	PVC [X] STEEL [X] C.I. [ ] Other [X]	Deficiencies (including cross-connections observed) transite pipe
Type of Distribution System	Gravity [X]	Pressure [ ] Both [ ]

Contaminant	Next Sample Date	Sample Frequency	Remarks
Micro-biological		2/mo	
Turbidity			
Organics			
Inorganic	9/90		
Radiological	9/91		
Secondary			

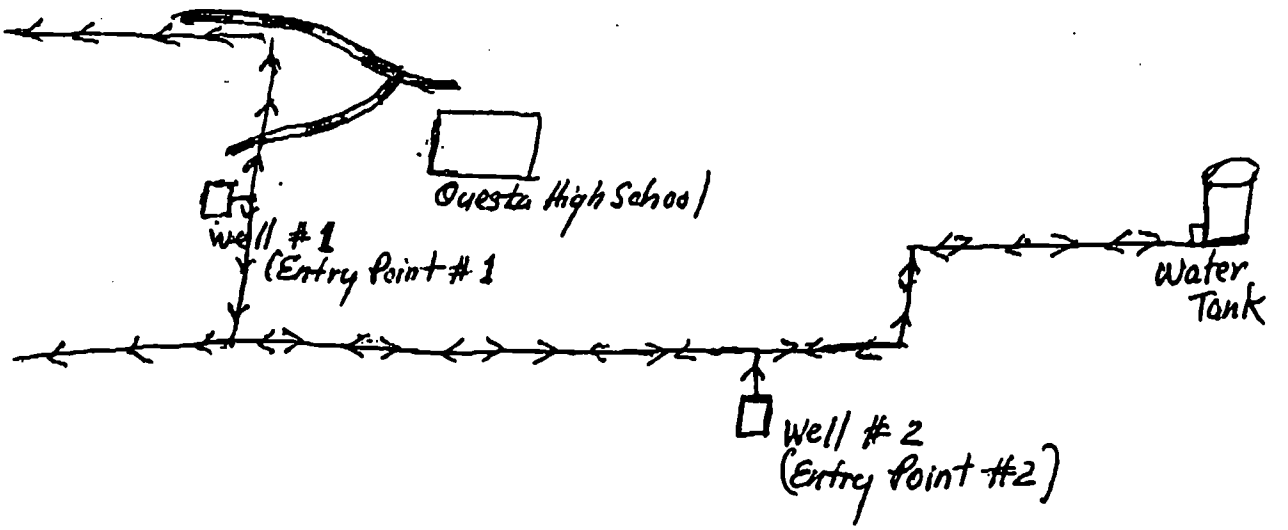
Section E - GENERAL OPERATION AND MAINTENANCE (O & M)

Does the system keep up-to-date O&M records?	Yes [X]	No [ ]
Are preventative maintenance activities routinely practiced?	Yes [X]	No [ ]
The importance of Cross Connection Control was discussed with the Operator	Yes [X]	No [ ]

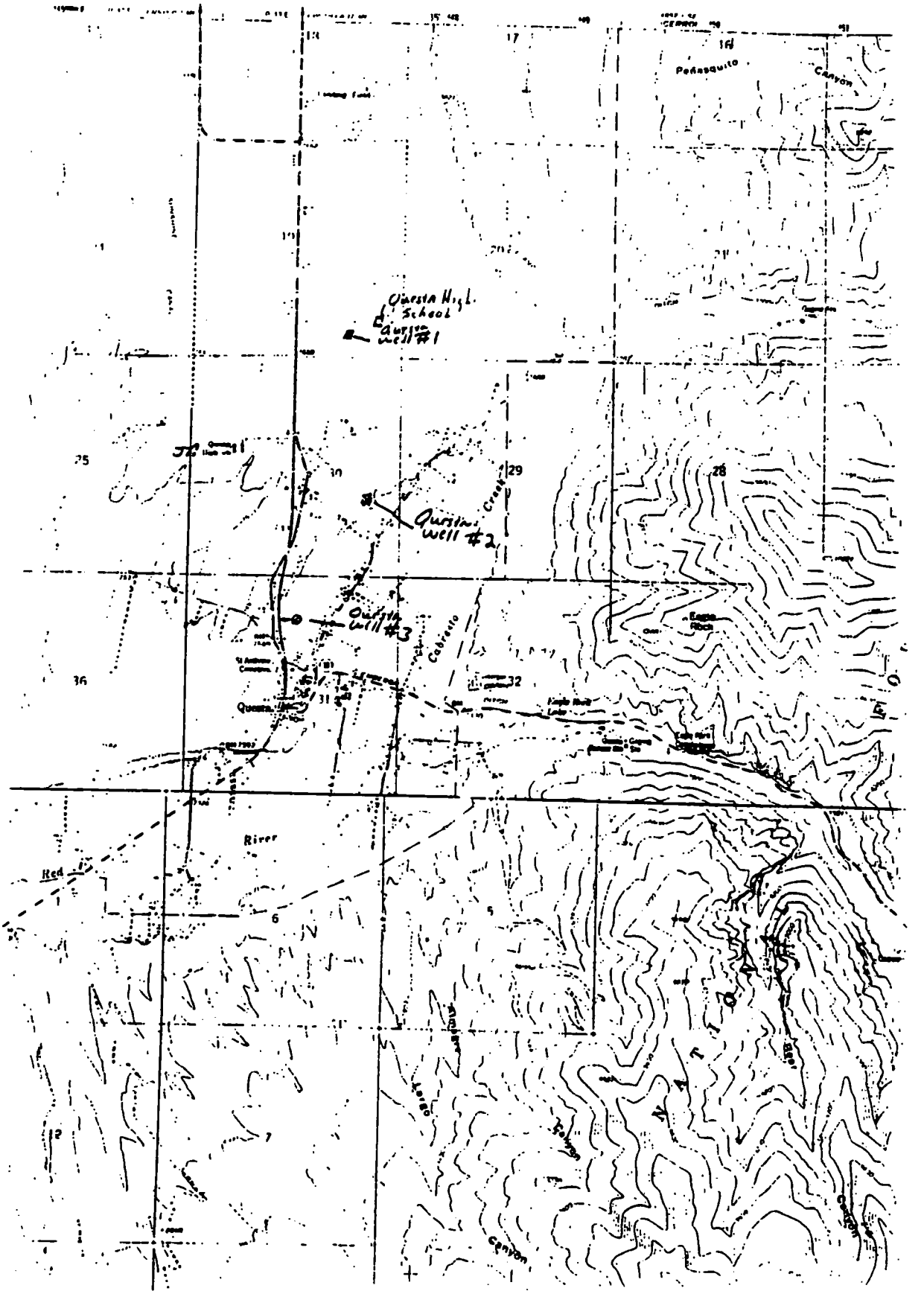
Indicate observed cross connections above (Pipe Materials in System)

Village of Questa
WSS # 068-29

Diagram for Entry Points:



...ED STATES
...T OF THE INTERIOR
...GICAL SURVEY



Reference 26

Randy Merker
Program Manager

Dale Doremus
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Seasonal

M.A. Menetrey
Supervisor

Darren Padilla
WRS 2
Stuart Kent
WRS 2

1990 CPH-1-33

1990 Census of Population and Housing

Summary Population and Housing Characteristics

New Mexico

Issued August 1991

U.S. Department of Commerce
Robert A. Mosbacher, Secretary
Rockwell A. Schnabel, Deputy Secretary

Economics and Statistics Administration
Michael R. Darby, Under Secretary
for Economic Affairs and Administrator

BUREAU OF THE CENSUS
Barbara Everitt Bryant, Director

CONTENTS

	Page
List of Statistical Tables	iv
How to Use This Census Report	I-1
Table Finding Guide	II-1
User Notes	III-1
Statistical Tables (For detailed list of statistical tables, see page iv.)	1

APPENDIXES

A. Area Classifications	A-1
B. Definitions of Subject Characteristics	B-1
C. Accuracy of the Data	C-1
D. Collection and Processing Procedures	D-1
E. Facsimiles of Respondent Instructions and Questionnaire Pages	E-1
F. Data Products and User Assistance	F-1
G. Maps	G-1

LIST OF STATISTICAL TABLES

[An asterisk (*) indicates that the table was omitted because there were no qualifying geographic areas or population groups]

Table		Page
1.	**Age: 1990** State County County Subdivision Place	1
2.	**Age: 1990** State County Place and [In Selected States] County Subdivision	7
3.	**Sex, Race, and Hispanic Origin: 1990** State County County Subdivision Place	11
4.	**Sex, Race, and Hispanic Origin: 1990** State County Place and [In Selected States] County Subdivision	17
5.	**Household, Family, and Group Quarters Characteristics: 1990** State County County Subdivision Place	21
6.	**Household, Family, and Group Quarters Characteristics: 1990** State County Place and [In Selected States] County Subdivision	25
7.	**Structural and Vacancy Characteristics: 1990** State County County Subdivision Place	28
8.	**Structural and Vacancy Characteristics: 1990** State County Place and [In Selected States] County Subdivision	32
9.	**Occupancy and Financial Characteristics for Owner-Occupied Housing Units: 1990** State County County Subdivision Place	35
10.	**Occupancy and Financial Characteristics for Owner-Occupied Housing Units: 1990** State County Place and [In Selected States] County Subdivision	39
11.	**Occupancy and Financial Characteristics for Renter-Occupied Housing Units: 1990** State County County Subdivision Place	42
12.	**Occupancy and Financial Characteristics for Renter-Occupied Housing Units: 1990** State County Place and [In Selected States] County Subdivision	46
13.	**Occupied Housing Units by Race and Hispanic Origin of Householder: 1990** State County County Subdivision Place	49
14.	**Occupied Housing Units by Race and Hispanic Origin of Householder: 1990** State County Place and [In Selected States] County Subdivision	53
15.	**Land Area and Population Density: 1990** State County County Subdivision Place	56
16.	**Land Area and Population Density: 1990** State County Place and [In Selected States] County Subdivision	58

Table 5. **Household, Family, and Group Quarters Characteristics: 1990**—Con.

For definitions of terms and meanings of symbols, see text

State / County / County Subdivision / Place	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Householder living alone: Total	65 years and over: Total	65 years and over: Female	Persons per— Household	Persons per— Family	Persons in group quarters: Total	Institutionalized persons	Other persons in group quarters
San Miguel County	24 454	8 701	6 405	4 486	1 408	2 296	1 980	757	522	2.81	3.31	1 289	444	845
Conchas Dam division	278	131	95	86	3	36	34	23	9	2.27	2.72	-	-	-
Mosquero village (pt.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Las Vegas division	18 792	6 735	4 906	3 310	1 199	1 829	1 589	503	429	2.79	3.30	1 289	444	845
Las Vegas city	14 220	5 131	3 655	2 322	1 017	1 476	1 299	495	365	2.73	3.27	733	112	621
Pecos division	3 452	1 165	894	729	126	271	212	63	44	2.96	3.40	-	-	-
Pecos village	1 012	335	261	217	40	74	60	14	9	3.02	3.43	-	-	-
Trementina division	238	115	73	67	6	42	40	21	9	2.07	2.60	-	-	-
Villanueva division	1 684	555	437	324	74	118	105	47	31	3.03	3.46	-	-	-
Santa Fe County	96 289	37 840	25 041	19 999	4 363	12 799	10 181	2 922	2 162	2.54	3.12	2 439	1 566	873
Santa Fe division	60 629	25 164	15 577	11 491	3 045	9 587	7 545	2 245	1 759	2.41	3.04	1 322	504	818
Agua Fria CDP	3 717	1 339	959	699	172	380	287	54	41	2.78	3.24	-	-	-
Santa Fe city (pt.)	54 225	22 741	13 898	10 177	2 804	8 843	7 061	2 147	1 687	2.38	3.02	816	504	312
Tesuque CDP (pt.)	12	2	2	2	-	-	-	-	-	6.00	6.00	-	-	-
Santa Fe North division	14 975	5 471	3 981	2 787	687	1 490	1 237	347	254	2.74	3.23	35	-	35
Chimayo CDP (pt.)	639	224	165	116	32	59	50	17	16	2.85	3.39	-	-	-
Cuyamungue CDP	329	117	92	78	12	25	18	3	3	2.81	3.18	-	-	-
Espanola city (pt.)	2 179	794	579	393	156	215	187	93	69	2.74	3.24	-	-	-
Jacona CDP	375	136	101	86	9	35	31	12	8	2.76	3.25	-	-	-
Nambe CDP	1 246	475	336	263	48	139	120	36	25	2.62	3.20	-	-	-
Pojoaque CDP	1 037	365	268	188	49	97	81	11	8	2.84	3.32	-	-	-
San Ildefonso Pueblo CDP	447	145	118	81	27	27	23	9	4	3.08	3.47	-	-	-
Santa Cruz CDP	2 504	821	665	500	107	156	124	30	19	3.05	3.37	-	-	-
Santa Fe city (pt.)	54	24	19	18	1	5	5	1	1	2.25	2.53	-	-	-
Tesuque CDP (pt.)	1 478	657	388	285	60	269	220	48	33	2.25	2.86	-	-	-
Santa Fe South division	20 685	7 205	5 483	4 511	631	1 722	1 299	230	149	2.87	3.29	1 282	1 162	120
Edgewood CDP (pt.)	2 880	943	800	722	49	143	117	36	29	3.05	3.35	-	-	-
Eldorado at Santa Fe CDP	2 260	838	647	573	54	191	130	16	10	2.70	3.01	-	-	-
La Cienega CDP	1 066	363	271	217	33	92	73	21	8	2.94	3.46	-	-	-
Santa Fe city (pt.)	30	24	19	17	-	5	4	1	-	3.33	3.74	184	184	-
Sierra County	9 569	4 428	2 834	2 380	335	1 594	1 460	891	553	2.16	2.72	343	254	89
Truth or Consequences East division	7 630	3 640	2 265	1 873	295	1 375	1 269	799	502	2.10	2.66	340	254	86
Truth or Consequences city	5 884	2 835	1 685	1 354	252	1 150	1 068	694	442	2.08	2.70	337	254	83
Williamsburg village	454	222	145	118	20	77	69	41	29	2.05	2.48	2	-	2
Truth or Consequences West division	1 939	788	569	507	40	219	191	92	51	2.46	2.93	3	-	3
Socorro County	14 333	5 217	3 705	2 933	554	1 512	1 254	404	267	2.75	3.31	431	113	318
Claunch division	122	46	34	30	3	12	10	1	-	2.65	3.12	-	-	-
Magdalena division	2 804	835	666	532	89	169	154	50	24	3.36	3.88	-	-	-
Magdalena village	861	304	230	181	37	74	69	26	14	2.83	3.36	-	-	-
Socorro city (pt.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rio Grande division	11 407	4 336	3 005	2 371	462	1 331	1 090	353	243	2.63	3.19	431	113	318
Socorro city (pt.)	7 769	3 015	2 035	1 560	359	980	791	262	187	2.58	3.15	390	72	318
Taos County	23 089	8 752	6 131	4 588	1 155	2 621	2 240	746	546	2.64	3.20	29	19	10
Arroyo Hondo division	2 679	1 053	696	546	103	357	276	67	43	2.54	3.13	-	-	-
Questa village (pt.)	8	5	3	3	-	2	2	1	-	1.60	2.00	-	-	-
Penasco division	1 257	434	323	258	47	111	102	44	30	2.90	3.47	-	-	-
Picuris division	1 882	640	493	350	107	147	134	69	47	2.94	3.41	-	-	-
Chamisal CDP	272	103	73	46	23	30	29	17	14	2.64	3.22	-	-	-
Penasco CDP	648	225	168	117	38	57	51	23	14	2.88	3.40	-	-	-
Vadito CDP	283	89	75	64	8	14	13	9	5	3.18	3.53	-	-	-
Questa division	3 376	1 229	926	763	122	303	271	90	68	2.75	3.24	-	-	-
Questa village (pt.)	1 699	575	454	364	68	121	107	43	32	2.95	3.40	-	-	-
Red River town	387	163	118	109	7	45	37	4	3	2.37	2.82	-	-	-
Taos division	11 226	4 437	2 991	2 185	624	1 446	1 231	392	297	2.53	3.12	29	19	10
Ranchos De Taos CDP	1 779	624	479	359	85	145	119	28	17	2.85	3.26	-	-	-
Taos town (pt.)	3 980	1 698	1 052	699	278	646	562	208	171	2.34	3.01	29	19	10
Taos Pueblo division	2 206	784	586	388	139	198	173	68	52	2.81	3.29	-	-	-
Taos town (pt.)	56	27	17	11	5	10	9	5	4	2.07	2.65	-	-	-
Taos Pueblo CDP	1 187	400	308	182	85	92	85	39	28	2.97	3.43	-	-	-
Tres Piedras division	453	175	116	98	13	59	53	16	9	2.59	3.28	-	-	-
Torrance County	10 272	3 670	2 785	2 312	330	885	771	321	217	2.80	3.26	13	13	-
Encino division	536	213	152	135	9	61	55	19	13	2.52	3.06	-	-	-
Encino village	131	50	39	34	3	11	11	7	3	2.62	3.08	-	-	-
Estancia division	8 018	2 806	2 169	1 805	250	637	543	207	136	2.86	3.29	13	13	-
Edgewood CDP (pt.)	444	156	122	110	8	34	30	4	3	2.85	3.30	-	-	-
Estancia town	779	308	216	155	45	92	86	51	38	2.53	3.08	13	13	-
Moriarty city	1 399	513	381	299	71	132	115	55	38	2.73	3.23	-	-	-
Mountainair division	1 718	651	464	372	71	187	173	95	68	2.64	3.20	-	-	-
Mountainair town	926	358	239	175	51	119	110	65	49	2.59	3.24	-	-	-
Willard village	183	70	47	39	6	23	21	11	8	2.61	3.36	-	-	-
Union County	4 069	1 615	1 150	956	146	465	439	242	179	2.52	3.07	55	55	-
Clayton North division	860	341	251	224	20	90	86	42	31	2.52	3.02	-	-	-
Clayton town (pt.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Des Moines village	168	71	46	41	4	25	24	10	7	2.37	3.04	-	-	-
Folsom village	71	32	19	15	4	13	12	5	4	2.22	2.79	-	-	-
Grenville village	24	10	7	7	-	3	3	2	2	2.40	3.00	-	-	-
Clayton South division	3 209	1 274	899	732	126	375	353	200	148	2.52	3.09	55	55	-
Clayton town (pt.)	2 429	989	670	523	116	319	301	179	134	2.46	3.08	55	55	-
Valencia County	43 897	15 170	11 992	9 631	1 689	3 178	2 626	1 049	756	2.89	3.27	1 338	1 336	2
Belen division	14 748	5 365	4 074	3 204	655	1 291	1 130	585	441	2.75	3.19	112	112	-
Belen city	6 435	2 310	1 711	1 214	396	599	534	258	199	2.79	3.29	112	112	-
Los Chaves CDP (pt.)	44	16	10	7	3	6	5	2	2	2.75	3.70	-	-	-
Los Trujillos-Gabaldon CDP (pt.)	1 841	622	495	399	58	127	107	51	38	2.96	3.33	-	-	-
Rio Communities CDP	3 233	1 356	1 014	878	108	342	305	201	163	2.38	2.78	-	-	-
Los Lunas division	29 149	9 805	7 918	6 427	1 034	1 887	1 496	464	315	2.97	3.32	1 226	1 224	2
Bosque Farms village	3 791	1 310	1 110	973	88	200	149	44	29	2.89	3.13	-	-	-
Isleta Pueblo CDP (pt.)	348	103	79	57	12	24	23	7	3	3.38	3.92	-	-	-
Los Chaves CDP (pt.)	3 828	1 301	1 062	936	104	239	189	62	39	2.94	3.28	-	-	-
Los Lunas village	5 936	2 059	1 602	1 124	374	457	364	115	84	2.88	3.27	77	77	-
Los Trujillos-Gabaldon CDP (pt.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meadow Lake CDP	1 590	519	401	343	33	118	96	31	19	3.06	3.51	-	-	-
Peralta CDP	3 182	1 111	892	757	97	219	174	67	43	2.86	3.22	-	-	-
Tome-Adelino CDP	1 695	573	461	379	63	112	94	31	27	2.96	3.31	-	-	-
Valencia CDP	3 907	1 289	1 060	979	117	229	177	53	34	3.03	3.34	10	10	-

Reference 27

TAILINGS DAM MONITOR WELLS

	DATE	PH	TDS	SO4	MO	F	PB	CD	ZN	MN	FE	CU
MW#1	5/13/92	7.7	1243	674	<.03	0.5	<.003	<.002	.014	.01	.050	<.005
MW#2	5/13/92	7.4	1506	762	1.78	0.9	<.003	<.002	.014	.04	.050	<.005
MW#3	5/13/92	7.5	1223	604	<.03	0.7	.014	<.002	.030	.01	<.050	.016
MW#4	5/13/92	7.5	929	493	0.09	2.8	<.003	<.002	.013	<.01	.050	<.005

PB AND CD ANALYSIS ARE GF/A

Reference 28

Molycorp, Inc.

Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

UNOCAL 76
MOLYCORP

November 2, 1993

Karen McCormack
Environment Department
Water Resource Specialist
Ground Water Section
P. O. Box 26110 - Runnels Bldg.
Santa Fe, NM 87502

Dear Ms. McCormack:

Enclosed are the analyses of the three private wells we recently sampled. When the analysis of MW-8 is complete, we will send you the results. If you have any questions, please call me at 586-0212, extension 3001.

Yours truly,

David R. Shoemaker
Mine Manager

DRS/bjd

enclosures

RECEIVED
NOV 05 1993
GROUND WATER BUREAU

Molycorp, Inc.
A Unocal Company
Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

UNOCAL 76
MOLYCORP

MONITOR WELL P4-B FELICIANO RAEL PRIVATE WELL
SAMPLED 9/27/93
NORTH SIDE EMBARGO ROAD

			NEW MEXICO WATER QUALITY STANDARDS
PH	7.5 (STANDARD UNITS)		PH 6-9 SU
SO4	(SULFATES) 97 PPM		SO4 600 PPM
TDS	(TOTAL DISSOLVED SOLIDS) 398 PPM		TDS 1000 PPM
MO	(MOLYBDENUM)	<.005 PPM	MO 1.0 PPM
FE	(IRON)	<.05 PPM	FE 1.0 PPM
MN	(MANGANESE)	<.01 PPM	MN 0.2 PPM
CD	(CADMIUM)	<.005 PPM	CD .010 PPM
CU	(COPPER)	.010 PPM	CU 1.0 PPM
PB	(LEAD)	<0.1 PPM	PB .05 PPM
F-	(FLUORIDE)	.45 PPM	F- 1.6 PPM
ZN	(ZINC)	.89	ZN 10.0 PPM

Molycorp, Inc.
A Unocal Company
Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

UNOCAL
MOLYCORP

MONITOR WELL P5 DANNY DURAN PRIVATE WELL
SAMPLED 9/15/93

				NEW MEXICO WATER QUALITY STANDARDS		
PH	7.7 (STANDARD UNITS)			PH	6-9 SU	
SO4	(SULFATES)	112	PPM	SO4	600	PPM
TDS	(TOTAL DISSOLVED SOLIDS)	276	PPM	TDS	1000	PPM
MO	(MOLYBDENUM)	<.005	PPM	MO	1.0	PPM
FE	(IRON)	0.08	PPM	FE	1.0	PPM
MN	(MANGANESE)	<.01	PPM	MN	0.2	PPM
CD	(CADMIUM)	<.005	PPM	CD	.010	PPM
CU	(COPPER)	<.01	PPM	CU	1.0	PPM
PB	(LEAD)	<.1	PPM	PB	.05	PPM
ZN	(ZINC)	.21	PPM	ZN	10.0	PPM
F-	(FLUORIDE)	.42	PPM	F-	1.6	PPM

MONITOR WELL FORMERLY
SAMUEL DURAN

Molycorp, Inc.
A Unocal Company
Questa Division
P.O. Box 469
Questa, New Mexico 87556
Telephone: (505) 586-0212

UNOCAL 76
MOLYCORP

MONITOR WELL P9 DELMIRIA MEDINA PRIVATE WELL
SAMPLED 9/17/93
EMBARGO ROAD

				NEW MEXICO WATER QUALITY STANDARDS		
PH	7.3 (STANDARD UNITS)			PH	6-9 SU	
SO4	(SULFATES)	94	PPM	SO4	600	PPM
TDS	(TOTAL DISSOLVED SOLIDS)	270	PPM	TDS	1000	PPM
MO	(MOLYBDENUM)	<.005	PPM	MO	1.0	PPM
FE	(IRON)	0.120	PPM	FE	1.0	PPM
MN	(MANGANESE)	<.143	PPM	MN	0.2	PPM
CD	(CADMIUM)	<.005	PPM	CD	.010	PPM
CU	(COPPER)	.01	PPM	CU	1.0	PPM
PB	(LEAD)	<.1	PPM	PB	.05	PPM
ZN	(ZINC)	.08	PPM	ZN	10.0	PPM
F-	(FLUORIDE)	.70	PPM	F-	1.6	PPM

Reference 29

GW-FEES 530340

Beginning in August of 1991 the Ground Water Section (GWS) began collecting fees to help fund the review of discharge permit applications by section staff. The GWS is responsible for reviewing, approving, monitoring, inspecting, renewing and modifying approximately 1000 permits for discharges of wastewater and other contaminants throughout New Mexico. The number of new permits which require action is increasing by approximately 20 percent each year and staffing levels have been cut each year, making it impossible for the GWS to comply with the regulatory requirements placed on the program by the Water Quality Control Commission (WQCC) Regulations.

The GWS is currently assigned 10 technical staff positions, one of which is federally funded for work on Underground Injection Control permits, which is a small subset of the total number of discharge plan applications. Each staff person is responsible for approximately 100 permits, which is approximately twice the workload that one person can reasonably handle. Additionally, one secretary is assigned to the GWS to handle fee collections, purchasing, typing, mail, and answering phones.

The GWS collected $123,000 in fees during FY81 and we expect that the amount of money collected will be approximately $120,000. The GWS requests that the budget for organizational code 530340 (GW Fees)be increased to reflect the amount of money collected and that line items for salaries and benefits and contracts be increased as follows:

Secretary 3 (currently employed by GWS in unauthorized, part-time, position)-To prepare public notices for publication as required by WQCC regulations. ($9197 + benefits).
Seasonal(currently employed by GWS in unauthorized position)-To assist the section's one secretary with clerical duties. ($12,190 + benefits).
Financial Specialist 4-To oversee fee collections, prepare budgets and other financial documents such as grant applications, track expenditures, etc. ($26,549 + benefits).

Currently, $25,600 is budgeted for term positions. However, an additional $9,400 is needed to maintain current term positions and $21,300 is needed for temporary staff positions.

Contract money in line item 053 is needed to pay for hearing officers who preside over public hearings mandated by the Water Quality Control Commission Regulations. The GWS requests that this line item be increased by $5300 to bring the amount available to $15,000. In general, the GWS conducts between 6 and 8 public hearings a year each of which costs between $1500 and $2000.

INTERIM STUDY OF THE ACIDIC DRAINAGE TO THE MIDDLE RED RIVER, TAOS COUNTY, NEW MEXICO

FOR

UNOCAL 76 MOLYCORP, INC.
QUESTA DIVISION

VAIL ENGINEERING, INC.
SANTA FE, NEW MEXICO

JULY 9, 1993

INTERIM STUDY OF THE ACIDIC DRAINAGE TO THE MIDDLE RED RIVER, TAOS COUNTY, NEW MEXICO

TABLE OF CONTENTS

Introduction and Summary	
Purpose	1
Background	1
Method of Investigation	2
Geological Setting	3
Mine Dumps	6
Ground Water Flow	7
Historical Data	8
Geochemical Overview	14
Red River Survey - pH	19
Red River Survey - Geochemical	21
Discussion	34
Temporal Variability of Mass Loading	38
Interception of Acidic Drainage	42
Storm Drainage	46
Summary	49
References	52
Appendices	

Most of the iron concentration is suspended matter. The significant fluctuation in iron concentration along the stream is attributed to oxidation and precipitation. Red staining by iron oxide is present along several reaches of Red River.

The zinc concentration at the Ranger Station ranged from .27 mg/l to .37 mg/l. The zinc concentration increased slightly in a downstream direction to Capulin Canyon with larger increases indicated along the lower reach.

Manganese concentrations were largely dissolved matter.

Discussion

For the purposes of discussion, we have divided the length of the Red River studied into four segments. Figure A shows the location of the prominent hydrothermal scars and the percentage of the total scar area along each segment.

1. Red River town to Molycorp mill area (stations 1 - 7). This reach is characterized by low accretion to the river and widespread scar and mud flow areas on the north and the smaller June Bug Creek scar on the south. Pioneer Creek, Mallette Creek, Bitter Creek, and Hansen Creek are intermittent flowing tributary streams in this reach. Below Hanson Creek, springs are the only significant source of acidic water and aluminum. Mildly acidic water enters the river in the town area, but no precipitate was observed there.

This reach contains approximately 45% of the middle Red River stream length and about 50% of the hydrothermal scar area.

Approximately 40% of the flow in Red River at the Ranger Station, during periods when the flow is less than 40 cfs, originates above the Town of Red River. The stream

water above the Town has a high pH, and concentrations of aluminum, sulfate and other constituents are very low. About 34% of the flow accretion to the middle Red River occurs in the vicinity of the Town of Red River and another 7%± originates from springs and seepage flow from below the Town to above Molycorp's mill area.

For Molycorp's surveys the gain in aluminum along this reach ranged from 24 to 28% of the total gain above the ranger station and the gain in sulfate ranged from 27 to 34% of the total. There was, however, a significant variation in the location of the accretions between the segment in the vicinity of the Town and the segment from below the Town to above the mill. Approximately one-half of the gain in both aluminum and sulfate along this reach appears to originate from drainage below the hydrothermal scar areas in the vicinity of Hansen Creek. Hansen Creek has surface flows on the order of 20 to 30 gpm at pH 3.5 during much of the time. The surface flows often extend all the way to the Red River.

2. Mill area to Columbine Creek (sample stations 8 - 11). This area contains the upstream mine dumps. There are a few acidic springs, notably at Sulfur Gulch, but little aluminum precipitate. Columbine Creek (sample 9), flowing from the south, is near the west end of this reach. Water quality in Columbine Creek is non-acidic with very low aluminum and sulfate concentrations. Chambers Spring, flowing from the south, discharges a small flow of moderately alkaline water to the river near the west end of the mill area. The river was generally relatively clear over this reach.

This reach extends over approximately 23% of the length of the middle Red River survey area. About 25% of the original hydrothermal scar area is drained along this reach

including Sulfur Gulch which probably was one of the most active of the scar areas. An estimated 25% of the total stream flow accretion along the middle Red River accrues along this reach which includes about 19% flowing from Columbine Creek.

Aluminum gains along this reach ranged from 7% of the total at the Ranger Station in 1988 to 13% in 1992 and 11% in 1993. Sulfate gains ranged from 18% in 1988 to 36% in 1992 and 26.6% in 1993. Most of both the aluminum and sulfate gain originated near the westerly end of this reach. Springs located along this reach on the north side of Red River had slightly acidic water (ph > 5.0).

3. Above Goathill Gulch to below Capulin Canyon (sample stations 12 - 14).

This reach extends along approximately 23% of the middle Red River survey area. Approximately 21% of the hydrothermal scar area including Goat Hill Gulch and Capulin Canyon, drain to Red River along this reach. The mine dumps at the heads of these drainages contain the majority of the altered rock material placed in the mine dumps. An estimated 6.3% of the total accretion to middle Red River occurs along this reach. This includes flow from Bear Canyon, a small non-acidic intermittent creek flowing from the south and the Goat Hill and Capulin drainages which had surface flow extending nearly to Red River a significant amount of the time until the flow was intercepted by Molycorp's activities.

Aluminum gain along this reach increased from 30.6% of the total in 1988 to 39.5% in 1992 and then decreased to 25.5% in 1993. Sulfate gain decreased from 41% in 1988 to 22% in 1992 and then increased to 32.5% in 1993. There was a significant variability between the three Molycorp surveys along this reach; however, all surveys indicated that

there was a significantly higher aluminum gain from the Capulin drainage than the Goat Hill drainage and less sulfate gain from the Capulin than the Goat Hill drainage. In 1988 and 1992 the aluminum gain from Goat Hill was about 12% of the total at the ranger station. In 1993 the survey indicated a slight decrease in aluminum in this reach. In the reach below Capulin Canyon the aluminum gain was 19% in 1988, 28% in 1992 and about 25% in 1993. Sulfate gain in the Goat Hill reach was 28% of the total at the ranger station in 1988; 11% in 1992 and 25% in 1993. Sulfate gain in the Capulin reach was about 12% in 1988 and 1992 and 7% in 1993.

There apparently is a significant difference in the drainage between Capulin Canyon and Goat Hill Gulch. The seeps and springs below Capulin are considerably more acidic resulting in higher aluminum transportation relative to the sulfate loading which is similar to that indicated from the drainage below Capulin to the ranger station. Drainage from Goat Hill Gulch is less acidic and more like the drainage from the scar areas upstream from the mill.

4. Below Capulin Canyon to Questa Ranger Station.

The downstream segment of the river is relatively short (.85 miles or 8% of the length of the river studied) and contains only 4% of the hydrothermal scar area. The acidity of the springs and seeps along this reach was generally lower and the aluminum gains generally higher than any of the other stream reaches. In this reach the pH of the river dropped to as low as 6.8 owing to the presence of many small acidic springs (pH 3.5 to 4.5). The greatest increase in cloudiness of the river was along this reach and the alkalinity was the lowest. Accretion to stream flow was low here as well (Figure 1). Taken together, these observations indicate that a small flow of very low

pH water carries concentrated amounts of metals to the river. Many small springs were observed in this area, mostly at pH 3.5 to 4.5. The solubility of aluminum increases 50-fold between pH 5.0 and 4.0, (Figure C) more than compensating for the low ground water flow.

The source of aluminum accretion from this segment is in all likelihood the small altered area which lies above the river on the north. Conditions here seem to favor generation of low pH waters. The altered area is rocky, fractured and not deeply weathered, which promotes infiltration of precipitation. The area is close to the river and no live streams are present. Consequently, the opportunity for dilution is diminished.

The aluminum gain along this reach was 38.6% of the total gain to the ranger station in 1988, 21% in 1992 and 36% in 1993. The sulfate gain was 14% in 1988, 9% in 1992 and 7% in 1993. The largest gains in zinc, copper and other trace metals occur along this reach. Accretions of aluminum and acid in the reaches upstream have raised the river to near saturation level, so that the large additions in the lower reach must precipitate rather than staying dissolved. This results in the greatest amount of turbidity occurring along this reach.

Temporal Variability of Mass Loading

There are significant variations over time in both concentration and total discharge of aluminum and sulfate in the Red River. Analysis of the available data, part of which is shown in Table 4, has led to development of reasonable correlations between aluminum and sulfate variations and variations in surface and ground water flow.

The primary controls on water chemistry are the quantity and source areas of surface and ground water discharge. Stream flow resulting from snow melt at higher elevations

Reference 30

RECORD OF TELEPHONE CONVERSATION

Time: 9.10	Date: 7-9-93
Originating Party: Stuart Kent	Other Parties: Ken McCallum (505) 758-8808
NMED - Superfund	NMED - Taos Dist. office

Subject:

Surface water intakes along Red River & Rio Grande

Discussion:

+ No surface water intakes exist within (15-mile Target Distance Limit) Red River & Rio Grande near Taos & above

+ Use of water from acequias for drinking is unlikely, Not documented

Stuart Kent

Signed

Reference 31

RECORD OF TELEPHONE CONVERSATION

Time: 3:15 PM	Date: 7-9-92
Originating Party: S Kent	Other Parties: George Lopez Assistant Chief of Fisheries
NMED - SuperFund	NM Game + Fish (505) 827-7905

Subject:

+ Fisheries on ~~Rio River~~ Red River + Rio Grande

Discussion:

+ Brown + Rainbow fisheries exist just below Fish Hatchery
Brown Trout Fry stocked once per year in Red River + Rio Grande

+ Red River is fished "pretty heavily" ~~up to~~ fished up to Molycorp mine

+ Stocked fish caught at >9 inch length + kept (ie eaten)

+ Red River is also stocked approx. bi-weekly below town at Red River + at USFS campgrounds

Signed

Reference 32

GW-GF 530110

The Ground Water Section (GWS) is responsible for reviewing, approving, monitoring, inspecting, renewing and modifying approximately 1000 permits for discharges of wastewater and other contaminants throughout New Mexico. The number of new permits which require action is increasing by approximately 20 percent each year and funding and staffing levels have been cut each year, making it impossible for the GWS to comply with the regulatory requirements placed on the program by the Water Quality Control Commission Regulations.

The GWS is currently assigned 10 technical staff positions, one of which is federally funded for work on Underground Injection Control permits, which is small subset of the total number of discharge plan applications. Each staff person is responsible for approximately 100 permits, which is approximately twice the workload that one person can reasonably handle. Because of the burden placed on staff, few site inspections have been completed over the last few years. Of the 1000 permits issued, only 50 percent have been inspected during the last year. Additionally, approximately 100 permits have expired, although the discharge is continuing, and staff have been unable to conduct the necessary work to renew the permits. Two additional staff positions are needed to conduct inspections of permitted facilities and to help process applications.

The FY82 general fund budget for the organizational code 530110, which includes the Bureau Chief and Administrative Secretary positions for the Ground Water Protection and Remediation Bureau, as well as two permanent positions in the Liquid Waste Section, is approximately $236,800 short of funds necessary to cover current permanent positions. Therefore, the attached request also includes an $236,800 increase in line-item 002 and a $71,000 increase in category 010, but no corresponding request for additional positions. A list of current staff is attached.

RECORD OF TELEPHONE CONVERSATION

Time: 2:30 PM	Date: 7-10-93
Originating Party: Stuart Kent - WRS II	Other Parties: Gene Santistevin - Wildlife Cultivist
NMED - Superfund	Red River Fish Hatchery (505) 586-0222

Subject:

Fish Production in Red River

Discussion:

+ Annual production for hatchery is ~ 300,000 lbs

+ Stocking of Red River occurs between May + Sept & is bi-weekly (ie everyother week)

+ Stocking fish are of catchable size (> 9")

+ Each tank load of fish (catchable) has approx 2,000 fish with 2 fish/lb, that equals 1,000 lbs per stocking event

Calc + May thru Sept. ≈ 22 weeks or 11 stocking events

11 stocking events/yr x 1,000 lbs/event = 11,000 lbs/yr

+ Stocking also occurs on Rio Grande at Taos Jnct. [this is beyond 15-mile target distance limit]

+ Winter stocking of Brown Trout fingerlings (2"-3") also occurs at basis from hatchery site but lbs/yr was unknown (by this individual)

+ Victor Trujillo is Hatchery Manager

Stuart Kent

Signed

Reference 33

ERMITTEE NAME/ADDRESS (Include Facility Name/Location if different)
AME MOLYCORP INC. QUESTA DIV.
DDRESS P. O. BOX 469
QUESTA NM 87556
ACILITY
OCATION
ATTN: DAVID R SHOEMAKER, GEN. SUPT.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
DISCHARGE MONITORING REPORT (DMR)

(2-16) NM0022300 PERMIT NUMBER
(17-19) 002 A DISCHARGE NUMBER

MAJOR
F - FINAL
SEEPAGE TAILING IMPOUNDMENT

Form Approved.
OMB No. 2040-0004.
Approval expires 6-30

MONITORING PERIOD
FROM YEAR 93 (20-21) MO 05 (22-23) DAY 01 (24-25) TO YEAR 93 (26-27) MO 05 (28-29) DAY 31 (30-31)

*** NO DISCHARGE |__| ***
NOTE: Read instructions before completing this form.

PARAMETER (32-37)		QUANTITY OR LOADING (46-53) AVERAGE	QUANTITY OR LOADING (54-61) MAXIMUM	UNITS	QUALITY OR CONCENTRATION (46-53) MINIMUM	QUALITY OR CONCENTRATION (46-53) AVERAGE	QUALITY OR CONCENTRATION (54-61) MAXIMUM	UNITS	NO. EX (62-65)	FREQUENCY OF ANALYSIS (66-68)	SAMPLE TYPE (69-70)
COPPER, TOTAL (AS CU) 01042 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	LESS THAN 0.01	.013	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	0.15 DAILY AV	0.30 DAILY MX			ONCE/ MONTH	COMP
IRON, TOTAL (AS FE) 01045 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.120	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	******	0.6 DAILY MX			WEEKLY	COMP
LEAD, TOTAL (AS PB) 01051 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT			( ) MG/L		LESS THAN 0.1	LESS THAN 0.1	( ) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	0.3 DAILY AV	0.6 DAILY MX			ONCE/ MONTH	COMP
MANGANESE, TOTAL (AS MN) 01055 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.41	1.49	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	REPORT DAILY AV	REPORT DAILY MX			ONCE/ MONTH	COMP
MOLYBDENUM, TOTAL (AS MO) 01062 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	2.12	2.17	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	REPORT DAILY AV	REPORT DAILY MX			ONCE/ MONTH	COMP
ZINC, TOTAL (AS ZN) 01092 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	.023	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	**** ****	******	******	0.2 DAILY MX			ONCE/ MONTH	COMP
FLOW, IN CONDUIT OR THRU TREATMENT PLANT 50050 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	0.360	0.384	(03) MGD	******	******	******	( )	0	DAILY	EST
	PERMIT REQUIREMENT	REPORT DAILY AV	REPORT DAILY MX	MGD	******	******	******	**** ****		DAILY	EST

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
David R. Shoemaker
Mine Manager
TYPED OR PRINTED

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED HEREIN AND BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION I BELIEVE THE SUBMITTED INFORMATION IS TRUE, ACCURATE AND COMPLETE. I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION, INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT. SEE 18 USC § 1001 AND 33 USC § 1319 (Penalties under these statutes may include fines up to $10,000 and/or maximum imprisonment of between 6 months and 5 years.)

David R. Shoemaker
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: AREA CODE 505, NUMBER 586-0212 EXT. 3001

DATE: YEAR 93, MO 06

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

[redacted] PERMIT PART III FOR FURTHER REQUIREMENTS.
[redacted] SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM EXCEPT IN TRACE AMOUNTS.
[redacted] PROL SPEC 8.1.

[redacted] (Rev. 6-88) Previous editions may be used. (REPLACES EPA FORM T-40 WHICH MAY NOT BE USED.)

Facility Name/Location (if different)
NAME: MO[redacted]CORP INC. QUESTA DIV.
ADDRESS: P. O. BOX 469
QUESTA NM 87556
FACILITY
LOCATION
ATTN: DAVID R SHOEMAKER, GEN. SUPT.

DISCHARGE MONITORING REPORT (DMR)

(2-16) NM002230[redacted] — PERMIT NUMBER
(17-19) 002 A — DISCHARGE NUMBER

MAJOR

Form Approved.
OMB No. 2040-000[redacted]
Approval expires 10-31-94

F - FINAL
SEEPAGE TAILING IMPOUNDMENT

MONITORING PERIOD

FROM YEAR (20-21)	MO (22-23)	DAY (24-25)	TO YEAR (26-27)	MO (28-29)	DAY (30-31)
93	04	01	93	04	30

*** NO DISCHARGE |__| ***

NOTE: Read instructions before completing this form.

PARAMETER (32-37)		(3 Card Only) (46-53) QUANTITY OR LOADING (54-61) AVERAGE	MAXIMUM	UNITS	(4 Card Only) (38-45) QUALITY OR CONCENTRATION (46-53) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-72)
COPPER, TOTAL (AS CU) 01042 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	.011	.014	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	ONCE/MONTH	COMP
IRON, TOTAL (AS FE) 01045 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	.071	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	COMP
LEAD, TOTAL (AS PB) 01051 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	[redacted]	LESS THAN 0.1	LESS THAN 0.1	(19) MG/L	[redacted]	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	ONCE/MONTH	COMP
MANGANESE, TOTAL (AS MN) 01055 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.61	1.63	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX		[redacted]	ONCE/MONTH	COMP
MOLYBDENUM, TOTAL (AS MO) 01062 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	2.17	2.41	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX		[redacted]	ONCE/MONTH	COMP
ZINC, TOTAL (AS ZN) 01092 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	.009	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	******	******	*** ****	[redacted]	[redacted]	0.2 DAILY MX		[redacted]	ONCE/MONTH	COMP
FLOW, IN CONDUIT OR THRU TREATMENT PLANT 00050 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	0.364	0.364	(03) MGD	******	******	******	( )	0	DAILY	ESTI
	PERMIT REQUIREMENT	REPORT DAILY AV	REPORT DAILY MX	MGD	[redacted]	[redacted]	[redacted]	**** ****	[redacted]	DAILY	ESTI

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER
David R. Shoemaker
Mine Manager
TYPED OR PRINTED

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED HEREIN AND BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION I BELIEVE THE SUBMITTED INFORMATION IS TRUE ACCURATE AND COMPLETE I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT SEE 18 USC § 1001 AND 33 USC § 1319 (Penalties under these statutes may include fines up to $10,000 and or maximum imprisonment of between 6 months and 5 years)

SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: AREA CODE 505 — NUMBER 586-0212 EXT 3001

DATE: YEAR 93 — MO 05 — D 1

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

SEE PERMIT PART III FOR FURTHER REQUIREMENTS.
THERE SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM EXCEPT IN TRACE AMOUNTS.
~~EXCEPTS FROM SUPP. 8.1~~

EPA Form 3320-1 (Rev. 9-88) Previous editions may be used. (REPLACES EPA FORM T-48 WHICH MAY NOT BE USED.)

00059/920401-1734

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

DISCHARGE MONITORING REPORT (DMR)

Facility Name/Location (if different)
NAME [redacted]CORP INC. QUESTA DIV.
ADDRESS P.O. BOX 469
[redacted] NM 87559
FACILITY
LOCATION

(2-16) NM0022[redacted] — PERMIT NUMBER
(17-19) 002 A — DISCHARGE NUMBER

MAJOR
F - FINAL
SEEPAGE TAILINGS [redacted]

Form Approved. OMB No. 2040-[redacted]

MONITORING PERIOD
FROM YEAR 93 MO 03 DAY 01 TO YEAR 93 MO 03 DAY 31

*** NO DISCHARGE |__| ***

NOTE: Read instructions before completing this form.

TYP: BATCH & SECONDARY, GEN. SUPP.

PARAMETER (32-37)		(3 Card Only) (46-53) QUANTITY OR LOADING (54-61) AVERAGE	MAXIMUM	UNITS	(4 Card Only) (38-45) QUALITY OR CONCENTRATION (46-53) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPL TYPE (69-70)
OPPER, TOTAL (AS CU) 1042 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	LESS THAN 0.01	LESS THAN 0.01	(19) MG/L	0	1/WK	COMPOS
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	[redacted]	[redacted]	MG/L	[redacted]	ONCE/ MONTH	COMPO
ON, TOTAL (AS FE) 1045 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.147	(19) MG/L	0	1/WK	COMPOS
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	[redacted]	[redacted]	MG/L	[redacted]	[redacted]	COMPO
EAD, TOTAL (AS PB) 1051 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	LESS THAN 0.1	LESS THAN 0.1	(19) MG/L	[redacted]	1/WK	COMPOS
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	[redacted]	[redacted]	MG/L	[redacted]	ONCE/ MONTH	COMPO
ANGANESE, TOTAL (AS MN) 1055 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.43	1.46	(19) MG/L	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX	MG/L	[redacted]	ONCE/ MONTH	COMPO
OLYBDENUM, TOTAL (AS MO) 1062 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	2.19	2.28	(19) MG/L	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX	MG/L	[redacted]	ONCE/ MONTH	COMPO
INC, TOTAL (AS ZN) 1092 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.031	(19) MG/L	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	**** ****	[redacted]	[redacted]	0.2 DAILY MX	MG/L	[redacted]	ONCE/ MONTH	COMPO
LOW, IN CONDUIT OR THRU TREATMENT PLANT 0050 1 0 0 FFLUENT GROSS VALUE	SAMPLE MEASUREMENT	0.374	0.383	(03) MGD	******	******	******	( ) **** ****	0	DAILY	ESTIM
	PERMIT REQUIREMENT	REPORT DAILY AV	REPORT DAILY MX	MGD	[redacted]	[redacted]	[redacted]		[redacted]	DAILY	ESTIM

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER

David R. Shoemaker
Mine Manager

TYPED OR PRINTED

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED HEREIN AND BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION I BELIEVE THE SUBMITTED INFORMATION IS TRUE ACCURATE AND COMPLETE I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT SEE 18 USC § 1001 AND 33 USC § 1319 (Penalties under these statutes may include fines up to $10,000 and/or maximum imprisonment of between 6 months and 5 years)

David R. Shoemaker
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: AREA CODE 505 — NUMBER 586-0212 EXT 3001

DATE: YEAR 93 — MO 04 — DAY 08

AMENTS AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

E PERMIT PART III FOR FURTHER REQUIREMENTS.
HERE SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM EXCEPT IN TRACE AMOUNTS.
SCHARGE FROM SEEP # 1.

(Form 3320-1 (Rev. 9-88) Previous editions may be used. (REPLACES EPA FORM T-49 WHICH MAY NOT BE USED.)

00056/920801-1730

Facility Name/Location (if different)
NAME M[redacted]CORP INC. QUESTA DIV.
ADDRESS P. O. BOX 469
QUESTA NM 07556

FACILITY
LOCATION
ATTN: DAVID R SHOEMAKER, GEN. SUPT.

DISCHARGE MONITORING REPORT (DMR)

(2-16) NM00223[redacted] — PERMIT NUMBER
(17-19) 002 A — DISCHARGE NUMBER

MAJOR

Form Approved.
OMB No. 2040-00[redacted]
Approval expires [redacted]

F - FINAL
SEEPAGE TAILING IMPOUNDMENT

MONITORING PERIOD	YEAR	MO	DAY		YEAR	MO	DAY
FROM	93	02	01	TO	93	02	28
	(20-21)	(22-23)	(24-25)		(26-27)	(28-29)	(30-31)

*** NO DISCHARGE |__| ***

NOTE: Read instructions before completing this form

PARAMETER (32-37)		(3 Card Only) (46-53) QUANTITY OR LOADING (54-61) AVERAGE	MAXIMUM	UNITS	(4 Card Only) (38-45) QUALITY OR CONCENTRATION (46-53) MINIMUM	AVERAGE	(54-61) MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAM TYP (69-
COPPER, TOTAL (AS CU) 01042 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	0.01	0.024	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
IRON, TOTAL (AS FE) 01045 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.162	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
LEAD, TOTAL (AS PB) 01051 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	Less Than 0.1	Less Than 0.1	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
MANGANESE, TOTAL (AS MN) 01055 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.48	1.76	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX		[redacted]	ONCE/ MONTH	[redacted]
MOLYBDENUM, TOTAL (AS MO) 01062 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	2.26	2.39	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	REPORT DAILY AV	REPORT DAILY MX		[redacted]	ONCE/ MONTH	[redacted]
ZINC, TOTAL (AS ZN) 01092 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.021	(19) MG/L	0	1/WK	COMP
	PERMIT REQUIREMENT	[redacted]	[redacted]	*** ****	[redacted]	[redacted]	0.2 DAILY MX		[redacted]	ONCE/ MONTH	[redacted]
FLOW, IN CONDUIT OR THRU TREATMENT PLANT 50050 1 0 0 EFFLUENT GROSS VALUE	SAMPLE MEASUREMENT	0.379	0.418	(03) MGD	******	******	******	( ) **** ****	0	DAILY	EST
	PERMIT REQUIREMENT	REPORT DAILY AV	REPORT DAILY MX	MGD	[redacted]	[redacted]	******		[redacted]	DAILY	EST.

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER

David R. Shoemaker
Mine Manager

TYPED OR PRINTED

I CERTIFY UNDER PENALTY OF LAW THAT I HAVE PERSONALLY EXAMINED AND AM FAMILIAR WITH THE INFORMATION SUBMITTED HEREIN AND BASED ON MY INQUIRY OF THOSE INDIVIDUALS IMMEDIATELY RESPONSIBLE FOR OBTAINING THE INFORMATION I BELIEVE THE SUBMITTED INFORMATION IS TRUE ACCURATE AND COMPLETE I AM AWARE THAT THERE ARE SIGNIFICANT PENALTIES FOR SUBMITTING FALSE INFORMATION INCLUDING THE POSSIBILITY OF FINE AND IMPRISONMENT SEE 18 USC § 1001 AND 33 USC § 1319 (Penalties under these statutes may include fines up to $10,000 and or maximum imprisonment of between 6 months and 5 years)

David R. Shoemaker
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE: AREA CODE 505 — NUMBER 586- 0212 EXT. 3001

DATE: YEAR 93 — MO 03

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

SEE PERMIT PART III FOR FURTHER REQUIREMENTS.
THERE SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM EXCEPT IN TRACE AMOUNTS.
~~NO DISCHARGE FROM SPEP # 1.~~

(Name/Location if different)
ES MOLYCORP INC. QUESTA DIV.
DRESS P. O. BOX 469
QUESTA NM 87556
CILITY
CATION
TN: DAVID R SHOEMAKER, GEN. SUPT.

DISCHARGE MONITORING REPORT (DMR)

(2-16) NM0022306 — PERMIT NUMBER
(17-19) 002 A — DISCHARGE NUMBER

MAJOR

Form Approved.
OMB No. 2040-0004

F - FINAL
SEEPAGE TAILINGS IMPOUNDMENT

MONITORING PERIOD

FROM YEAR (20-21)	MO (22-23)	DAY (24-25)	TO YEAR (26-27)	MO (28-29)	DAY (30-31)
93	01	01	93	01	31

*** NO DISCHARGE |__| ***

NOTE: Read instructions before completing this form.

PARAMETER (32-37)		(3 Card Only) (46-53) QUANTITY OR LOADING (54-61) AVERAGE	MAXIMUM	UNITS	(4 Card Only) (38-45) QUALITY OR CONCENTRATION (46-53) MINIMUM	AVERAGE	MAXIMUM	UNITS	NO. EX (62-63)	FREQUENCY OF ANALYSIS (64-68)	SAMPLE TYPE (69-70)
PPER, TOTAL (AS CU) .042 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	LESS THAN 0.01	LESS THAN 0.01	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	******	******	MG/L		ONCE/ MONTH	COMPO
ION, TOTAL (AS FE) .045 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	0.161	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	******	******	MG/L		WEEKLY	COMPO
AD, TOTAL (AS PB) .051 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	LESS THAN 0.1	LESS THAN 0.1	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	******	******	MG/L		ONCE/ MONTH	COMPO
NGANESE, TOTAL (AS MN) .055 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.60	1.64	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	REPORT DAILY AV	REPORT DAILY MX	MG/L		ONCE/ MONTH	COMPO
LYBDENUM, TOTAL (AS MO) .062 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	1.95	2.09	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	REPORT DAILY AV	REPORT DAILY MX	MG/L		ONCE/ MONTH	COMPO
NC, TOTAL (AS ZN) .092 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	******	******	( ) MG/L	******	******	.023	(19)	0	1/WK	COMPO
	PERMIT REQUIREMENT	******	******	*** ****	******	******	.052 DAILY MX	MG/L		ONCE/ MONTH	COMPO
OW, IN CONDUIT OR RU TREATMENT PLANT .050 1 0 0 FLUENT GROSS VALUE	SAMPLE MEASUREMENT	0.374	0.390	(03) MGD	******	******	******	( )	0	DAILY	ESTIM
	PERMIT REQUIREMENT	REPORT DAILY AV	REPORT DAILY MX	MGD	******	******	******	**** ****		DAILY	ESTIM

NAME/TITLE PRINCIPAL EXECUTIVE OFFICER

David R. Shoemaker
Mine Manager

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David R Shoemaker
SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT

TELEPHONE AREA CODE	NUMBER	DATE YEAR	MO	DAY
505	586 7601	93	02	11

MENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here)

E PERMIT PART III FOR FURTHER REQUIREMENTS.
ERE SHALL BE NO DISCHARGE OF FLOATING SOLIDS OR VISIBLE FOAM EXCEPT IN TRACE AMOUNTS.
~~SCHARGE FROM SEEP # 1~~

Reference 34

RECORD OF TELEPHONE CONVERSATION

Time: 3:00	Date: 2-1-94
Originating Party: Stuart Kent 827-0037	Other Parties: Victor Trujillo (505) 586-0222
NMED	Red River Hatchery Mngr

Subject: Water Supply at Hatchery

Discussion:

+ Hatchery constructed in 1940's

+ He's unsure when the 2nd spring was tapped into as a water source
(Mr Trujillo has been at hatchery for ~10 yrs)

+ Currently, approx. 8,000 gpm (gal/min) comes from springs
- Bulk of which comes from spring 1/4 mi. upstream
" 6,000 gpm comes from Red River

+ No fish kills have occurred at hatchery since he's been manager (even when Molycorp spills had been reported)

+ Sample collection (for analysis) is realistically only possible at junction (collection) box - not at the springs

Stuart Kent

Signed

Reference 35

GW-FEES 530340

Beginning in August of 1991 the Ground Water Section (GWS) began collecting fees to help fund the review of discharge permit applications by section staff. The GWS is responsible for reviewing, approving, monitoring, inspecting, renewing and modifying approximately 1000 permits for discharges of wastewater and other contaminants throughout New Mexico. The number of new permits which require action is increasing by approximately 20 percent each year and staffing levels have been cut each year, making it impossible for the GWS to comply with the regulatory requirements placed on the program by the Water Quality Control Commission (WQCC) Regulations.

The GWS is currently assigned 10 technical staff positions, one of which is federally funded for work on Underground Injection Control permits, which is a small subset of the total number of discharge plan applications. Each staff person is responsible for approximately 100 permits, which is approximately twice the workload that one person can reasonably handle. Additionally, one secretary is assigned to the GWS to handle fee collections, purchasing, typing, mail, and answering phones.

The GWS collected $123,000 in fees during FY81 and we expect that the amount of money collected will be approximately $120,000. The GWS requests that the budget for organizational code 530340 (GW Fees)be increased to reflect the amount of money collected and that line items for salaries and benefits and contracts be increased as follows:

Secretary 3 (currently employed by GWS in unauthorized, part-time, position)-To prepare public notices for publication as required by WQCC regulations. ($9197 + benefits).
Seasonal(currently employed by GWS in unauthorized position)-To assist the section's one secretary with clerical duties. ($12,190 + benefits).
Financial Specialist 4-To oversee fee collections, prepare budgets and other financial documents such as grant applications, track expenditures, etc. ($26,549 + benefits).

Currently, $25,600 is budgeted for term positions. However, an additional $9,400 is needed to maintain current term positions and $21,300 is needed for temporary staff positions.

Contract money in line item 053 is needed to pay for hearing officers who preside over public hearings mandated by the Water Quality Control Commission Regulations. The GWS requests that this line item be increased by $5300 to bring the amount available to $15,000. In general, the GWS conducts between 6 and 8 public hearings a year each of which costs between $1500 and $2000.

RECORD OF TELEPHONE CONVERSATION

Time: 10:00	Date: 6-16-93
Originating Party: Stuart Kent	Other Parties: Mrs. Perry US Post office
NMED - Superfund	Questa

Subject: # of people in Cerro

Discussion:

+ She used to work in the Cerro Postoffice

+ She wasn't sure of the total population but did say there were 144 mail boxes

Signed

Reference 36

GW-FEES 530340

Beginning in August of 1991 the Ground Water Section (GWS) began collecting fees to help fund the review of discharge permit applications by section staff. The GWS is responsible for reviewing, approving, monitoring, inspecting, renewing and modifying approximately 1000 permits for discharges of wastewater and other contaminants throughout New Mexico. The number of new permits which require action is increasing by approximately 20 percent each year and staffing levels have been cut each year, making it impossible for the GWS to comply with the regulatory requirements placed on the program by the Water Quality Control Commission (WQCC) Regulations.

The GWS is currently assigned 10 technical staff positions, one of which is federally funded for work on Underground Injection Control permits, which is a small subset of the total number of discharge plan applications. Each staff person is responsible for approximately 100 permits, which is approximately twice the workload that one person can reasonably handle. Additionally, one secretary is assigned to the GWS to handle fee collections, purchasing, typing, mail, and answering phones.

The GWS collected $123,000 in fees during FY81 and we expect that the amount of money collected will be approximately $120,000. The GWS requests that the budget for organizational code 530340 (GW Fees)be increased to reflect the amount of money collected and that line items for salaries and benefits and contracts be increased as follows:

Secretary 3 (currently employed by GWS in unauthorized, part-time, position)-To prepare public notices for publication as required by WQCC regulations. ($9197 + benefits).
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PARAMETER	AMBIENT BACKGROUND 1.	
	Western PPM U.S. 2.	Eastern PPM U.S. 2.
Matrix type	Soil	Soil
Aluminum	58,000	33,000
Antimony	.47	.52
Arsenic	5.5	4.8
Barium	580	290
Beryllium	0.68	0.55
Cadmium	1	1
Calcium	18,000	3,200
Chromium	41	33
Cobalt	7.1	5.9
Copper	21	13
Iron	21,000	14,000
Lead	17	14
Magnesium	7,800	2,300
Manganese	380	260
Mercury	0.046	0.081
Nickel	15	11
Potassium		
Selenium	.23	.30
Silver	-	-
Sodium	10,000	2,600
Thallium	9.1	7.7
Tin	.90	.96
Vanadium	70	43
Zinc	55	40
Cyanide		
Station No.	1. Values obtained from "Element Concentrations Soils and Other Surface Materials of the Conterminous United States", dated 1984. U.S.G.S. Professional Paper 1270.	
Sample Station Location		
:-indicates	2. Reference for East/ West Division is the 96 W longitudinal line which bisects Region VI.	
3-spike samp		
'-duplicate		

10/31/85

CONCENTRATIONS IN PPM

Reference 37

GW-FEES 530340

Beginning in August of 1991 the Ground Water Section (GWS) began collecting fees to help fund the review of discharge permit applications by section staff. The GWS is responsible for reviewing, approving, monitoring, inspecting, renewing and modifying approximately 1000 permits for discharges of wastewater and other contaminants throughout New Mexico. The number of new permits which require action is increasing by approximately 20 percent each year and staffing levels have been cut each year, making it impossible for the GWS to comply with the regulatory requirements placed on the program by the Water Quality Control Commission (WQCC) Regulations.

The GWS is currently assigned 10 technical staff positions, one of which is federally funded for work on Underground Injection Control permits, which is a small subset of the total number of discharge plan applications. Each staff person is responsible for approximately 100 permits, which is approximately twice the workload that one person can reasonably handle. Additionally, one secretary is assigned to the GWS to handle fee collections, purchasing, typing, mail, and answering phones.

The GWS collected $123,000 in fees during FY81 and we expect that the amount of money collected will be approximately $120,000. The GWS requests that the budget for organizational code 530340 (GW Fees)be increased to reflect the amount of money collected and that line items for salaries and benefits and contracts be increased as follows:

Secretary 3 (currently employed by GWS in unauthorized, part-time, position)-To prepare public notices for publication as required by WQCC regulations. ($9197 + benefits).
Seasonal(currently employed by GWS in unauthorized position)-To assist the section's one secretary with clerical duties. ($12,190 + benefits).
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Currently, $25,600 is budgeted for term positions. However, an additional $9,400 is needed to maintain current term positions and $21,300 is needed for temporary staff positions.

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Co	-186.594	179.781	ppm
Ni	86.5185	55.6418	ppm
Cu	10.7992	30.2410	ppm
Zn	19.8703	25.7406	ppm
As	9.41859	18.8919	ppm
Se	28.9752	12.5576	ppm
Sr	225.372	10.2555	ppm
Zr	265.587	9.61697	ppm
Mo	0.733950	3.22548	ppm
Hg	-5.40480	23.0698	ppm
Pb	20.1290	11.3091	ppm
Rb	112.559	8.88320	ppm
Cd	-41.5073	81.2589	ppm
Sn	98.6266	50.5231	ppm
Sb	0.468923	30.1034	ppm
Ba	773.457	29.2220	ppm

X-ray Fluorescence analysis of various soil samples (unpublished data)

Application:SOIL SAMPLES Q018 07-11-1992
Meas Time: 2-MAR-1993 14:53:50
ID: <MSG> MOLY CORP - Red River *
( ) ( )

= Mine Waste 1 (Table 1)

Values rounded to nearest 10.

	Value	Std. dev.	
CrHI	24.9889	182.980	ppm
K	21588.9	578.080	ppm
Ca	20400.5	396.201	ppm
Ti	2594.16	170.005	ppm
CrLO	106.461	118.642	ppm
Mn	*593.346	216.529	ppm
Fe	36975.9	621.300	ppm
Co	-282.004	189.325	ppm
Ni	56.0871	57.3137	ppm
Cu	*138.798	37.5383	ppm
Zn	*33.7475	26.0724	ppm
As	-46.1900	20.6094	ppm
Se	-10.5267	10.5688	ppm
Sr	538.685	15.9632	ppm
Zr	191.704	9.27871	ppm
Mo	*203.926	7.33142	ppm
Hg	-22.8480	22.4021	ppm
Pb	*83.5371	14.6324	ppm
Rb	139.989	9.96128	ppm
Cd	87.4035	89.4807	ppm
Sn	113.541	54.3615	ppm
Sb	-36.1587	32.0163	ppm
Ba	932.750	32.5882	ppm

Application:SOIL SAMPLES Q018 07-11-1992
Meas Time: 2-MAR-1993 15:02:58
ID: <PK> PIONEER CREEK - RED RIVER *
( ) ( )

	Value	Std. dev.	
CrHI	101.150	174.195	ppm
K	31744.3	686.440	ppm
Ca	1073.91	181.017	ppm
Ti	1361.82	129.850	ppm
CrLO	105.594	112.392	ppm
Mn	427.528	196.920	ppm
Fe	26819.7	524.698	ppm
Co	297.003	174.838	ppm
Ni	*85.4429	56.3489	ppm

	Value	Std. dev.	
CrHI	42.4738	198.503	ppm
K	25296.7	615.950	ppm
Ca	1518.09	176.100	ppm
Ti	3010.22	175.430	ppm
CrLO	121.666	116.484	ppm
Mn	-153.657	188.488	ppm
Fe	37619.7	618.443	ppm
Co	*277.023	199.926	ppm
Ni	14.7182	62.5410	ppm
Cu	28.4800	31.8257	ppm
Zn	23.9460	26.0196	ppm
As	*53.8249	20.3996	ppm
Se	-0.656631	11.1668	ppm
Sr	294.446	11.7518	ppm
Zr	334.023	10.8951	ppm
Mo	*547.379	11.5421	ppm
Hg	-39.6870	21.3237	ppm
Pb	*18.0403	11.1430	ppm
Rb	136.780	9.71154	ppm
Cd	74.8416	84.5013	ppm
Sn	11.3614	49.8094	ppm
Sb	-6.36759	31.0669	ppm
Ba	1130.50	35.2094	ppm

Application:SOIL SAMPLES Q018 07-11-1992
Meas Time: 2-MAR-1993 15:14:39
ID: <MPM> MOLY CORP - Red River
( ) ( )

= Mine Waste 2 (in Table 1)
Values to nearest 10

	Value	Std. dev.	
CrHI	483.996	209.098	ppm
K	14777.5	487.022	ppm
Ca	15689.6	344.143	ppm
Ti	2188.81	152.591	ppm
CrLO	144.403	110.836	ppm
Mn	1026.98	242.764	ppm
Fe	36864.9	609.014	ppm
Co	-195.773	187.712	ppm
Ni	-6.90709	54.2077	ppm
Cu	*137.390	36.2756	ppm
Zn	*238.610	33.5880	ppm
As	-52.8151	19.8688	ppm
Se	-11.9512	9.92491	ppm
Sr	702.129	18.0064	ppm
Zr	157.283	8.94893	ppm
Mo	*342.236	9.07643	ppm
Hg	-56.5115	19.4666	ppm
Pb	*87.4616	14.4952	ppm
Rb	126.655	9.47699	ppm
Cd	41.1273	74.5037	ppm
Sn	-42.1786	42.3568	ppm
Sb	-11.7772	27.0827	ppm
Ba	686.949	27.4819	ppm

Application:SOIL SAMPLES Q018 07-11-1992
Meas Time: 2-MAR-1993 14:47:48
ID: <ESRR> EROSIONAL SCAR ABV FAWN LAKES - Red River ★
( ) ( )

= Background sample (in Table 1)

	Value	Std. dev.	
CrHI	236.850	183.791	ppm
K	30924.4	678.370	ppm
Ca	4896.23	242.897	ppm
Ti	2302.02	159.897	ppm
CrLO	-172.555	109.899	ppm
Mn	335.344	203.086	ppm
Fe	32800.6	582.513	ppm

Erosional Scar - Red River ★

Ti	2627.79	171.661	ppm
CrLO	-159.118	108.296	ppm
Mn	1358.14	261.133	ppm
Fe	71818.3	861.157	ppm
Co	159.122	269.509	ppm
Ni	38.4598	67.6866	ppm
Cu	156.927	41.5943	ppm
Zn	165.968	34.2086	ppm
As	23.7369	23.3625	ppm
Se	-5.67792	11.3008	ppm
Sr	178.413	10.2407	ppm
Zr	71.9337	6.37176	ppm
Mo	11.5076	3.22765	ppm
Hg	25.1498	27.8180	ppm
Pb	53.2387	14.6178	ppm
Rb	22.8689	6.47717	ppm
Cd	-5.90106	99.3768	ppm
Sn	120.843	60.8043	ppm
Sb	60.1327	37.9576	ppm
Ba	181.000	18.4674	ppm

Application:SOIL SAMPLES Q018 07-11-1992
Meas Time: 2-MAR-1993 14:30:37
ID: <AC1> ALAMITOS CANYON
( ) ( )

	Value	Std. dev.	
CrHI	-271.445	166.612	ppm
K	4558.88	298.505	ppm
Ca	5783.97	213.447	ppm
Ti	633.456	87.8495	ppm
CrLO	168.800	94.5817	ppm
Mn	-360.336	213.201	ppm
Fe	104242	1034.92	ppm
Co	827.404	327.784	ppm
Ni	-163.353	75.3834	ppm
Cu	1237.46	86.4135	ppm
Zn	304.019	43.5576	ppm
As	-724.168	126.912	ppm
Se	10.1025	17.5199	ppm
Sr	10.3308	5.18844	ppm
Zr	58.8934	6.22133	ppm
Mo	-0.174310	2.97636	ppm
Hg	-30.0854	31.6898	ppm
Pb	5346.41	105.175	ppm
Rb	7.87106	7.77275	ppm
Cd	65.9059	94.9099	ppm
Sn	-31.2312	54.4962	ppm
Sb	25.8526	15.3741	ppm

Reference 38

APPENDIX B

RESPONSE TO "SUMMARY STATEMENT" PRESENTED BY QUESTA BOARD OF EDUCATION

March,1982

RESPONSE TO "SUMMARY STATEMENT" PRESENTED

BY QUESTA BOARD OF EDUCATION

INTRODUCTION & CONCLUSIONS

Molycorp has worked with the New Mexico Environmental Improvement Division (EID), the Questa Council and the Questa Board of Education for several years to inform concerned parties on the dust control program, and to determine if potential hazards exist with blowing tailings dusts. All study information collected to date, including one contracted by the Questa Board of Education in mid-1981, indicates that there is no potential for health problems associated with the tailings dusts. While this dust is a nuisance problem during periods of strong wind, no chronic health problems have been associated with it.

Molycorp's dust control program, including wetting of the tailings, chemical stabilization and reclamation is well documented. The continued research on the problem has been addressed in the past, and is discussed further in this report.

There have been substantial improvements to the dust control program in recent years. The current surfactant spraying

program with newly purchased equipment has resulted in a 30 percent reduction in airborne particulates in 1980-81 as reported by the EID.

Previous tailings pond management planning, which called for early completion of Section 36 tailings disposal is being further studied as a result of discussions with the school board. If design approval is obtained from the State Engineer's office, it would be possible to complete and revegetate the northern portion of Section 36 (within 3/4 miles of the school) by late 1984 or early 1985.

A BRIEF HISTORY OF TAILINGS DISPOSAL

During the feasibility studies for the open pit operations the issue of tailings disposal was considered carefully. Because of the steep terrain around the mill operations, tailings disposal was one of the major technical considerations in planning the mine. Several studies were undertaken to determine the best location of the tailings impoundment and to develop a plan of operations. The Questa location was chosen because it offered stability and flexibility for construction and the closest economic site to the mine.

Several consulting engineers were called in to analyze the site and design before construction started. In the summer of 1964, work on the site began so the new mill could start up in

January, 1965. Tailings have been discharged into the area almost continuously since that time.

From 1974 through 1976, an additional study was performed by outside consultants and in-house experts to evaluate long range tailings disposal sites. The study evaluated many areas such as the present open pit, which had to be rejected due to its proximity to the underground mine; an area near Llama; the canyon above the fish hatchery; Cerro; the present area of Sections 35 and 36; and the Guadalupe saddle. The study found that the only workable alternative was to utilize the existing site to its designed capacity and gradually transfer the tailings disposal facilities to the Guadalupe saddle area.

Tailings disposal is one of the costliest aspects of a milling operation. There are many engineering, safety and environmental aspects which have to be considered. The Questa disposal site has been designed for construction in stages; a starter dam is begun, the area behind the dam is filled with tailings, and the dam is then raised to provide more tailings disposal. The Section 36 area, nearest to Questa, is currently undergoing construction for the final stage of the impoundment.

The impoundment has been monitored and studied continuously since before the initial construction. Various experimental

projects have been undertaken to ensure that the tailings are managed in the safest possibly way.

Among the many analyses done at the tailings impoundment are seismic and stability studies, water flow, water quality and rainwater run-off studies and reclamation testwork. In addition, water and air quality in the vicinity of the impoundment is monitored. From 1969, when Pope Lake was constructed, until the mill shut-down in mid 1981, a trout population was maintained to ensure that decanted water from the disposal system would not adversely affect fish life.

Reclamation testwork began in early 1970's. Since that time, more than 100 acres of tailings have been reclaimed, demonstrating that the impoundment can be left as useful, productive land after closure. The entire impoundment will be reclaimed upon closure. Reclamation involves capping the tailings with local borrow material and seeding with grass species. In 1982, more than 50 acres will be seeded to prevent dust problems in exposed areas.

Fugitive dust emission control has long been studied. Tailings dust is not an uncommon problem in the mining industry and Molycorp has studied methods used at other operations to control it. In 1977 advice was sought from the U.S. Bureau of Mines to assist in dust control measures. The Bureau

recommended the use of chemical stabilizers. Several test areas were established to determine the most effective stabilizer or "surfactant". By 1979 a dust control system using the chemical stabilizer recommended by the Bureau of Mines was in use. This stablizer is sprayed on dried tailings forming a crust, holding down dust particles which would otherwise be picked up by the wind. Over the past two years, major improvements have been made in the dust control program. New technology has been developed. A modified agricultural sprayer purchased in 1981 to spray stablizer has increased the program's efficiency substantially. This machine sprays areas which can be sources of dust but are otherwise inaccessible due to the nature of the tailings.

The sprayer system was adapted from one designed to apply agricultural chemicals on fields with the minimum amount of surface disturbance. Fully loaded, the machine has a surface bearing pressure of 10-15 pounds per square inch, less than that of the average person. Several modifications of the agricultural system were required to enable use of the machine for dust control. It is not known what is meant by the "Summary Paper" comment that the vehicle "cannot 'free wheel' through even those areas that are accessible". Molycorp invites the school board to observe the sprayer in operation; the vehicle is not underpowered and has proven to be a suitable vehicle for spraying the inactive portion of the tailings ponds.

Research is continuing on dust control program. New chemical stabilizers are being tested, reclamation testwork is ongoing and new technological developments are being considered for use in the program. During 1981, the cost of the chemical stablizer was about $300,000. As shown from Molycorp's past record, changes in the program are readily made when studies demonstrate their feasibility.

The existing tailings disposal facilities do not have sufficient capacity for the expected life of the new underground mine. Molycorp is currently investigating methods and locations for future disposal to ensure continous operation of the new mine and mill. Section 36, the area closest to Questa, is expected to be completely closed in by 1990, and the area will be capped with borrow material and revegetated.

Future plans for the impoundment will be discussed in detail later in this report.

DISCUSSION OF DATA

Over the past several years, many analyses of the tailings have been made. They have been interpreted by many individuals with respect to toxicity and health standards. None of the studies by EID, Union Oil and Dr. Freeark, College of Santa Fe, who interpreted the Summary Statement results, identified any

tailings constituent at a concentration which would cause health problems.

At the time the school board collected its sample of tailings, Molycorp collected a "split" sample, i.e. one taken at the same time and location. Split samples are routinely used in analytical chemistry as a quality control check. The Molycorp sample was sent to Camp, Dresser & McKee (CDM), a consulting laboratory in Denver, for analysis. Although CDM performed the tailings analysis by a different method than that used by the Colorado School of Mines Research Institute, the results should not differ significantly.

The results of the split sample are shown in Table I. The two parameters where the greatest discrepancy occurred were arsenic and selenium. Mr. Larry Tisdel from the School of Mines Research saved the sample and reanalyzed it for those two parameters. The second analysis, done in duplicate, was considerably lower than the first reading. Mr. Tisdel's report is attached. As can be seen from the analysis, neither arsenic nor selenium are in high concentration, as was first reported.

One other parameter requiring explanation is Total Organic Carbon (TOC). The TOC value represents all organic carbon in the sample. Its source is unidentified by this analysis and could come from many things. As Dr. Freeark pointed out in his

report to Mr. Archuleta, any plant or animal material contains high concentrations of TOC. Fertilizer and top soil contribute to TOC. Mill reagents contain organic carbons. So does the dust control surfactant. Mill reagents containing organic carbons are added in the mill at a combined rate of less than 0.3#/ton of ore. If all reported to the tailings pond, the maximum in the tailings would be less than 150 parts/million. The organic reagents are added as collectors in the flotation process. Thus the bulk of them report with the molybdenum concentrate and do not reach the tailings pond.

When asked by Mr. Archuleta to interpret the results, Dr. Freark concluded that there were no obvious health problems associated with the tailings. He stated that "the data indicated that on the whole, Questa air is very good when compared to OSHA and NMEID Standards. Furthermore, there appears to be little or no problems associated with TSP originating from the Molycorp tailings". Dr. Freeark's report is attached.

A copy of a portion of the 1979-80 NMEID Annual Air Quality Report is also attached. This chart compares air quality of various New Mexico communities and shows that air quality in Questa is superior to many areas of New Mexico. The mean total suspended particulates in Questa in 1980 was well below state standards; more than half of the communities monitored in the

state, including Taos, have averages which exceed the state standard for mean particulates.

FUTURE PROJECTS

Monitoring of the dust concentrations in the air probably will continue by EID. It has set up a special monitor at the high school to measure the amount of particles in the air which are less than 15 microns and could be taken into the lungs. In addition, air filters from the school monitor will be analyzed to determine the chemical makeup of the dust that is collected. The direct determinations could be compared to health standards. Earlier data about the chemical constituents of the dust is available from EID.

Studies aimed at improving Molycorp's dust control program are continuing. Significant progress is being made, as the EID data suggests. The 1980-81 dust levels show about 1/3 reduction over 1979 levels.

Molycorp is reviewing new technology to further control dust; it has developed special equipment for use in the program. Every conceivable control method is being considered. One method currently being evaluated is accelerated closure of the north end of Section 36, which is close to the high school.

Construction at Section 36 is underway and will continue through the summer of 1982. Design modifications are being studied to determine whether the construction at the north end could be completed in 1983 instead of 1985 so that the area near the high school can be closed early. The north third of Section 36 could be capped and revegetated by about 1986 if approval for the design and associated construction modifications are approved by the State Engineer.

Since the existing tailings impoundment does not have enough capacity to enable operations for the life of the underground operations, new sites are now under consideration. The entire tailings pond nearest the high school is expected to be closed prior to 1990. The Guadalupe saddle west of the existing ponds appears the most promising for future tailings disposal. To ensure continuous operation of the mine without shut-down and employee layoff, it is hoped that a new site can be permitted and developed within the next few years.

CONCLUSION

Tailings disposal is a necessary adjunct of all milling operations. Many different factors govern the design and operation of a tailings impoundment. The Environmental Protection Agency, the NM Environmental Improvement Division, the NM State Engineer, Mine Safety and Health Administration,

the Bureau of Land Management and other agencies have regulations concerning tailings disposal. It is a dynamic operation which often undergoes many changes from original design.

All information collected to date indicates that there is no potential for health problems associated with the tailings dust. While this dust is a nuisance problem during periods of strong wind, no chronic health problems have been associated with it. Monitoring of the dust will continue by EID to add to the data base.

Molycorp is studying the possibility of accelerating the closure of the north end of Section 36. This would require redesigning the dams and obtaining a special permit from the State Engineer's office. It is hoped that the feasibility of accelerated closure can be determined by the end of April.

The suggestion made on the "Summary Report" for a committee to address the dust problem is good; Molycorp is prepared to name a person or persons to such a committee at any time. The further suggestion at the January 19 meeting that efforts be made to complete the area of the tailings pond nearest the high school as rapidly as possible is being investigated.

We appreciate the concern of the Questa Board of Education and will continue to make every effort to alleviate the problems of tailings dust.

Enclosures:
1. Split Sample Results, Table I
2. CSMRI Report by L. Tisdel, 1/25/82
3. Report from Dr. C. Wayne Freeark to G. Archuleta, 11/1/81
4. New Mexico EID Annual Air Quality Report 1979-1980

TABLE I

SPLIT SAMPLE RESULTS

	School Board Dry Sample	Moly Dry Sample	School Board Wet Sample	Moly Wet Sample
Aluminum (Al)	63,000	>10,000	65,000	>10,000
Arsenic (As)	8*	2.7	3*	1.1
Barium (Ba)	<50	740	<50	740
Boron (B)	6	1.3	12	1.3
Cadmium (Cd)	<10	.28	<10	.44
Calcium (Ca)	18,900	>10,000	20,300	>10,000
Chromium (Cr)	60	87	80	87
Cobalt (Co)	35	8.9	37	18
Copper (Cu)	140	94	200	150
Iron (Fe)	29,300	>10,000	31,900	>10,000
Lead (Pb)	90	180	80	70
Magnesium (Mg)	8,300	10,000	10,300	>10,000
Manganese (Mn)	620	490	500	770
Mercury (Hg)	<0.5	NR	<0.5	NR
Molybdenum (Mo)	290	130	210	87
Nickel (Ni)	40	5.6	50	12
Potassium (K)	39,900	>10,000	39,700	>10,000
Selenium (Se)	<5*	4.7	<5*	2.7
Silver (Ag)	10	5.5	5	.45
Sodium (Na)	20,400	10,000	19,800	>5,000
Uranium (U)	<10	2.3	<10	1.7
Vanadium (V)	<40	50	60	50
Zinc (Zn)	240	98	210	170
Carbonate (CO_3)	7,300		15,100	
Chloride (Cl^-)	4,100		1,900	
Chlorine (Cl)		24		51
Cyanide (CN)	<1	<0.4	<1	<0.4
Fluoride (Fl^-)	2,200		1,000	
Fluorine (Fl)		4,500		>5,000
Silica (SiO_2)	665,000		632,000	
Silicon (Si)		>10,000		>10,000
Sulfide (H_2S)	6,470		5,750	
Sulfate (SO_4)	5,440	>1,000	7,790	1,000
Total Organic Carbon (TOC)	2,000	600	1,100	1,000
Tin (Sn)				
Tungsten (W)				
Bismuth (Bi)				
Thallium (TI)				

* Corrected by Colorado School of Mines

Colorado School of Mines Research Institute

P.O. BOX 112 • GOLDEN, COLORADO 80402
PHONE (303) 279-2581 • TWX 910-934-0194 • CSM Res Gldn

CSMRI

REPLY T
Environmental Technology Divis
5920 McIntyre Stre
Golden, Colorado 80

February 25, 1982
CSMRI Project J20205

Ms. Cindy Stark
Molycorp Inc.
P.O. Box 469
Questa, New Mexico 87556

Dear Ms. Stark:

Our analytical laboratory has completed their work on re-analyzing the two tailings samples for arsenic and selenium. These two samples were originally submitted by Mr. G.A. Archuleta in June of 1981. The samples have been in storage at our facilities since that time.

For this re-analysis work, each sample was blended, and a new representative portion was split out. Then, as before, the representative portion was dried, pulverized, and blended prior to analysis.

The original analysis results and the re-analysis results are compared as follows:

	original analysis results reported 7/22/82		re-analysis results reported 2/18/82	
	"dry sample"	"wet sample"	"dry sample"	"wet sample"
Arsenic, ppm	400	450	8	3
Selenium, ppm	50	100	<5	<5

From the information that you have furnished by telephone, it appears that the re-analysis results from our analytical laboratory are comparable to those which you have had performed on similar material.

A copy of a memorandum from our laboratory supervisor is attached which reports on both the original and the recent analytical work on the two samples. From this report, it appears that a mixup in samples material may have occurred in our analytical laboratory during the original work.

On the basis of the re-analysis results, arsenic concentrations, and possibly selenium concentrations, now appear to be in the same general range as average or typical literature values for various rock types and soils. This is the converse of our interpretation of the original laboratory analysis data.

Ms. Cindy Stark
Molycorp Inc.
February 25, 1982
Page 2

We are sending a copy of this letter to Mr. Archuleta, and we hope that this new analysis data will be of assistance in resolving problems which may have occurred due to the original erroneous analytical laboratory results.

Very truly yours,

Lawrence Tisdel
Project Manager
Environmental Technology Division

/laj
Attach.

cc: Mr. G.A. Archuleta

MEMORANDUM

COLORADO SCHOOL OF MINES RESEARCH INSTITUTE

P.O. Box 112

GOLDEN, COLORADO 80401

TO: Larry Tisdel

FROM: Larry Cox

SUBJECT: As, Se Analyses

DATE: February 23, 1982

PROJECT NO.: J10662 & J20205

After looking at the lab work sheets concerning the Arsenic and Selenium analyses, no definite reason can be found to explain the discrepancies between the original and the re-run values.

The samples were fused with sodium peroxide, leached with water, and acidified with a slight excess of hydrochloric acid for both sets of analyses. In both cases, duplicate analyses were performed and a reagent blank and standard reference material were evaluated and found to be in agreement with accepted values.

As the Arsenic and Selenium were determined on a sample decomposition separate from any other analyses, it is possible that the wrong samples were weighed for the first set.

On the split submitted for the re-run analyses an initial decomposition revealed that the Arsenic and Selenium values were less than 100 parts per million. Subsequent sample fusions and determinations by gaseous hydride generation resulted in the values reported in Lab Group Number 0191, Project No. J20205.

LC:ab

College of Santa Fe St. Michael's Drive Santa Fe, New Mexico 87501

November 2, 1981

Mr. Gilbert A. Archuleta, Supt.
Questa Independent School Dist. No.9
Questa, New Mexico 87556

Dear Gilbert:

I've studied the data you provided me to see what I could make of it and I've enclosed my conclusions for your review, along with your papers. Given the answers to the questions alluded to in the summary, there are perhaps more inferences to be drawn, but with the data at hand, I believe I've done all that is necessary or warranted at this time. I could have done some extensive arithmetic (statistic on the comparison of "average" rock and soil composition and that of the tailings piles, but it would only have confirmed the obvious; some elements are present in unusually high amounts. It would not have contributed anything toward our knowledge of Questa air quality.

If you have more questions after you've had an opportunity to read over this, please let me know at once. I've kept copies of all your data sheets so that we can communicate about them at a distance, if necessary.

I hope that this is of assistance to you and the Board members. I enjoyed doing it and look forward to visiting you in Questa before too long of a time passes.

All My Best Wishes,

Wayne

C. Wayne Freeark, Ph.D.
Prof. of Chem. & Math

REVIEW AND INTERPRETATION OF ANALYTICAL DATA
RE: QUESTA AIR QUALITY & QUESTA ROAD DUST

REQUESTED BY: MR. GILBERT ARCHULETA, SUPT., QUESTA SCHOOL DIST.

Based upon my study of the data made available to me by Mr. Gilbert Archuleta, Superintendent, Questa Independent School District No. 9, my conclusion is that the quality of Questa air is very good. To be sure, some questions remain to be answered, but the data at hand appear to support this finding.

Two factors emerge as critical to the quality of Questa air: (1) amount of total suspended particulates (TSP), dust in other words, which is so finely divided that it may be inhaled; and (2) the composition of that dust. It is generally accepted that TSP smaller than 5 microns (0.000175 inches) in diameter may escape Nature's respiratory filtering system, be inhaled, and subsequently ingested into the body. It is at this point that the composition of the TSP becomes important. If the TSP does not contain, or contains less than the amounts which have been determined by OSHA and/or the NMEID to be harmful to one's health, than one can be fairly assured of the quality of the air he or she breaths.

Table 1 lists analytical results for fifteen elements found in representative samples of Questa air. All of these are toxic if sufficiently high concentrations are ingested into the body, although many, like Zinc, for example, may be essential in trace amounts for proper body functioning. The degree of toxicity of an element is reflected by the OSHA limits, which are also given in Table 1; the higher the OSHA limit, the relatively less toxic is the element, i.e., the more of it the body can tolerate without suffering discernable harm. In each case, Questa air falls well within the OSHA safety limits. For greater ease of understanding, I have converted the data into percentages of the allowable OSHA limits for each element. Table 1 can, then, be re-expressed as follows:

Element	Percentage of OSHA Limit
Arsenic	0.0006 %
Berylium	less than 0.025
Cadmium	less than 0.002
Chromium	less than 0.0001
Copper	0.0177
Fluorine	no analysis*
Lead	0.156
Mercury	0.0008
Molybdenum	less than 0.00004
Nickle	no analysis*
Selenium	less than 0.0005
Silicon	no analysis*
Uranium	less than 0.0014
Vanadium	no analysis*
Zinc	less than 0.0028

* meaning unclear: refer to comment in text

The term in the body of Table 1, "no analysis," may mean that no traces of those elements were found, or that analyses for those elements were not performed. Except for Silicon, I would expect the former to be the case; but given the prevalence of Silicon (as sand) I'm forced to conclude the latter interpretation is probably correct. Why no analyses were performed, if this is indeed the case, is unknown. This point needs to be clarified.

Table 2 compares the particle size of Questa Road Dust with that of dust from the Molycorp tailings piles. It shows Questa Road Dust to contain 16.4 times as much TSP smaller than 5 microns in diameter as does dust from the tailings piles. The implication is that one could accumulate 16.4 times more dirt in his lungs in Questa than if he were sitting atop a Molycorp tailings heap. Questa road dust is exposed to more traffic and that fact probably accounts for the additional "fine grind" TSP. Weathering would be expected to have about the same effects in Questa as at the tailings site and is probably largely responsible for the less than 5 microns in diameter TSP at the latter.

Table 3 shows the elemental analyses of tailings dust and of Questa Road Dust. These percentages add to (very)roughly 35%. One may assume that much of the remaining 65% of the composition of the dust is oxygen, since most of these elements occur in nature as their oxides. The point is not certain, however, and should be clarified.

One noteworthy point appears among these data; Molybdenum and Nickle are found in tailings dust, but not in Questa Road Dust. On the other hand, Zirconium is found in Questa, but not at the tailings piles. The implication appears to be that little or none of the Questa Road Dust had its origin at the Molycorp tailings heaps. The traces of Molybdenum found in the Questa air samples may or may not have originated at the tailings piles; no inferences can be drawn. If the Questa air had been totally free of Molybdenum and Nickle (depending upon the interpretation of "no analysis," perhaps it is free of Nickle) then one might have concluded that the tailings dust was not a significant component of its TSP, but since some Molybdenum was found, we can not draw that conclusion with complete assurance.

The data summarized in Figures 2 and 3 tell something about the quality of Questa air, but nothing about the contribution of tailings dust to it. Cyanide is not detected in the tailings dust, indicati ng that Molycorp does a good job of policing its operations to preclude any environmental contamination. Cyanide is found in small amounts in both Questa and Taos Road Dust, but about the only conclusion which may be drawn is that it didn't come from Molycorp tailings.

Cyanides and organic artifacts result normally from the natural biodegradation of plant and animal materials and are a normal part of the environmental ecology. Only when they result from non-nature processes do they begin to pose a potential threat, and the data provide no informations concerning their origins in this case.

Given the barren nature of a tailings pile and the absence of cyanide in it as compared with the plant and animal population of Questa and environs, one could probably safely conclude that the cyanide and organic artifacts present in Questa dust result primarily from natural processes and normal daily commerce.

The Air Quality Data Report (received Nov. 2, 1981) shows no significant change in air quality from the Jan.-June 1979 period until the more recent July 1980-June 1981 period. Mean Total Suspended Particulates for the latter period is 63.3ug/M^3 ± 63.8, compared with 90ug/M^3 for the former, both of which are well within both OSHA and NMEID exposure limits. Certainly there are occasional bad days when these limits are greatly exceeded, but these are the exception.

The data compiled in Table 1, chemical analysis of tailings are interesting, but not very informative with respect to air quality. One might compare these data with the "AverageConcentration" of "typical rocks and soils" * and find that some elements such as Molybdenum and Arsenic are present in much higher than "average" amounts--which is to be expected in, say, a Molybdenum mining area. That some other elements are present in higher than average amounts reflects the relative wealth of minerals native to the Rocky Mountain area, but doesn't point to a health hazard <u>per se</u>.

In summary, four question remain to be answered: (1) What is the correct interpretation of "no analysis" in Table 1? (2) What is the balance of the elemental composition (on the order of 65%) of the dust samples described in Table 3? Is it or is it not oxygen? (3) Are there any non-natural sources of cyanide and other organics known to be in the Questa area, such as chemical dumps, spills, etc.? (4) Are copies of the original, Jan-June 1979 air quality sample data available for statistical comparison with the most recent data?

Apart fromthese questions, the data indicate that on the whole, Questa air is very good when compared to OSHA and NMEID standards. Furthermore, there appears to be little or no problem associated with TSP originating from the Molycorp tailings. It seems that virtually all the dust in the Questa area results from natural causes and normal daily business.

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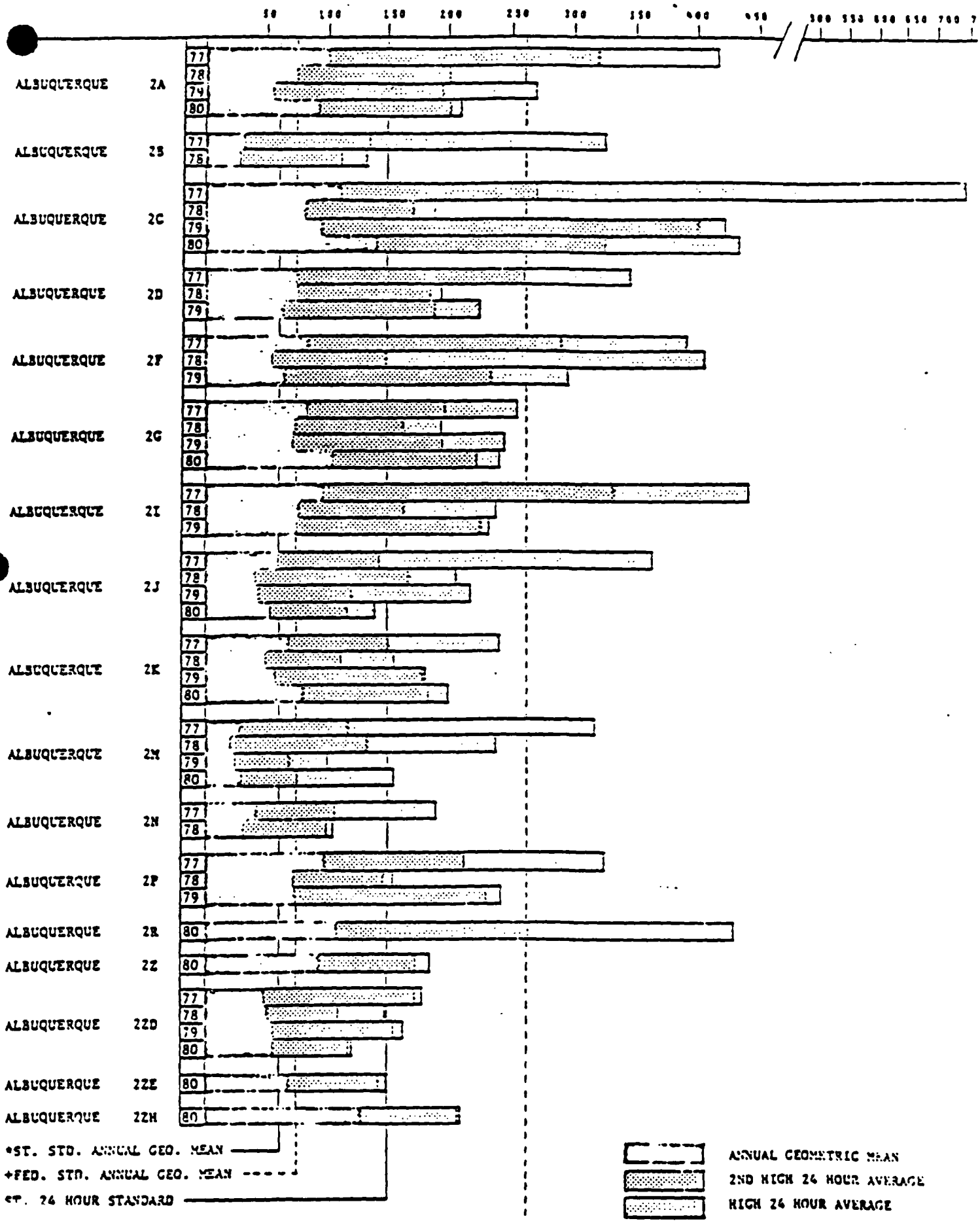
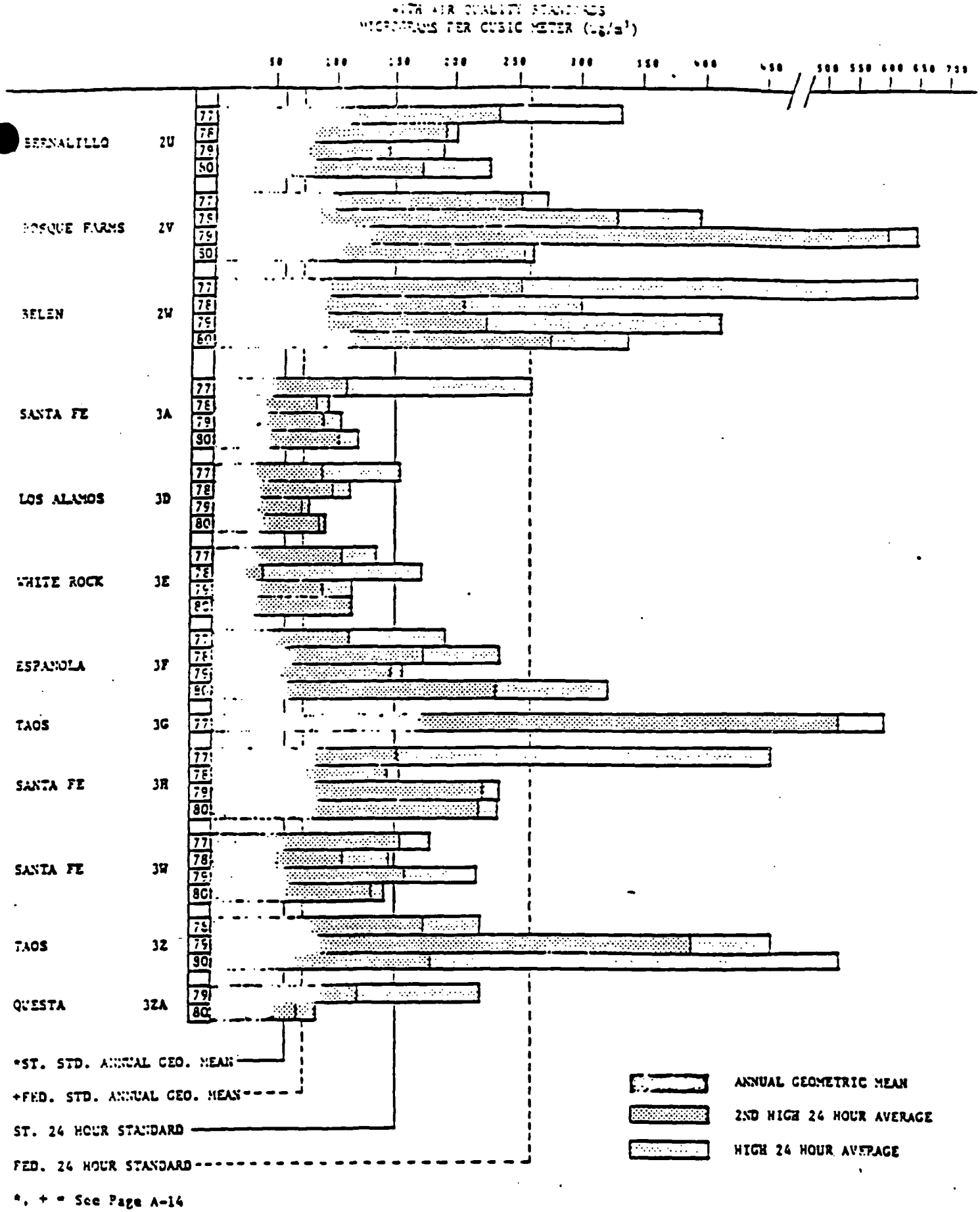
*<u>Average or Typical Parameter Concentrations as Found in Rocks and Soils</u>; Bowen, H.J.M., Trace Elements in Biochemistry, 1966, Academic Press, New York, N.Y.

PARTICULATE CONCENTRATIONS COMPARED
WITH AIR QUALITY STANDARDS
MICROGRAMS PER CUBIC METER (µg/m³)




MICROGRAMS PER CUBIC METER
BERNALILLO 2U
BOSQUE FARMS 2V
BELEN 2W
SANTA FE 3A
LOS ALAMOS 3D
WHITE ROCK 3E
ESPANOLA 3F
TAOS 3G
SANTA FE 3H
SANTA FE 3W
TAOS 3Z
QUESTA 3ZA
*ST. STD. ANNUAL GEO. MEAN
+FED. STD. ANNUAL GEO. MEAN
ST. 24 HOUR STANDARD
FED. 24 HOUR STANDARD
ANNUAL GEOMETRIC MEAN
2ND HIGH 24 HOUR AVERAGE
HIGH 24 HOUR AVERAGE

*, + = See Page A-14

Reference 39

3

755 wex

88-0416-C

SCIENTIFIC LABORATORY DIVISION

700 Camino de Salud NE
Albuquerque, NM 87106 841-2570

REPORT TO: CYNTHIA ARDITO
HED - EID Ground Water
P.O. BOX 968
SANTA FE NM 87504-0968

S.L.D. No. OR- 416 A+B
DATE REC. 3-31-88
PRIORITY
PHONE(S):

COLLECTION CITY: Questa ; COUNTY:

COLLECTION DATE/TIME CODE: (Year-Month-Day-Hour-Minute) 8 8 0 3 2 8 1 0 3 0

LOCATION CODE: (Township-Range-Section-Tracts) 36° 41' 41", 105° 37' 18" (10N06E24342)

USER CODE: 5 9 3 0 1 SUBMITTER: ARDITO CODE:

SAMPLE TYPE: WATER [X], SOIL [ ], FOOD [ ], OTHER:

RECEIVED APR 28 1988 GROUND WATER/HAZARDOUS WASTE BUREAU

This form accompanies ____ Septum Vials, 2 Glass Jugs, and/or ____

Samples were preserved as follows:

- [ ] NP: No Preservation; Sample stored at room temperature.
- [X] P-Ice Sample stored in an ice bath (Not Frozen).
- [ ] P-$Na_2S_2O_3$ Sample Preserved with Sodium Thiosulfate to remove chlorine residual.

ANALYSES REQUESTED: Please check the appropriate box(es) below to indicate the type of analytical screens required. Whenever possible list specific compounds suspected or required.

PURGEABLE SCREENS

- [ ] (753) Aliphatic Headspace (1-5 Carbons)
- [ ] (754) Aromatic & Halogenated Purgeables
- [ ] (765) Mass Spectrometer Purgeables
- [ ] (766) Trihalomethanes

Other Specific Compounds or Classes

- [ ] ____
- [ ] ____
- [ ] ____
- [ ] ____
- [ ] ____

EXTRACTABLE SCREENS

- [X] (751) Aliphatic Hydrocarbons
- [X] (755) Base/Neutral Extractables
- [ ] (758) Herbicides, Chlorophenoxy acid
- [ ] (759) Herbicides, Triazines
- [ ] (760) Organochlorine Pesticides
- [ ] (761) Organophosphate Pesticides
- [ ] (767) Polychlorinated Biphenyls (PCB's)
- [X] (764) Polynuclear Aromatic Hydrocarbons
- [ ] (762) SDWA Pesticides & Herbicides

Remarks: Carlos Herrera well claimed water tastes like oil - maybe biesal fuel - Molycorp.

FIELD DATA:

pH=____; Conductivity=____umho/cm at ____°C; Chlorine Residual=____mg/l

Dissolved Oxygen=____mg/l; Alkalinity=____mg/l; Flow Rate____ ____/____

Depth to water ____ft.; Depth of well____ft.; Perforation Interval ____-____ft.; Casing:____

Sampling Location, Methods and Remarks (i.e. odors, etc.)

I certify that the results in this block accurately reflect the results of my field analyses, observations and activities.(signature collector):____ Method of Shipment to the Lab:____

CHAIN OF CUSTODY

I certify that this sample was transferred from ____ to ____

at (location) ____ on ____/____/____ - ____:____ and that

the statements in this block are correct. Evidentiary Seals: Not Sealed [ ] OR Seals Intact: Yes [ ] No [ ]

ANALYSES PERFORMED

LAB. N... OR- 416

THIS PAGE FOR LABORATORY RESULTS ONLY

This sample was tested using the analytical screening method(s) checked below:

PURGEABLE SCREENS

- [ ] (753) Aliphatic Headspace (1-5 Carbons)
- [ ] (754) Aromatic & Halogenated Purgeables
- [ ] (765) Mass Spectrometer Purgeables
- [ ] (766) Trihalomethanes

Other Specific Compounds or Classes

- [ ] _____
- [ ] _____
- [ ] _____
- [ ] _____

EXTRACTABLE SCREENS

- [ ] (751) Aliphatic Hydrocarbons
- [x] (755) Base/Neutral Extractables
- [ ] (758) Herbicides, Chlorophenoxy acid
- [ ] (759) Herbicides, Triazines
- [ ] (760) Organochlorine Pesticides
- [ ] (761) Organophosphate Pesticides
- [ ] (767) Polychlorinated Biphenyls (PCB's)
- [ ] (764) Polynuclear Aromatic Hydrocarbons
- [ ] (762) SDWA Pesticides & Herbicides

ANALYTICAL RESULTS

COMPOUND(S) DETECTED	CONC. [PPB]	COMPOUND(S) DETECTED	CONC. [PPB]
BASE/NEUTRALS			
GASOLINE MDL = 250	ND < 250		
KEROSINE MDL = 250	ND < 250		
DIESEL MDL = 250	ND < 250		
LUBOIL MDL = 2500	ND < 2500		
PNA's MDL = 5	ND < 5		
MISC. IDD MDL = 5	ND < 5		
PCB's, CHLORDANE MDL = 1000	ND < 1000		
* DETECTION LIMIT *		- DETECTION LIMIT -	

ABBREVIATIONS USED:

N D = NONE DETECTED AT OR ABOVE THE STATED DETECTION LIMIT

T R = DETECTED AT A LEVEL BELOW THE STATED DETECTION LIMIT (NOT CONFIRMED)

[RESULTS IN BRACKETS] ARE UNCONFIRMED AND/OR WITH APPROXIMATE QUANTITATION

A - 800 B - 700

LABORATORY REMARKS: _____

CERTIFICATE OF ANALYTICAL PERSONNEL

Seal(s) Not Sealed [x] Intact: Yes [ ] No [ ]. Seal(s) broken by: _____ date: _____

I certify that I followed standard laboratory procedures on handling and analysis of this sample unless otherwise noted and that the statements on this page accurately reflect the analytical results for this sample.

Date(s) of analysis: 4/4/88. Analyst's signature: C.S. Burney

I certify that I have reviewed and concur with the analytical results for this sample and with the statements in this block.

Reviewers signature: L. Meyerhoi

(4)

754 wpu

88-0417-C

SCIENTIFIC LABORATORY DIVISION

700 Camino de Salud NE
Albuquerque, NM 87106 841-2570

REPORT TO: CYNTHIA ARDITO
HED-EID Ground Water
P.O. Box 968
Santa Fe, NM 87504-0968

S.L.D. No. OR- 417 A+B
DATE REC. 3-31-88
PRIORITY
PHONE(S):

COLLECTION CITY: Questa ; COUNTY:

COLLECTION DATE/TIME CODE: (Year-Month-Day-Hour-Minute) 8 8 0 3 2 8 1 0 3 0

LOCATION CODE: (Township-Range-Section-Tracts) 36° 41' 41", 105° 37' 18" (10N06E24342)

USER CODE: 5 9 3 0 1 SUBMITTER: C. ARDITO CODE:

SAMPLE TYPE: WATER [X], SOIL [ ], FOOD [ ], OTHER:

This form accompanies 2 Septum Vials, ____ Glass Jugs, and/or ____

Samples were preserved as follows:

- [ ] NP: No Preservation; Sample stored at room temperature.
- [X] P-Ice Sample stored in an ice bath (Not Frozen).
- [ ] P-$Na_2S_2O_3$ Sample Preserved with Sodium Thiosulfate to remove chlorine residual.

RECEIVED JUN 15 1988 GROUND WATER HAZARDOUS WASTE BUREAU

ANALYSES REQUESTED: Please check the appropriate box(es) below to indicate the type of analytical screens required. Whenever possible list specific compounds suspected or required.

PURGEABLE SCREENS

- [ ] (753) Aliphatic Headspace (1-5 Carbons)
- [X] (754) Aromatic & Halogenated Purgeables
- [ ] (765) Mass Spectrometer Purgeables
- [ ] (766) Trihalomethanes

Other Specific Compounds or Classes

- [ ] ____
- [ ] ____
- [ ] ____
- [ ] ____
- [ ] ____

EXTRACTABLE SCREENS

- [ ] (751) Aliphatic Hydrocarbons
- [ ] (755) Base/Neutral Extractables
- [ ] (756) Herbicides, Chlorophenoxy acid
- [ ] (759) Herbicides, Triazines
- [ ] (760) Organochlorine Pesticides
- [ ] (761) Organophosphate Pesticides
- [ ] (767) Polychlorinated Biphenyls (PCB's)
- [ ] (764) Polynuclear Aromatic Hydrocarbons
- [ ] (762) SDWA Pesticides & Herbicides

Remarks: Carlos Herrera well claimed smelled + tested like oil - likely corp.

FIELD DATA:

pH=____; Conductivity=____umho/cm at ____°C; Chlorine Residual=____mg/l

Dissolved Oxygen=____mg/l; Alkalinity=____mg/l; Flow Rate____ ____/____

Depth to water ____ft.; Depth of well____ft.; Perforation Interval ____-____ft.; Casing:____

Sampling Location, Methods and Remarks (i.e. odors, etc.)

I certify that the results in this block accurately reflect the results of my field analyses, observations and activities.(signature collector):____ Method of Shipment to the Lab:____

CHAIN OF CUSTODY

I certify that this sample was transferred from ____ to ____

at (location) ____ on ____/____/____ - ____:____ and that

the statements in this block are correct. Evidentiary Seals: Not Sealed [ ] OR Seals Intact: Yes [ ] No [ ]

Signatures ____ ____

ANALYSES PERFORMED

LAB. No.: OR- 417

THIS PAGE FOR LABORATORY RESULTS ONLY

This sample was tested using the analytical screening method(s) checked below:

PURGEABLE SCREENS

- [ ] (753) Aliphatic Headspace (1-5 Carbons)
- [x] (754) Aromatic & Halogenated Purgeables
- [ ] (765) Mass Spectrometer Purgeables
- [ ] (766) Trihalomethanes

Other Specific Compounds or Classes

- [ ] _____
- [ ] _____
- [ ] _____
- [ ] _____

EXTRACTABLE SCREENS

- [ ] (751) Aliphatic Hydrocarbons
- [ ] (755) Base/Neutral Extractables
- [ ] (758) Herbicides, Chlorophenoxy acid
- [ ] (759) Herbicides, Triazines
- [ ] (760) Organochlorine Pesticides
- [ ] (761) Organophosphate Pesticides
- [ ] (767) Polychlorinated Biphenyls (PCB's)
- [ ] (764) Polynuclear Aromatic Hydrocarbons
- [ ] (762) SDWA Pesticides & Herbicides

ANALYTICAL RESULTS

COMPOUND(S) DETECTED	CONC. [PPB]	COMPOUND(S) DETECTED	CONC. [PPB]
halogenated purgeables	N.D.		
aromatic purgeables			
benzene	.5		
toluene	1.3		
p+m-xylene	1.4		
o-xylene	.5		
ethylbenzene	T.R.		
butanone	~~60~~ 27		
tetrahydrofuran	120		
* DETECTION LIMIT *	.5 ug/L	- DETECTION LIMIT -	

ABBREVIATIONS USED:

N D = NONE DETECTED AT OR ABOVE THE STATED DETECTION LIMIT

T R = DETECTED AT A LEVEL BELOW THE STATED DETECTION LIMIT (NOT CONFIRMED)

[RESULTS IN BRACKETS] ARE UNCONFIRMED AND/OR WITH APPROXIMATE QUANTITATION

LABORATORY REMARKS: _____

CERTIFICATE OF ANALYTICAL PERSONNEL

Seal(s) Not Sealed [ ] Intact: Yes [ ] No [✓] Seal(s) broken by: not sealed date: _____

I certify that I followed standard laboratory procedures on handling and analysis of this sample unless otherwise noted and that the statements on this page accurately reflect the analytical results for this sample.

Date(s) of analysis: 4/13/88 Analyst's signature: Mary C. Eden

I certify that I have reviewed and concur with the analytical results for this sample and with the statements in this block.

Reviewers signature: R Meyer Lein

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud N.
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	[illegible]	Lab No.	[illegible]	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 09 mm 35

COLLECTED BY: C ARDITO

RECEIVED

GROUND WATER BUREAU

TO:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

COLLECTION SITE DESCRIPTION
Molycorp
Old Tailings Pile
NWA

OWNER:

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 42' 04" 105° 37' 07"

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped	☒ Pump ☐ Tap	Water Level:	Discharge:	Sample Type: Water

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.9	800 µmho	14.0 °C	µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☒ WPF: Water Preserved w/HNO_3 Filtered	☒ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.7	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.9	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	160.		Zinc	<0.1	
Chromium	<0.1	☒ <0.005	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	<0.1				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	29.				☐
Manganese	<0.05				☐
Molybdenum	0.5				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB
Analysis Date: 5/3/88
Reviewer: [signature]
Date Reviewed: 9/6/88

New Mexico Health and Environment Department
SCIENTIFIC LABORATC IVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY IETAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	4/22/88	Lab No. TCP 13	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 14 mm 52

COLLECTED BY: C ARDITO

COLLECTION SITE DESCRIPTION: Rio Corp Old Tailings Pile MW 3

RECEIVED JUL 19 1988 GROUND WATER BUREAU

RECEIVED JUL 19 1988 GROUND WATER/HAZARDOUS WASTE BUREAU

TO:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

OWNER:

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 41' 48" 105° 37' 05"

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped	☒ Pump ☐ Tap	Water Level: 19'	Discharge:	Sample Type: WATER

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.29	900 µmho	13.5 °C	µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☒ WPF: Water Preserved w/HNO_3 Filtered	☒ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.7	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.0	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	170.		Zinc	<0.1	
Chromium	<0.1	☒ 0.0010	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	<0.1				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	33.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB

Analysis Date: 5/3/88

Reviewer: Jim Ashby

Date Reviewed: 7/15/88

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	4/27/88	Lab No.	ICP-142	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 14 mm 16

COLLECTION SITE DESCRIPTION: Molycorp Old Tailings Pile MW 4

COLLECTED BY: C ARDITO

TO:

OWNER:

RECEIVED MAY 17 1988 GROUND WATER & HAZARDOUS WASTE BUREAU

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

SITE LOCATION:
County: TAOS

Township, Range, Section, Tract: (10N06E24342)

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36°42' 02" 105° 36' 26"

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped ☐ Pump ☐ Tap	Water Level: 40.5	Discharge:	Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.5	1000 µmho	15.0 °C	µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☒ WPF: Water Preserved w/HNO_3 Filtered	☒ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.5	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.1	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	190.		Zinc	<0.1	
Chromium	<0.1	☒ <0.005	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	<0.1				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	38.				☐
Manganese	<0.05				☐
Molybdenum	0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB

Analysis Date: 5/3/88

Reviewer: Jim Robby

Date Reviewed: 6/14/88

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	4/22/88	Lab No.	ICP-140	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 10 mm 55

COLLECTED BY: C. ARDITO

TO:

COLLECTION SITE DESCRIPTION: [illegible] Pile HWL

OWNER:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 17 1988

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

SITE LOCATION:
County: Taos
Township, Range, Section, Tract: (10N06E24342)

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 41' 50" - 105° 37' 12"

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped	☒ Pump ☐ Tap	Water Level: 18'	Discharge:	Sample Type: WATER

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.1	1210 µmho	12.0 °C	µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☒ WPF: Water Preserved w/HNO_3 Filtered	☒ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	3.6	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.6	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	280.		Zinc	<0.1	
Chromium	<0.1	☒ <0.005	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	0.4				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	46.				☐
Manganese	<0.05				☐
Molybdenum	1.8				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB
Analysis Date: 5/3/88

Reviewer: Jim Ashby
Date Reviewed: 6/14/88

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	4/22/88	Lab No. ICP-141	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 13 mm 32

COLLECTION SITE DESCRIPTION: Molycorp Old Tailings Pile MW1

COLLECTED BY: C. ARDITO

TO:

OWNER:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 1 , 1988
GROUND WATER/HAZARDOUS WASTE

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 41' 38" 105° 57' 20"

SAMPLING CONDITIONS:

☐ Bailed ☒ Pump ☐ Dipped ☐ Tap	Water Level: 51.4'	Discharge:	Sample Type: WATER

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.0	1190 µmho	12.0 °C	µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☒ WPF: Water Preserved w/HNO_3 Filtered	☒ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	11.	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.9	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	260.		Zinc	<0.1	
Chromium	<0.1	☒ <0.005	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	<0.1				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	51.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB

Analysis Date: 5/3/88

Reviewer: [signature]

Date Reviewed: 6/14/88

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud N.
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	4/22/88	Lab No.	ICP-143	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 04 dd 19 hh 10 mm 15

COLLECTION SITE DESCRIPTION: Rancorp Old Sludge Pile MWC

COLLECTED BY: C ARDITO

TO:

OWNER:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

RECEIVED JUN 17 1988 GROUND WATER/HAZARDOUS WASTE BUREAU

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 42' 04" 105° 37' 04"

SAMPLING CONDITIONS:

☐ Bailed ☒ Pump ☐ Dipped ☐ Tap	Water Level: 18.5"	Discharge:	Sample Type: WATER
pH(00400) 6.2	Conductivity(Uncorr.) 1050 µmho	Water Temp.(00010) 11.5 °C	Conductivity at 25°C (00094) µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☒ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☒ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.7	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.4	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☒ <0.001	Vanadium	<0.1	
Calcium	230.		Zinc	<0.1	
Chromium	<0.1	☒ <0.005	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☒ <0.0005
Iron	<0.1				☐
Lead	<0.1	☒ <0.01			☐
Magnesium	40.				☐
Manganese	1.2				☐
Molybdenum	2.0				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB

Analysis Date: 5/3/88

Reviewer: Jim Ashley

Date Reviewed: 6/14/88

(2)

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	3/3/88	Lab No. ICP-102	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☒ 59301

COLLECTION DATE & TIME: yy 88 mm 03 dd 2[illegible] hh [illegible] mm 30

COLLECTION SITE DESCRIPTION: holycorp, Carlos Herrera

COLLECTED BY: Cindy Ardito / Gabriel

MAY 12 1988

TO:

OWNER: Herrera

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)
28 N+12E+01+131

ATTN: Cynthia Ardito
PHONE: 827-2703

STATION/ WELL CODE:
36° 41' 4", 105° 37' 18"

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped ☐ Pump ☒ Tap	Water Level:	Discharge:	Sample Type: WATER

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.9	1150 µmho	15.0 °C	µmho

FIELD COMMENTS: Kitchen Sink at Carlos Herrera

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☒ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☐ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	14.	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.3	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☐	Vanadium	<0.1	
Calcium	250.		Zinc	<0.1	
Chromium	<0.1	☐	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☐			☐
Magnesium	47.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB
Analysis Date: 4/30/88

Reviewer: Jim Ashby
Date Reviewed: 5/6/88

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	5/28/87	Lab No.	ICP-303	User Code	☐ 59400 ☐ 53400 ☐ 53300 ☑ 59300 ☐ 59500 ☐

COLLECTION DATE & TIME: yy 87 mm 05 dd 26 hh 10 mm 30

COLLECTED BY: Childers / Ardito

COLLECTION SITE DESCRIPTION: Questa, New Mexico
south of tailings
P1

OWNER: Carlos Herrera

TO:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 06 1987
GROUND WATER/HAZARDOUS WASTE BUREAU

ATTN: Amy Childers
PHONE: 827-2901

SITE LOCATION:
County: Taos
Township, Range, Section, Tract: (10N06E24342)
2 8 N+ 1 2 E+ 0 1 + 1 3 1

STATION/WELL CODE:

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped ☑ Pump ☐ Tap	Water Level:	Discharge:	Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
6.65	1180 µmho	13.5 °C	1568 µmho

FIELD COMMENTS: pumped for 4 hours

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☑ WPF: Water Preserved w/HNO_3 Filtered	☑ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	12.	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	1.3	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☑ <0.001	Vanadium	<0.1	
Calcium	240.		Zinc	<0.1	
Chromium	<0.1	☑ <0.005	Arsenic		☐
Cobalt	<0.05		Selenium		☐
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☑ <0.01			☐
Magnesium	44.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB+JK
Analysis Date: 6/1/87

Reviewer: Jim Gabby
Date Reviewed: 6/30/87

REPORT TO: GROUND WATER SECTION
Environmental Improvement Division
Health & Environment Department
P.O. Box 968 - Crown Building
Santa Fe, NM 87504-0968
ATTENTION: Amy Childers

LAB NUMBER TCAP-57
DATE RECEIVED 2-6-87
DATE REPORTED 3/17/87 JTA
Initials
SLD USER CODE NUMBER 51.32

Sample Location Molycorp Questa New Mexico

Station/Well Code P1 Herrera Well

Collected 870204 (Date) 11:30 (Time) By Childers/Dye (Name) Groundwater (Unit)

Pumping Conditions ~~pump~~ ran water at outside faucet for 5 minutes

Water Level

Discharge

Sample Type

pH (00400) 7.02

Conductivity (Uncorrected) 1100 umho

Water Temp (00010) 9 °C

1077 at 25°C

☑ ICAP SCAN METAL ANALYSES ☐ ATOMIC ABSORPTION(AA)

	F, A-HNO_3		Date Analyzed		F, A-HNO_3		Date Analyzed
☐	Arsenic, dissolved	mg/l		☑	Aluminum	mg/l	
☑	Barium, dissolved	mg/l		AA ☑	Chromium	mg/l	
AA ☑	Cadmium, dissolved	mg/l		☑	Iron	mg/l	
AA ☑	Lead, dissolved	mg/l		☑	Manganese	mg/l	
☑	Molybdenum, diss.	mg/l		☑	Nickel	mg/l	
☑	Selenium, diss.	mg/l		☑	Copper	mg/l	
☑	Uranium, diss.	mg/l		☑	Cobalt	mg/l	
☑	Zinc, dissolved	mg/l		☐		mg/l	

Remarks ICAP except where marked AA

This form accompanies 1 sample(s) marked as follows to indicated field treatment:

F, A-HNO_3: Filtered sample (0.45u membrane filter); acidified with 5 ml conc. HNO_3/l

RECEIVED
MAR 18 1987
GROUND WATER/HAZARDOUS WASTE
BUREAU

ICAP SCAN

SLD Lab No. ICP-57

Analyst JK & JB

Date Analyzed 2/9/87

Reviewed by: Jim Ashby

Date Reported: 3/17/87

P1

ELEMENT	ICAP VALUE(mg/l)	AA VALUE(mg/l)
Aluminum	<0.1	
Barium	<0.1	
Beryllium	<0.1	
Boron	<0.1	
Cadmium	<0.1	<0.001
Calcium	230.	
Chromium	<0.1	<0.005
Cobalt	<0.05	
Copper	<0.1	
Iron	0.2	
Lead	<0.1	<0.01
Magnesium	42.	
Manganese	<0.05	
Molybdenum	<0.1	
Nickel	<0.1	
Silicon	10.	
Silver	<0.1	
Strontium	1.1	
Tin	<0.1	
Vanadium	<0.1	
Zinc	0.2	
Arsenic		<0.005
Selenium		<0.005
Mercury		
Uranium		0.01[illegible]

RECEIVED
[illegible] 20 1987
[illegible] WASTE

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud
Albuquerque, NM 871

HEAV METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	3/3/88	Lab No: ICP-99	User Code	☐ 59400 ☐ 59300	☐ 53400 ☐ 59500	☐ 53300 ☐

COLLECTION DATE & TIME: yy 88 mm 03 dd 28 hh 15 mm 00

COLLECTION SITE DESCRIPTION: Holy Cross HW-1

COLLECTED BY: ARDITO GABRIEL

TO:

OWNER:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)

ATTN: CYNTHIA ARDITO
PHONE: 827-2703

STATION/ WELL CODE:

LATITUDE, LONGITUDE: 36° 41' 46", 105° 37' 18"

SAMPLING CONDITIONS:

☐ Bailed ☒ Pump ☐ Dipped ☐ Tap	Water Level: 53.4	Discharge:	Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
8.0	1190 µmho	13.5 °C	µmho

FIELD COMMENTS: TD of well 116.4 - pumped for 15 minutes behind Hercera's house

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☒ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☒ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	12.	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.8	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☐	Vanadium	<0.1	
Calcium	250.		Zinc	<0.1	
Chromium	<0.1	☐	Arsenic		☒ <0.005
Cobalt	<0.05		Selenium		☒ <0.005
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☐			☐
Magnesium	48.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

MAY 1988 HAZARDOUS WASTE BUREAU

LAB COMMENTS:

ICAP Analyst: JB

Analysis Date: 4/14/88

Reviewer: Jim Ashley

Date Reviewed: 5/3/88

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	5/28/87	Lab No.	ICP-298	User Code	☐ 59400 ☐ 53400 ☐ 53300 ☑ 59300 ☐ 59500 ☐

COLLECTION DATE & TIME: yy 87 mm 05 dd 26 hh 14 mm 12

COLLECTED BY: Amy Childers

COLLECTION SITE DESCRIPTION: Questa, New Mexico South of Tailings

PB

OWNER: Jose Durane

TO:

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 06 1987
GROUND WATER/HAZARDOUS WASTE

ATTN: Amy Childers
PHONE: 827-2901

SITE LOCATION:
County: Taos
Township, Range, Section, Tract: (10N06E24342)
2 8 N+1 2 E+0 1 +2 1 3

STATION/ WELL CODE:

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Pump ☑ Dipped ☐ Tap | Water Level: | Discharge: | Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
7.25	200 µmho	16 °C	248 µmho

FIELD COMMENTS: Domestic hand dug well, 4 foot diameter

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☑ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☑ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	7.7	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.2	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☑ <0.001	Vanadium	<0.1	
Calcium	35.		Zinc	<0.1	
Chromium	<0.1	☑ <0.005	Arsenic		☐
Cobalt	<0.05		Selenium		☐
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☑ <0.01			☐
Magnesium	4.8				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JK + JB
Analysis Date: 6/1/87
Reviewer: Jim Kelly
Date Reviewed: 6/30/87

New Mexico Health and Environment Department
SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud N'
Albuquerque, NM 87106

HEAV' METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	5/28/87	Lab No.	ICP-306	User Code	☐ 59400 ☐ 53400 ☐ 53300 ☑ 59300 ☐ 59500 ☐

COLLECTION DATE & TIME: yy 87 mm 05 dd 26 hh 12 mm 00

COLLECTED BY: Childers / Ardito

COLLECTION SITE DESCRIPTION: Questa, New Mexico south of tailings

TO:

OWNER: Simon Durane

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 06 1987
GROUND WATER HAZARDOUS WASTE BUREAU

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)
28 N+1 2 E+0 1+1 2 2

ATTN: Amy Childers
PHONE: 827-2901

STATION/ WELL CODE:

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped ☐ Pump ☐ Tap	Water Level:	Discharge:	Sample Type:

pH(00400)	Conductivity (Uncorr.)	Water Temp. (00010)	Conductivity at 25°C (00094)
7.3	310 µmho	16 °C	384 µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☑ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☑ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.0	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.4	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☑ <0.001	Vanadium	<0.1	
Calcium	53.		Zinc	0.2	
Chromium	<0.1	☑ <0.005	Arsenic		☐
Cobalt	<0.05		Selenium		☐
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☑ <0.01			☐
Magnesium	10.				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB & JK

Analysis Date: 6/1/87

Reviewer: Jim Kelly

Date Reviewed: 6/30/87

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	5/28/87	Lab No.	ICP-302	User Code	☐ 59400 ☐ 53400 ☐ 53300 ☑ 59300 ☐ 59500 ☐

COLLECTION DATE & TIME: yy 87 mm 05 dd 26 hh 11 mm 00

COLLECTED BY: Childers / Ardito

COLLECTION SITE DESCRIPTION
Questa, New Mexico
south of tailings

TO:

OWNER: Teleofo Durone

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUN 1 06 1987
GROUND WATER/HAZARDOUS WASTE BUREAU

SITE LOCATION:
County: Taos

Township, Range, Section, Tract: (10N06E24342)
2 8 N+1 2 E+0 1+1 3 1

ATTN: Amy Childers
PHONE: 827-2901

STATION/ WELL CODE:

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped	☑ Pump ☐ Tap	Water Level:	Discharge:	Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
7.1	910 µmho	13.5 °C	1209 µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT
Check proper boxes:

☐ WPN: Water Preserved w/HNO_3 Non-Filtered

☑ WPF: Water Preserved w/HNO_3 Filtered

LAB ANALYSIS REQUESTED:

☑ ICAP Scan
Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	13.	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.9	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☑ <0.001	Vanadium	<0.1	
Calcium	190.		Zinc	<0.1	
Chromium	<0.1	☑ <0.005	Arsenic		☐
Cobalt	<0.05		Selenium		☐
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☑ <0.01			☐
Magnesium	34.				☐
Manganese	<0.05				☐
Molybdenum	0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB & JK
Analysis Date: 6/1/87

Reviewer: Jim Ashby
Date Reviewed: 6/30/87

SCIENTIFIC LABORATORY DIVISION
700 Camino de Salud NE
Albuquerque, NM 87106

HEAVY METAL ANALYSIS FORM

Telephone: (505)841-2500

Date Received	5/28/87	Lab No. ICP-301	User Code	☐ 59400 ☐ 53400 ☐ 53300 ☑ 59300 ☐ 59500 ☐

COLLECTION DATE & TIME: yy 87 mm 05 dd 26 hh 11 mm 45

COLLECTED BY: Childers / Ardito

COLLECTION SITE DESCRIPTION: Questa, New Mexico south of tailings P46

TO:

OWNER: Helvinne Roel

GROUND WATER & HAZARDOUS WASTE BUREAU
NEW MEXICO EID/HED
PO BOX 968 - RUNNELS BUILDING
SANTA FE, NM 87504-0968

JUL 06 1987
GROUND WATER/HAZARDOUS WASTE

ATTN: Amy Childers
PHONE: 827-2901

SITE LOCATION:
County: Taos
Township, Range, Section, Tract: (10N06E24342)
28 N+12 E+01+21

STATION/ WELL CODE:

LATITUDE, LONGITUDE: -

SAMPLING CONDITIONS:

☐ Bailed ☐ Dipped ☑ Pump ☐ Tap	Water Level:	Discharge:	Sample Type:

pH(00400)	Conductivity(Uncorr.)	Water Temp.(00010)	Conductivity at 25°C (00094)
7.4	305 µmho	18 °C	359 µmho

FIELD COMMENTS:

SAMPLE FIELD TREATMENT Check proper boxes:		LAB ANALYSIS REQUESTED:
☐ WPN: Water Preserved w/HNO_3 Non-Filtered	☑ WPF: Water Preserved w/HNO_3 Filtered	☑ ICAP Scan Mark box next to metal if AA is required.

ANALYTICAL RESULTS (MG/L)

ELEMENT	ICAP VALUE	AA VALUE	ELEMENT	ICAP VALUE	AA VALUE
Aluminum	<0.1		Silicon	9.1	
Barium	<0.1		Silver	<0.1	
Beryllium	<0.1		Strontium	0.4	
Boron	<0.1		Tin	<0.1	
Cadmium	<0.1	☑ < 0.001	Vanadium	<0.1	
Calcium	48.		Zinc	0.1	
Chromium	<0.1	☑ < 0.005	Arsenic		☐
Cobalt	<0.05		Selenium		☐
Copper	<0.1		Mercury		☐
Iron	<0.1				☐
Lead	<0.1	☑ <0.01			☐
Magnesium	8.6				☐
Manganese	<0.05				☐
Molybdenum	<0.1				☐
Nickel	<0.1				☐

LAB COMMENTS:

ICAP Analyst: JB & JK
Analysis Date: 6/1/87
Reviewer: Jim Ashby
Date Reviewed: 6/30/87

REPORT TO: GROUND WATER SECTION
Environmental Improvement Division
Health & Environment Department
P.O. Box 968 - Crown Building
Santa Fe, NM 87504-0968
ATTENTION: Amy Childers

LAB NUMBER ICAP-55
DATE RECEIVED 2-6-87
DATE REPORTED 3/17/87 JJA
Initials
SLD USER CODE NUMBER 51.32

Sample Location Molycorp Questa New Mexico
Rael's Old well

Station/Well Code P4a

Collected 870204 Date 1030 Time By Childers/Dye Name / Groundwater Unit

Pumping Conditions bailed

Water Level 9.35'

Discharge

Sample Type

pH (00400) 7.0

Conductivity (Uncorrected) 550 umho

Water Temp (00010) 5 °C

965 at 25°C

☑ ICAP SCAN

METAL ANALYSES ☐ ATOMIC ABSORPTION(AA)

	F, A-HNO_3		Date Analyzed		F, A-HNO_3		Date Analyzed
☑	Arsenic, dissolved	mg/l		☑	Aluminum	mg/l	
☑	Barium, dissolved	mg/l		AA ☑	Chromium	mg/l	
AA ☑	Cadmium, dissolved	mg/l		☑	Iron	mg/l	
AA ☑	Lead, dissolved	mg/l		☑	Manganese	mg/l	
☑	Molybdenum, diss.	mg/l		☑	Nickel	mg/l	
☑	Selenium, diss.	mg/l		☑	Copper	mg/l	
☑	Uranium, diss.	mg/l		☑	Cobalt	mg/l	
☑	Zinc, dissolved	mg/l		☐		mg/l	

Remarks ICAP except where marked AA

This form accompanies 1 sample(s) marked as follows to indicated field treatment:

F, A-HNO_3: Filtered sample (0.45u membrane filter); acidified with 5 ml conc. HNO_3/l

RECEIVED
MAR 18 1987
GROUND WATER/HAZARDOUS WASTE BUREAU

ICAP SCAN

SLD Lab No. ICP-55

Analyst JK

Date Analyzed 2/9/87

Reviewed by: Jim Kelley

Date Reported: 3/17/87

P4a

ELEMENT	ICAP VALUE(mg/l)	AA VALUE(mg/l)
Aluminum	<0.1	
Barium	<0.1	
Beryllium	<0.1	
Boron	<0.1	
Cadmium	<0.1	<0.001
Calcium	110.	
Chromium	<0.1	<0.005
Cobalt	<0.05	
Copper	<0.1	
Iron	<0.1	
Lead	<0.1	<0.01
Magnesium	18.	
Manganese	<0.05	
Molybdenum	<0.1	
Nickel	<0.1	
Silicon	7.1	
Silver	<0.1	
Strontium	0.7	
Tin	<0.1	
Vanadium	<0.1	
Zinc	<0.1	
Arsenic		<0.005
Selenium		<0.005
Mercury		
Uranium		0.012

RECEIVED
MAR 20 1987
WASTE

REPORT TO: GROUND WATER SECTION
Environmental Improvement Division
Health & Environment Department
P.O. Box 968 - Crown Building
Santa Fe, NM 87504-0968
ATTENTION: Amy Childers

LAB NUMBER IEAP-59
DATE RECEIVED 2-6-87
DATE REPORTED 3/17/87 JGA
Initials
SLD USER CODE NUMBER 51.32

Sample Location MolyCorp Questa New Mexico
Rael's new well

Station/Well Code P4b

Collected 870204 (Date) 1000 (Time) By Childers/Dye (Name) / Groundwater (Unit)

Pumping Conditions ran tap for three minutes

Water Level 48.99

Discharge

Sample Type

pH (00400) 6.98

Conductivity (Uncorrected) 310 umho

Water Temp (00010) 5 °C

544 at 25°C

☑ ICAP SCAN METAL ANALYSES ☐ ATOMIC ABSORPTION(AA).

	F, A-HNO_3		Date Analyzed		F, A-HNO_3		Date Analyzed
☑	Arsenic, dissolved	mg/l		☑	Aluminum	mg/l	
☑	Barium, dissolved	mg/l		AA ☑	Chromium	mg/l	
AA ☑	Cadmium, dissolved	mg/l		☑	Iron	mg/l	
AA ☑	Lead, dissolved	mg/l		☑	Manganese	mg/l	
☑	Molybdenum, diss.	mg/l		☑	Nickel	mg/l	
☑	Selenium, diss.	mg/l		☑	Copper	mg/l	
☑	Uranium, diss.	mg/l		☑	Cobalt	mg/l	
☑	Zinc, dissolved	mg/l		☐		mg/l	

Remarks ICAP except where marked AA

This form accompanies 1 sample(s) marked as follows to indicated field treatment:

F, A-HNO_3: Filtered sample (0.45u membrane filter); acidified with 5 ml conc. HNO_3/l

RECEIVED
MAR 18 1987
GROUND WATER/HAZARDOUS WASTE BUREAU

ICAP SCAN

SLD Lab No. ICP-58

Reviewed by: Jim Ashby

Analyst JK + JB

Date Reported: 3/17/87

Date Analyzed 2/9/87

P4b

ELEMENT	ICAP VALUE(mg/l)	AA VALUE(mg/l)
Aluminum	<0.1	
Barium	<0.1	
Beryllium	<0.1	
Boron	<0.1	
Cadmium	<0.1	<0.001
Calcium	46.	
Chromium	<0.1	<0.005
Cobalt	<0.05	
Copper	<0.1	
Iron	<0.1	
Lead	<0.1	<0.01
Magnesium	8.4	
Manganese	<0.05	
Molybdenum	<0.1	
Nickel	<0.1	
Silicon	8.0	
Silver	<0.1	
Strontium	0.3	
Tin	<0.1	
Vanadium	<0.1	
Zinc	0.2	
Arsenic		<0.005
Selenium		<0.005
Mercury		
Uranium		0.006

RECEIVED
MAR 20 1987
HAZARDOUS WASTE BUREAU

REPORT TO: GROUND WATER SECTION
Environmental Improvement Division
Health & Environment Department
P.O. Box 968 - Crown Building
Santa Fe, NM 87504-0968
ATTENTION: Amy Childers

LAB NUMBER IC 42-58
DATE RECEIVED 2-6-87
DATE REPORTED 3/17/87 QTA
Initials

SLD USER CODE NUMBER 51.32

Sample Location MolyCorp Questa New Mexico

Station/Well Code Samuel Durane's Well P7

Collected 870204 1415 By Childers/Dye Groundwater
Date Time Name Unit

Pumping Conditions tap

Water Level

Discharge

Sample Type

pH (00400) 7.00

Conductivity (Uncorrected) 230 umho

Water Temp (00010) 7 °C

375 umhos at 25°C

☑ ICAP SCAN METAL ANALYSES ☐ ATOMIC ABSORPTION(AA)

	F, A-HNO_3		Date Analyzed		F, A-HNO_3		Date Analyzed
☑	Arsenic, dissolved	mg/l		☑	Aluminum	mg/l	
☑	Barium, dissolved	mg/l		AA ☑	Chromium	mg/l	
AA ☑	Cadmium, dissolved	mg/l		☑	Iron	mg/l	
AA ☑	Lead, dissolved	mg/l		☑	Manganese	mg/l	
☑	Molybdenum, diss.	mg/l		☑	Nickel	mg/l	
☑	Selenium, diss.	mg/l		☑	Copper	mg/l	
☑	Uranium, diss.	mg/l		☑	Cobalt	mg/l	
☑	Zinc, dissolved	mg/l		☐		mg/l	

Remarks ICAP except where marked AA

This form accompanies 1 sample(s) marked as follows to indicated field treatment:

F, A-HNO_3: Filtered sample (0.45u membrane filter); acidified with 5 ml conc. HNO_3/l

RECEIVED
MAR 18 1987
GROUND WATER HAZARDOUS WASTE

ICAP SCAN

SLD Lab No. ICP-59 Reviewed by: Jim Ackley

Analyst JK & JB Date Reported: 3/17/87

P7

ELEMENT	ICAP VALUE(mg/l)	AA VALUE(mg/l)
Aluminum	<0.1	
Barium	<0.1	
Beryllium	<0.1	
Boron	<0.1	
Cadmium	<0.1	<0.001
Calcium	57.	
Chromium	<0.1	<0.005
Cobalt	<0.05	
Copper	<0.1	
Iron	<0.1	
Lead	<0.1	<0.01
Magnesium	9.7	
Manganese	<0.05	
Molybdenum	<0.1	
Nickel	<0.1	
Silicon	8.2	
Silver	<0.1	
Strontium	0.4	
Tin	<0.1	
Vanadium	<0.1	
Zinc	0.3	
Arsenic		<0.005
Selenium		<0.005
Mercury		
Uranium		0.008

RECEIVED 20 1987

DRAFT

SITE SAFETY PLAN
MOLYCORP, INC.
QUESTA, NM

CERCLIS ID: NMD002899094

FEBRUARY 28, 1994

PREPARED BY:

STUART KENT
NEW MEXICO ENVIRONMENT DEPARTMENT

TABLE OF CONTENTS

1.0 SITE EMERGENCY 1
1.1 Emergency Telephone Numbers 1
1.2 First Aid 1
1.3 Emergency Environmental Contacts 1
1.4 Encountering Hazardous Situations (requiring evacuation) . . 2

2.0 INFORMATIONAL SUMMARY 2
2.1 Hazards of Concern 2
2.2 Health and Safety Summary 2

3.0 INTRODUCTION 3
3.1 Background 3
3.2 Purpose 3
3.3 Objective 3

4.0 HAZARD EVALUATION 3
4.1 Site and Environmental Setting 3
4.2 Site Tasks 3
4.3 Job Task Hazards 4
4.3.1 Physical Hazards 4
4.3.2 Chemical Hazards 6

5.0 PERSONAL PROTECTIVE EQUIPMENT 8
5.1 Equipment Decontamination 8
5.2 Personal Decontamination 8

6.0 AIR MONITORING 8

7.0 HEALTH AND SAFETY REQUIREMENTS 9
7.1 Medical Monitoring Program 9
7.2 Training 9
7.3 Emergency Equipment 9
7.4 General Health 10
7.5 MSDS Information 10
7.6 Accident/Injury Reporting 10

8.0 PROJECT PERSONNEL 10
8.1 Project Manager: 10
8.4 Field Team Leader 11
8.5 Other Field Personnel 11

APPENDICES

APPENDIX A-1: Site Maps
APPENDIX A-2: Agreement and Acknowledgement Statement
APPENDIX A-3: MSDS
APPENDIX A-4: Accident/Injury Form

1.0 SITE EMERGENCY PLAN

Site address:

Mine site: 6 miles east of Questa along Hwy 38
Tailings ponds: one mile west of Questa
Molycorp Offices: P.O. Box 469
Questa, NM
87556

1.1 Emergency Telephone Numbers

Ambulance:	call 911
Fire:	call 911
Police:	call 911 (or 758-8878/758-3361)
Poison Control:	call 1-800-432-6866
Nearest Hospital:	Holy Cross Hospital
Street Address:	in Taos at Santa Fe Rd.
Telephone:	758-8883
Directions to:	South from Questa to Taos on Hwy 3 (22 miles). Hospital is along Hwy 3 at Santa Fe Rd. PLEASE SEE MAP (Appendix A-1)

1.2 First Aid:

Ingestion: Give water if patient is conscious. Call Poison Control - follow instructions. Administer CPR, if necessary. Seek medical attention.

Inhalation: Remove person from contaminated environment. Administer CPR, if necessary. Seek medical attention.

Skin Contact: Brush off dry material, remove contaminated clothing. Wash skin with soap and water. Seek medical attention if irritation develops.

Eye Contact: Flush eyes and surrounding tissue with water for 15 minutes. Seek medical attention.

* Exposure Symptoms:
  Irritation of eyes, nose, throat, breathing difficulties.

Report incident to Project Manager and Safety Manager after emergency procedures have been implemented.

1.3 Emergency Environmental Contacts

		TELEPHONE:
National Response Center:		**1-800-424-8802**
U.S. EPA (24-hour Hotline):		**1-800-424-9346**
State Emergency Response Agency:		
	New Mexico State Patrol	758-8878 or 758-3361
Facility:	Molycorp, Inc.	
Contact Person:	Dave Shoemaker, Site Manager	586-0212 x3001

1.4 Encountering Hazardous Situations (requiring evacuation)

In the event of an emergency, i.e. fires, explosions or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil or surface water at the facility, appropriate response actions, as dictated by the emergency, will be taken. All appropriate local emergency response agencies shall be notified immediately. The police, fire department, emergency response teams and ambulance may be reached via telephone by dialing 911.

The nearest hospital and additional emergency contacts are listed on the previous page (Section 1.0).

Personnel encountering a hazardous situation shall **instruct others on site to evacuate the vicinity immediately** and notify the Site Safety Officer/ Program Manager for instructions.

The site must not be re-entered until back-up help, monitoring equipment, and personal protective equipment is on hand.

2.0 INFORMATIONAL SUMMARY

2.1 Hazards of Concern

Physical hazards such as heat/cold and uneven or slippery terrain are considered the major hazards at Molycorp mine site and tailings disposal ponds. The hazards of respirable dusts, including silica dust, is expected to be low. While chemical hazards are generally of lesser concern, chemical exposure is possible through dermal contact and ingestion of contaminated soil and water samples during sample collection and preservation.

2.2 Health and Safety Summary

Minimum Level of Protection:

Level D is the minimum acceptable level for this site.

Action Level for Upgrading Personal Protection: Upgrade from Level D to Level C (which will include the use of respirators which remove respirable dusts) will occur when continuous dust clouds from either mine waste dumps or tailings ponds are visible. While air monitoring equipment will not be used to determine concentrations of (respirable) nuisance dusts, the qualitative evaluation of dust concentrations will be protective of workers.

3.0 INTRODUCTION

3.1 Background

NMED is currently conducting an Expanded Site Investigation at Molycorp, Inc., Questa Division, under the authority of Comprehensive Environmental Recovery, Compensation and Liability Act.

3.2 Purpose

The purpose of the site safety plan is to provide NMED field personnel and subcontractors with an understanding of the potential chemical and physical hazards that exist or may arise while the tasks of this project are being performed.

This SSP describes the procedures to be followed in order to reduce employee exposure to potential health hazards which may be present at the project site. The emergency response procedures necessary to respond to such hazards are also described within this SSP.

3.3 Objective

The primary objective is to ensure the well-being of all field personnel and the community surrounding this site. In order to accomplish this, project staff and approved subcontractors shall acknowledge and adhere to the policies and procedures established herein. Accordingly, all personnel assigned to this project shall read this site safety plan and sign the Agreement and Acknowledgement Statement (Appendix A-2) to certify that they have read, understood and agreed to abide by its provisions. In addition, all NMED personnel shall abide by the Site Safety Plan of Molycorp, Inc.

4.0 HAZARD IDENTIFICATION AND EVALUATION

4.1 Site and Environmental Setting

Molycorp site is a molybdenum mine and tailings disposal site located near Questa, NM in Taos County. The site is situated along the Red River drainage which enters the Rio Grande four to five miles below the tailings ponds. Environmental assessment of the site will necessitate the collection of waste, soil, water and air samples to evaluate potential migration of contamination along several exposure pathways (i.e. groundwater, surface water, contaminated soil and air).

4.2 Site Tasks

The field tasks at this site may include:

- Soil sampling
- Monitoring well bailing
- Groundwater sampling
- Surface water sampling
- Sediment sampling
- Air monitoring equipment installation
- Air sampling
- *Operation and maintenance*

4.3 Job Task Hazards

4.3.1 Physical hazards at this site may include:

I. Uneven or Slippery Terrain:

All employees must wear ANSI approved work boots with steel toe protection. Skid proof soles are highly recommended.

II. Exposure - Heat Stress:

Since climatic changes cannot be avoided work schedules will be adjusted to provide time intervals for intake of juices, juice products and water in an area free from contamination and in quantity appropriate for fluid replacement.

Heat stress may occur even in moderate temperature areas and may present any or all of the following:

A. Heat Rash: result of continuous exposure to heat, humid air, and chafing clothes. Heat rash is uncomfortable and decreases the ability to tolerate heat.

B. Heat Cramps: result of the inadequate replacement of body electrolytes lost through perspiration. Signs include severe spasms and pain in the extremities and abdomen.

C. Heat Exhaustion: result of increase stress on the vital organs of the body in the effort to meet the body's cooling demands. Signs include shallow breathing; pale, cool, moist skin; profuse sweating; dizziness.

D. Heat Stroke: result of overworked cooling system. Heat stroke is the most serious form of heat stress. Body surfaces must be cooled and medical help must be obtained immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; absence of perspiration; nausea; dizziness and confusion; strong, rapid pulse. Can lead to coma and death.

Heat Stress Prevention

A. Replace body fluids (water and electrolytes) lost through perspiration.

B. Cooling devices to aid the natural body ventilation. Cooling occurs through evaporation of perspiration and limited body contact with heat-absorbing protective clothing. Limit any contact with heat-absorbing protective clothing (e.g., coated Tyvek suits and fishing waders).

C. Provide shelter against heat and direct sunlight to protect personnel.

D. Rotate workers wearing protective clothing during hot weather.

III. Exposure - Cold Stress:

Work schedules will be adjusted to provide sufficient rest periods in a heated area for warming up during operations conducted in cold weather. Also thermal protective clothing such as wind and/or moisture resistant outerwear is recommended to be worn.

If work is performed continuously in the cold at or below -7°C (20°F), including wind chill temperature, heated warming shelters (tents, cabins, company vehicles, rest rooms, etc.) shall be made available nearby and the worker should be encouraged to use these shelters at regular intervals the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria, are indications for immediate return to the shelter. When entering the heated shelter the outer layer of clothing shall be removed and the remainder of the clothing loosened to permit sweat evaporation. A change of dry work clothing shall be provided as necessary to prevent worker from returning to their work with wet clothing. Dehydration, or the loss of body fluids, occurs in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited. (Adapted from TLV's and Biological Exposure Indices 1988-1989; ACGIH).

IV. Falling Objects:

Hard hats must be worn by all NMED personnel whenever entering Molycorp underground mine, during other activities on Molycorp property as dictated by Molycorp's Site Safety Plan and when the Site Safety Officer proclaims a hazard from falling objects exists (e.g. falling rocks at the mouth of a canyon).

V. Vehicular traffic:

All employees will be required to wear a fluorescent safety vest or brightly colored clothing at all times while on site.

VI. Confined Space:

All NMED personnel who are to enter the underground mine for groundwater sampling purposes shall abide by Molycorp's Site Safety Plan for mine safety.

VII. Potential Physical Hazards from Waste Sources:

Nuisance dusts are potential respiration hazard.

Compound	Permissible Exposure Limits	Source	Short-term Health Effects	Long-term Health Effects
Nuisance Dust	15 mg/m3 (TWA)	OSHA	Eye, nose, throat irritation	Not well characterized

TWA = 8-hr Time Weighted Average
OSHA = Occupational Safety and Health Administration

4.3.2 Potential Chemical Hazards

I. Waste source generated

Compound	Permissible Exposure Limits	Source	Short-term Health Effects	Long-term Health Effects
Aluminum Dust*	10 mg/m3 (as AL Oxides) 2 mg/m3 (not otherwise classified)	ACGIH	Eye Irritation	Pulmonary fibrosis from dust Higher levels cause brain damage
Cadmium Dust*	0.2 mg/m3 (TWA) 0.6 mg/m3 (STEL)	OSHA	Shortness of breath; cough; chest pain; flu symptoms; headaches	Probable carcinogen (kidney, prostate); Probable teratogen (testes)
Copper Dust*	1.0 mg/m3 (TWA)	OSHA	Eye Irritation; Skin rash	Chronic irritation to nose; may cause ulcers; liver damage at high exposures
Lead Dust*	0.05 mg/m3	OSHA	Not well characterized; short-term exposure unlikely but seizures possible	Teratogen; accumulation in body; tiredness, headaches; mood changes; Short concentration span, weakness, kidney, brain damage; increased risk of blood pressure.
Zinc*	None Established		Eye Irritation; No known acute/chronic effects	
SiO2 (as quartz)**	0.05 mg/m3 - 0.1 mg/m3	OSHA	Eye Irritation	Silicosis; shortness of breath; cough; chest pain

TWA = 8 -hr Time Weighted Average
STEL = Short-term (15 min.) Exposure Limit
OSHA = Occupational Safety and Health Administration
ACGIH = American Conference of Governmental Industrial Hygienists

* These compounds were tentatively identified in mine waste (ref. 37)
** Identified from % composition analysis of tailings (ref. 38)

These exposure limits are based upon an 8-hour, time weighted average (unless otherwise noted). With silica being the highest constituent of the tailings (ref. 38), the PEL which would most likely be exceeded is that for silica dust (as quartz). The silica standards are based upon the long-term exposure endpoint of silicosis. Actual exposure time in environments where atmospheric conditions approach the PEL is expected to be minimal, however, as various jobs tasks, some of which are not to be conducted near locations of highest exposure, will reduce

dust exposure. Therefore, only qualitative assessment of contaminant concentrations will occur.

II. Surface and Equipment Contamination:

Contact with contaminated surfaces, or surfaces suspected of being contaminated should be avoided. This includes walking through, kneeling or placing equipment in puddles, mud, discolored surfaces, or on drums and other containers. Eating, smoking and drinking beverages is not allowed in areas of contamination. This reduces the likelihood of contamination by ingestion.

III. Well Purging and Sampling.

Skin and eye contact with contaminated groundwater and/or soil may occur during these tasks. Nitrile butyl rubber or neoprene gloves and approved safety goggles should be worn when contact with contaminated substance and/or splash is possible. The use of gloves will also reduce the possibility of contamination of samples from hands.

IV. Soil and Surface Water Sampling

Skin and eye contact with contaminated surface water and/or soil may occur during these tasks. Nitrile butyl rubber or neoprene gloves and approved safety goggles should be worn when contact with contaminated substance and/or splash is possible. The use of gloves will also reduce the possibility of contamination of samples from hands.

V. Sample Preservation:

When sulfuric or nitric acid is used, skin and eye contact can occur. This hazard can be reduced with the use of Nitrile butyl rubber or neoprene gloves and the use of safety goggles.

VI. Spill and Disposal Procedures

Water which is purged from monitoring wells and private wells is not anticipated to be considered RCRA Hazardous Waste. This determination is based upon prior analysis of the groundwater. This purge water will be discharged on-site next to the wells. Other materials of which spills of concern involve the acids with which to preserve water samples. Spills will be contained with an absorbent material such as paper towels and which will be properly disposed.

5.0 PERSONAL PROTECTIVE EQUIPMENT

Level D is the minimum acceptable level for this site.

Level D includes:

- coveralls/work uniform
- steel toe and shank boots
- Nitrile butyl rubber or neoprene gloves (optional)
- splash goggles/safety glasses if potential for splash
- hard hat (recommended)
- fluorescent vest or brightly colored clothing
- dust mask

Level C (if necessary)

- same as above plus use of NIOSH-approved respirator for removal of respirable dust*

All operations conducted at this site have the potential to contaminate monitoring equipment and personal protective equipment (PPE). To prevent the transfer of contamination to vehicles, administrative areas and personnel, the following procedures must be followed:

5.1 Equipment Decontamination

Whenever possible, field equipment such as hand auger, shovel or water sampling bucket should be decontaminated by thoroughly rinsing with water prior to leaving the immediate work area. Decontamination of the X-ray fluorescence will require the gentle brushing of the monitoring plate with tissues. These procedures will prevent cross contamination from various sampling points.

5.2 Personal Decontamination

LEVEL D

- segregate equipment drop
- brush/rinse outer boot (as appropriate)
- wash/rinse chemical resistant outer glove, then remove (as appropriate)
- remove and throw out inner disposable gloves in designated lined receptacles (as appropriate)

LEVEL C

- remove respirator/hard hat and dispose of cartridges and wash respirator

6.0 AIR MONITORING

Respirable dusts represents the most significant air hazard at this site. Ongoing visual observation during field activities by each technician will ensure a working environment where respirable dust is minimized. The identification of dust cloud generation from the waste sources (i.e. mine waste dumps or tailings ponds) will trigger the use of dust masks or respirators.

Tasks which will be performed within the underground mine is considered work within a confined space. Procedures to ensure a non-hazardous atmosphere will entail following the Site Safety Plan of Molycorp, Inc.

7.0 HEALTH AND SAFETY REQUIREMENTS

7.1 Medical Monitoring Program

All NMED staff are required to have annual medical evaluations in accordance with the federal and state Health and Safety Program policy. Additional re-evaluation will be considered in the event of chemical over-exposure while working on this site.

The respirable dusts potentially generated at the mine waste dumps and tailings disposal ponds are most likely to cause respiratory impairment and eye irritation. The medical evaluation will, therefore, focus on spirometry tests.

7.2 Training

All personnel working at this site should have received a minimum of 40 hours of initial hazardous waste activity instruction, and a minimum of three days of field experience under the direct supervision of a trained, experienced person. Personnel assigned to the site will also receive eight hours refresher training per year. On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations have received an additional eight hours of supervisory training. These training requirements comply with the OSHA Hazardous Waste Operations and Emergency Response regulation, 29 CFR 1910.120.

The initial 40-hour training and the 8-hour annual refresher training includes specific details on the following:

- Regulatory Requirements
- First Aid/CPR
- Confined Space Entry
- Respiratory Protection
- Air Monitoring
- Decontamination Procedures
- Hazard Communication
- Toxicology

These specifications are then complimented with actual hands-on experience with the use of personal protective equipment and air monitoring equipment.

7.3 Emergency Equipment

Vehicles used for site work will be equipped with a first aid kit and safety equipment including:

- fluorescent vests,
- flags (as needed)
- fire extinguisher-dry chemical ABC-type extinguisher,
- flashlight,
- water, suitable for drinking,
- portable eye wash,
- appropriate emergency bandage material.

7.4 General Health

Medicine and alcohol can increase the effects of exposure to toxic chemicals. Unless specifically approved by a qualified physician, prescription drugs should not be taken by personnel assigned to operations where the potential for absorption, inhalation, or ingestion of toxic substances exists.

Drinking alcoholic beverages is prohibited. Drinking alcoholic beverages and driving is prohibited at any time. Driving at excessive speeds is always prohibited.

Skin abrasions must be thoroughly protected to prevent chemicals from penetrating the abrasion. It is recommended that Contact Lenses not be worn by persons working on the site.

7.5 MSDS Information

Material Safety Data Sheets (MSDS) on chemical substances encountered at the site shall be made available to all persons (including subcontractors) working at the site. These MSDSs shall be enclosed within this site safety plan in Appendix A-3. For emergency situations not specifically addressed by this site safety plan, refer to MSDS recommendations for action information.

7.6 Accident/Injury Reporting

All accidents or injuries will be reported using the form in Appendix A-4.

8.0 PROJECT PERSONNEL

NMED will oversee and act accordingly during all phases of the project. The following management structure will be instituted for the purpose of successfully and safely completing this project.

8.1 Project Manager:

Stuart Kent, NMED, is the Project Manager and Site Safety Manager for this project and is responsible for the field activities taken in conducting this Expanded Site Inspection. He is responsible for obtaining any necessary personnel or resources for the completion of the project. Specific duties will include:

- ensuring that the tasks assigned are being completed as planned and on schedule,
- preparing reports and recommendations about the project to NMED personnel, EPA and the public in a manner consistent with the Freedom of Information Act.
- ensuring that persons allowed to enter the site (i.e., EPA, contractors, state officials, visitors) are made aware of the potential hazards associated with the substances known or suspected to be on site, and are knowledgeable as to the on-site copy of the specific site safety plan.
- approving the selection of the types of personal protective equipment (PPE) to be used on site for specific tasks,
- evaluating weather and chemical hazard information and making any modifications to work plans or personal protection levels in order to maintain personnel safety,

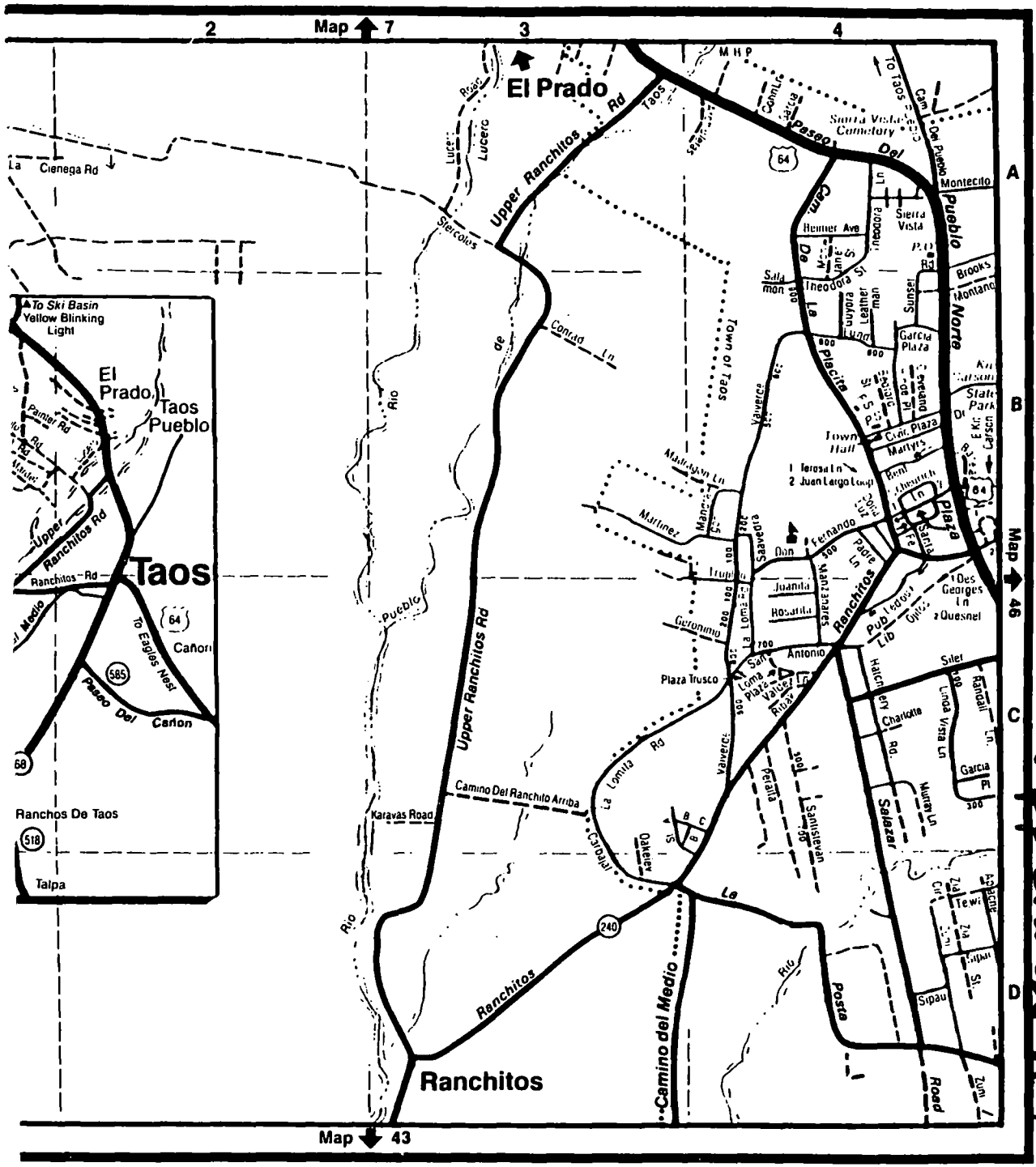
- monitoring the compliance of field personnel for the routine and proper use of the PPE that has been designated for each task,
- stopping work on the site or changing work assignments or procedures if any operation threatens the health and safety of workers or the public,
- knowing emergency procedures, evacuation routes and the telephone numbers of the ambulance, local hospital, poison control center, fire and police departments,
- ensure that all NMED personnel know and abide by Molycorp Safety Plan.

8.2 Field Team Leader

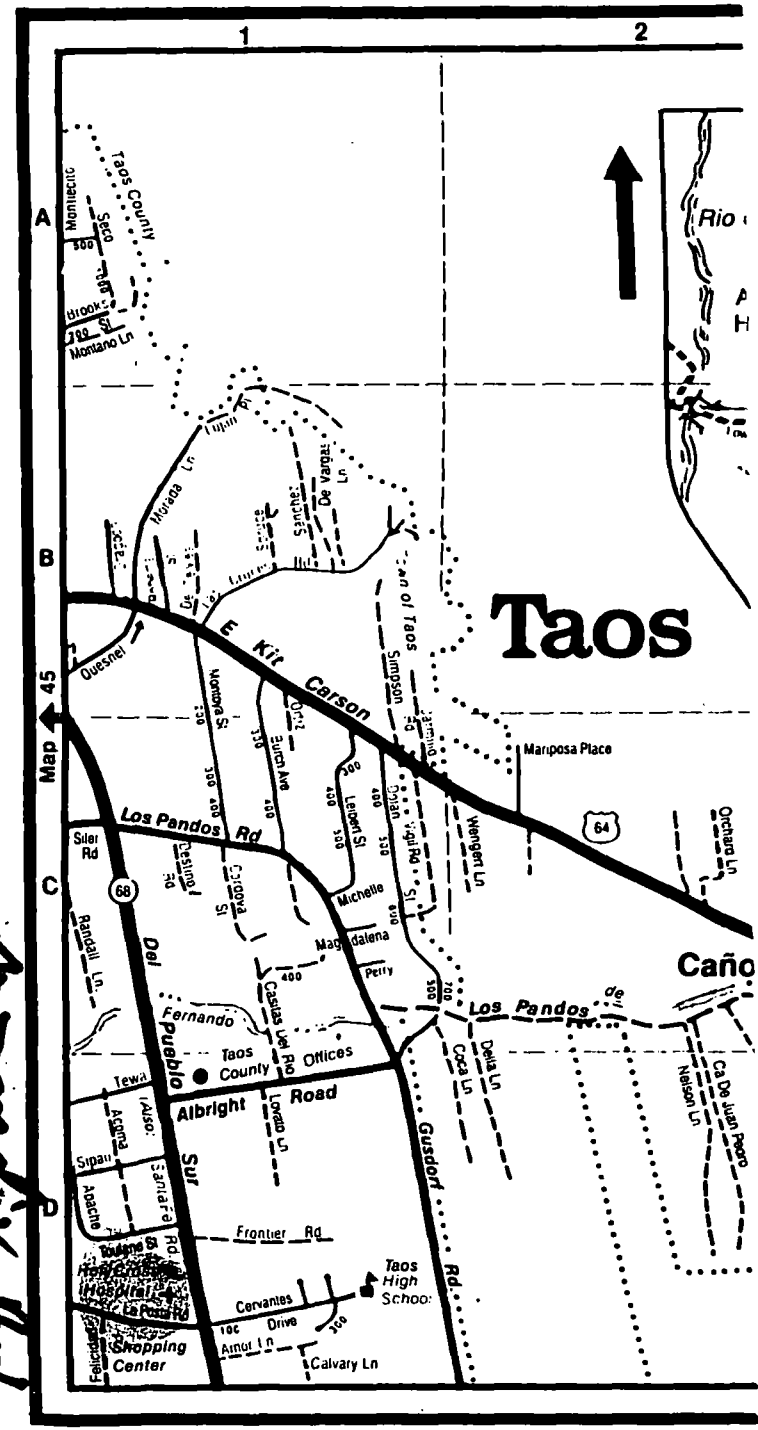
In the event that the Project Manager/Site Safety Officer is not available in the immediate vicinity, a Field Team Leader will be assigned and will assume all responsibility of the Site Safety Officer.

8.3 Other Field Personnel

Technician staff is responsible for system maintenance, calibration and system operation. Records of site visits documenting system conditions are maintained by the technicians. All field personnel shall be responsible for acting in compliance with all safety procedures outlined in the site safety plan. Any hazardous work situations or procedures should be reported to the Site Safety Officer so that corrective steps can be taken.



Map 7
El Prado
Upper Ranchitos Rd
Taos
Cienega Rd
Stercoles
Conrad Ln
Rio de Pueblo
Town of Taos
Paseo Del Pueblo Norte
Sierra Vista Cemetery
Montecito
Sierra Vista
Heimer Ave
Theodora St
Salamon
Brooks
Montano
Garcia Plaza
Town Hall
Martyrs
Plaza
Santa Fe
Fernando
Don
Juanita
Rosarita
Manzanares
Ranchitos
Geronimo
Antonio
Plaza Trusco
La Loma Rd
Vaivence
Saavedra
Martinez
Madragon Ln
Camino Del Ranchito Arriba
Karavas Road
Oakeley
Carbajal
Perafta
Santistevan
Salazar
Charlotte
Hatchery Rd
Murray Ln
Linda Vista Ln
Randall Ln
Garcia Pl
Siler
Zia
Tewa
Sipau
Zuni
Posta Road
Camino del Medio
Ranchitos
Rio
Map 46
Map 43
To Ski Basin
Yellow Blinking Light
El Prado
Taos Pueblo
Painter Rd
Upper Ranchitos Rd
Ranchitos Rd
Taos
To Eagles Nest
Cañon
Paseo Del Cañon
Ranchos De Taos
Talpa



Taos
Taos County
Montecito
Seco
Brooks
Montano Ln
Rio
Quesnel
E Kit Carson
Mariposa Place
Los Pandos Rd
Siler Rd
Del Pueblo Sur
Fernando
Taos County Offices
Albright Road
Tewa
Sipau
Apache
Santa Fe Rd
Frontier Rd
Cervantes Drive
Taos High School
Shopping Center
Calvary Ln
Gusdorf Rd
Los Pandos
Coca Ln
Delta Ln
Nelson Ln
Ca De Juan Pedro
Orchard Ln
Wengert Ln
Michelle
Magdalena
Perry
Castas Del Rio
Lovato Ln
Rio
Map 45

Appendix H-1

APPENDIX A-2

Agreement and Acknowledgement Statement

I have read and fully comprehended the Site Safety Plan stated above and agree to abide by the requirements of this plan.

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

NAME: _____ DATE: _____

Appendix A-3

Chemical Fact Sheet* February 1983

NITRIC ACID

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Azotic acid, hydrogen nitrate; CAS 7697-37-2.

Trade Names: Aqua Fortis, Nital, Nitryl Hydroxide, Engravers Acid, White fuming acid, Red fuming acid, WFNA, RFNA.

Uses: In the manufacture of fertilizer, explosives, pesticides, antibiotics, ceramics, pharmaceuticals, nylons, and dyes; as a laboratory reagent; in metallurgy as a pickling agent; in photoengraving and others.

PHYSICAL INFORMATION

Appearance: Colorless, yellow or red fuming liquid when concentrated. May be sold as a dilute solution.

Odor: Suffocating, acrid. Behavior in Water: Soluble.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 2 ppm.

NIOSH Recommended Limit: Average 10 hour day/40 hour week -- 2 ppm.

ACGIH Recommended Limit: Average 8 hour exposure -- 2 ppm.

Short Term Exposure:

Inhalation: Contact with vapor or mist may cause dryness or severe irritation of the nose and throat, cough, diffult breathing, chest pain and bluish coloration of the skin. 62 ppm can cause immediate throat irritation. Vapor or mist can cause inflammation, injury and congestion of the lungs which can be fatal. Onset of symptoms may be delayed 4-30 hours.

Skin: Can cause painful inflammation, blisters, severe irritation, gangrene and second or third degree burns. May stain skin a bright yellow or yellowish brown color.

Eyes: May cause severe irritation or burns, swelling of the eyelids and permanent damage.

Ingestion: Can cause corrosion and burning of the mouth, throat and stomach; abdominal pain; vomiting; shock; and collapse. As little as 1/6 ounce of concentrated acid has caused death.

Long Term Exposure:

Inhalation of mists or vapors can cause tooth erosion, bronchitis, lung inflammation and skin irritation.

*Prepared by the Bureau of Toxic Substance Assessment, New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.

EMERGENCY AND FIRST AID INSTRUCTION

Inhalation: Move person to fresh air. Give artificial respiration or oxygen as required. Seek medical attention immediately.

Skin: Remove contaminated clothes immediately. Blot off excess acid. Wash affected area with large amounts of water for at least five minutes. Seek medical attention.

Eyes: Wash with large amounts of water for at least 15 minutes. Seek medical attention immediately.

Ingestion: If conscious, give large quantities of water or milk of magnesia. Do NOT induce vomiting. Seek immediate medical attention

Note to Physician: Avoid gastric lavage or emetics. Administer a neutralizer and diluent such as magnesium oxide, milk of magnesia or lime water. Avoid carbonates and bicarbonates. Effects due to inhalation may be delayed up to several days.

FIRE AND EXPLOSION INFORMATON

General: Non-flammable. Reacts explosively with combustible materials. When mixing with water always add the acid to the water to avoid dangerous splattering and release of heat.

REACTIVITY

Conditions to Avoid: Contact with heat, water or steam can cause breakdown into poisonous nitrogen oxides.

Materials to Avoid: May react with many organic and inorganic substances, including native metals, wood and sawdust. Reacts explosively with readily oxidizable materials. Contact with strong bases may cause violent spattering.

PROTECTIVE MEASURES

Storage and Handling: Store in stainless steel, aluminum or glass containers in a well-ventilated area. Store separately from incompatible substances, away from sunlight and heat sources.

Engineering Controls: Use local exhaust or general dilution ventilation. Use process enclosure where possible. Sinks, showers and eyewash stations should be readily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): If direct contact is likely, wear splash-proof goggles, face shield, impervious clothing, rubber apron, and neoprene, vinyl or Viton gloves.

Protective Equipment: For levels up to 125 mg/m^3 wear a chemical cartridge respirator with a full facepiece and cartridges providing protection against airborne nitric acid and nitrogen oxides, a gas mask providing protection against airborn nitric acid and nitrogen oxides, any supplied air respirator with a full facepiece, or any self-contained breathing apparatus with a full facepiece. For up to 250 mg/m^3 wear a Type C supplied-air respirator or a self-contained breathing apparatus, both with a full facepiece. For up to 500 mg/m^3 wear a Type C supplied-air respirator with a full facepiece operated in a positive pressure mode. For levels greater than 500 mg/m^3 wear a self-contained breathing apparatus operated in a positive pressure mode or a Type C supplied-air respirator with a full facepiece operated in a positive pressure mode and an auxiliary self-contained breathing apparatus operated in a positive pressure mode. For escape from a contaminated area wear a self-contained breathing apparatus with a full facepiece operated in a positive pressure mode.

PROCEDURES FOR SPILLS AND LEAKS

Warn all workers of spill. Wearing proper protective clothing and equipment, ventilate area. Neutralize with alkaline material such as soda ash or lime. Place in appropriate containers. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information:

Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.

Chemical Fact Sheet* July 1982

SULFURIC ACID

The information in this sheet applies to workplace exposure resulting from processing, manufacturing, storing or handling and is not designed for the population at large. Any generalization beyond occupational exposures should not be made. The best industrial hygiene practice is to maintain concentrations of all chemicals at levels as low as is practical.

Chemical Names: Sulphuric Acid; CAS 7664-93-9.

Trade Names: Vitriol brown oil, oil of vitriol, dipping acid and boy.

Uses: In the production of fertilizers, chemicals, pigments, rayon, film, explosives and parchment paper; in petroleum refining, non-ferrous metallurgy, etching and alkylation.

PHYSICAL INFORMATION

Appearance: Clear, colorless to brownish, oily liquid.

Odor: Pungent

Behavior in Water: Very soluble , gives off large amounts of heat.

Evaporation: Liquid evaporates slowly.

HEALTH HAZARD INFORMATION

OSHA Standard: Average 8 hour exposure -- 1 mg/m^3.

NIOSH Recommended Limit: Average 8 hour exposure -- 1 mg/m^3.

ACGIH Recommended Limit: Average 8 hour exposure -- 1 mg/m^3.

Short Term Exposure:

Inhalation: May cause irritation of nose and throat at levels of 5 mg/m^3. Swelling of the throat and lungs and inflammation of the bronchial membranes may occur at levels of 12-35 mg/m^3. A few drops in the lung air passages may be fatal.

Skin: May cause severe irritation, burns and ulceration.

Eyes: May cause severe irritation, damage to the cornea and blindness.

Ingestion: May cause damage to teeth, burning of the mouth, throat and stomach, nausea, vomiting of blood and eroded tissue, holes in the stomach and intestines, shock and kidney damage. Death may occur from as little as one ounce.

Long Term Exposure:

Exposure to amounts greater than 3.0 mg/m^3 may cause all of the above symptoms in greater severity.

*Prepared by the Bureau of Toxic Substance Assessment , New York State Department of Health. For an explanation of the terms and abbreviations used, see "Toxic Substances: How Toxic is Toxic" available from the New York State Department of Health.

EMERGENCY AND FIRST AID INSTRUCTIONS

Inhalation: Move person to fresh air. Give artificial respiration or oxygen, if necessary. Seek medical attention, if necessary.

Skin: Immediately take off clothing soaked with chemical. Blot off as much as possible. Wash skin with large amounts of soap and water. Seek medical attention if required.

Eyes: Wash for at least 15 minutes with large amounts of water. Consult an eye doctor immediately.

Ingestion: Give large amounts of water if the victim is conscious. Seek immediate medical attention.

Note to Physician: If gastric lavage is performed, suggest endotracheal and/or esophagoscopic control. Oxygen, with use of intermittent positive - pressure breathing apparatus: 5% solution of sodium bicarbonate as aerosol may be used, as well as broncodilators and decongestants.

FIRE AND EXPLOSION INFORMATION

General: Non-flammable, capable of igniting finely divided combustible materials.

Extinguisher: Use carbon dioxide or dry chemical. Use water on combustibles burning in vicinit of this material but use extreme care as water applied directly to this acid results in generation of heat and causes splattering.

REACTIVITY

Conditions to Avoid: Moisture may cause release of large quantities of heat.

Materials to Avoid: Reacts violently with metals, nitrates, chlorates, carbides, fulminate, picrates and organic chemicals.

PROTECTIVE MEASURES

Storage and Handling: Store in glass bottles in a cabinet separate from materials listed above. Avoid physical damage.

Engineering Controls: Use in enclosed processes where possible; otherwise, use in a well ventilated area with no cross drafts. Sinks, showers and eyewash stations should be easily available.

Protective Clothing (Should not be substituted for proper handling and engineering controls): Chemical goggle, faceshield, rubber gloves, neoprene or PVC boots and acid resistant aprons should be worn.

Protective Equipment: For levels up to 50 mg/m^3 use a high efficiency particulate filter respirator, a supplied-air respirator or a self-contained breathing apparatus, all with a full facepiece, or a gas mask with an acid gas canister and a high efficiency particulate filter. For up to 100 mg/m^3 use a Type C supplied-air respirator with a full facepiece and operated in a positive pressure mode. For levels greater than 100 mg/m^3 or in areas of unknown concentrations use a self-contained breathing apparatus or a combination Type C supplied-air respirator with an auxiliary self-contained breathing apparatus, all with a full facepiece and operated in a positive pressure mode. For escape from a contaminated area use a gas mask with an acid gas canister and a high efficiency particulate filter or an escape self-contained breathing apparatus.

PROCEDURES FOR SPILLS AND LEAKS

Get all workers out of the spill area. Provide ventilation. Neutralize spill with sodium bicarbonate or sodium carbonate or soda ash. Shovel slurry into suitable container. For final disposal contact your regional office of the New York State Department of Environmental Conservation.

For more information: Contact the Industrial Hygienist or Safety Officer at your worksite or the New York State Department of Health, Bureau of Toxic Substance Assessment, Empire State Plaza, Tower Building, Albany, New York 12237.

APPENDIX A-4 ACCIDENT/INJURY REPORT FORM

Employee's Name: _____ D.O.B. _____

Address: _____ D.O.H. _____

_____ SS# _____

Job Title: _____ Supervisors's Name: _____

Office Location: _____

Location at Time of Incident: _____

Date/Time of Incident: _____

Description: Describe clearly how the accident occurred:

_____

_____

_____

Was Incident: Physical _____ Chemical _____

Part(s) of body affected: _____ Exposure: Dermal _____

right left Inhalation _____

Ingestion _____

Witnesses: 1) _____ 2) _____

Conditions/acts contributing to this incident: _____

_____

_____

Explain specifically the corrective action you have taken to prevent a recurrence:

_____

_____

_____

Did the injured go to a doctor? _____ Where? _____

_____ When? _____

Did injured go to a hospital? _____ Where? _____

_____ When? _____

Signatures:

_____	_____	_____
Employee	Reporting Manager	Regional H&S Manager
_____	_____	_____
Date	Date	Date

NEW MEXICO ENVIRONMENT DEPARTMENT
GROUNDWATER PROTECTION AND REMEDIATION BUREAU
SUPERFUND SECTION

QUALITY ASSURANCE PROGRAM PLAN

State of New Mexico Contract No. 50/667.50/019

RECEIVED
SEP 1992

September 22, 1992

TABLE OF CONTENTS

1.0 IDENTIFICATIONS, CONCURRENCES, AND APPROVALS 1

2.0 INTRODUCTION 2

3.0 QUALITY ASSURANCE POLICY STATEMENT 3

4.0 QUALITY ASSURANCE MANAGEMENT 5
- 4.1 ORGANIZATION 5
- 4.2 RESPONSIBILITIES 5
  - 4.2.1 Bureau Chief 5
  - 4.2.2 Program Manager 5
  - 4.2.3 Technical Supervisors 6
  - 4.2.4 Project Manager 6
  - 4.2.5 Quality Assurance Officer 6
- 4.3 DOCUMENT AND INFORMATION CONTROL 7
- 4.4 QUALITY ASSURANCE PROGRAM ASSESSMENT 8

5.0 PERSONNEL QUALIFICATIONS AND TRAINING 9
- 5.1 PROGRAM MANAGER QUALIFICATIONS 9
- 5.2 GEOLOGIST III QUALIFICATIONS 9
- 5.3 ENVIRONMENTAL SPECIALIST QUALIFICATIONS 10
- 5.4 QA OFFICER QUALIFICATIONS 10
- 5.5 ENVIRONMENTAL SCIENTIST QUALIFICATIONS 10
- 5.6 TRAINING 11

6.0 EQUIPMENT AND SERVICES 12
- 6.1 EQUIPMENT 12
- 6.2 PROCURED ITEMS AND SERVICES 12

7.0 DATA GENERATION 13
- 7.1 WORK PLANS AND TASK ACTIVITIES 13
- 7.2 STANDARD OPERATING PROCEDURES 14

8.0 DATA PROCESSING 15
- 8.1 DATA COLLECTION 15
- 8.2 VALIDATION 16
- 8.3 DATA STORAGE 17
- 8.4 REDUCTION 17

9.0 DATA QUALITY ASSESSMENT 18
- 9.1 PRECISION 18
- 9.2 ACCURACY 18
- 9.3 COMPLETENESS 19
- 9.4 REPRESENTATIVENESS 19
- 9.5 COMPARABILITY 20
- 9.6 DATA QUALITY OBJECTIVES 20

10.0 CORRECTIVE ACTION SYSTEM 21

11.0 IMPLEMENTATION REQUIREMENTS AND SCHEDULE 22

APPENDIX A FIELD LOGBOOK CHECKLIST EXAMPLE
APPENDIX B SELECTED ANALYTICAL METHODS
APPENDIX C FUNCTIONAL GUIDELINES FOR DATA REVIEW

APPENDIX C

FUNCTIONAL GUIDELINES FOR DATA REVIEW

LABORATORY DATA VALIDATION

FUNCTIONAL GUIDELINES FOR EVALUATING INORGANICS ANALYSES

Prepared for the

HAZARDOUS SITE EVALUATION DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

Compiled by

Ruth Bleyler
Sample Management Office
Viar & Company

Prepared by

The USEPA Data Review Work Group
Jeanne Hankins - EPA Region III - Chairperson
Frank Messina, Laura Scalise - EPA Region II
Gary Bennett - EPA Region IV
Ida Levin - EPA Region V
Mahmoud El-Feky - EPA Region VI
Larry Marchin - EPA Region VII

July 1, 1988

TABLE OF CONTENTS

Page

INTRODUCTION 1

PRELIMINARY REVIEW 2

INORGANICS PROCEDURE 2

I. Holding Times 3

II. Calibration 4

III. Blanks 6

IV. ICP Interference Check Sample (ICS) 7

V. Laboratory Control Sample (LCS) 9

VI. Duplicate Sample Analysis 10

VII. Matrix Spike Sample Analysis 11

VIII. Furnace Atomic Absorption QC 12

IX. ICP Serial Dilution 13

X. Sample Result Verification 14

XI. Field Duplicates 14

XII. Overall Assessment of Data for a Case 15

GLOSSARY A: Data Qualifier Definitions 16

GLOSSARY B: Additional Terms 17

INTRODUCTION

This document is designed to offer guidance in laboratory data evaluation and validation. In some aspects, it is equivalent to a Standard Operating Procedure (SOP). In other, more subjective areas, only general guidance is offered due to the complexities and uniqueness of data relative to specific samples. These Guidelines have been updated to include all requirements in the 7/87 Statement of Work (SOW) for Inorganics, Amendment 1 and December 1987 Revisions.

Those areas where specific SOPs are possible are primarily areas in which definitive performance requirements are established. These requirements are concerned with specifications that are not sample dependent; they specify performance requirements on matters that should be fully under a laboratory's control. These specific areas include blanks, calibration standards, calibration verification standards, laboratory control standards, and interference check standards. In particular, mistakes such as calculation and transcription errors must be rectified by resubmission of corrected data sheets.

This document is intended for technical review. Some areas of overlap between technical review and Contract Compliance Screening (CCS) exist; however, determining contract compliance is not intended to be a goal of these guidelines. It is assumed that the CCS is available and can be utilized to assist in the data review procedure.

At times, there may be an urgent need to use data which do not meet all contract requirements and technical criteria. Use of these data does <u>not</u> constitute either a new requirement standard or full acceptance of the data. Any decision to utilize data for which performance criteria have not been met is strictly to facilitate the progress of projects requiring the availability of the data. A contract laboratory submitting data which are out of specification may be required to rerun or resubmit data even if the previously submitted data have been utilized due to urgent program needs; data which do not meet specified requirements are never fully acceptable. The only exception to this requirement is in the area of requirements for individual sample analysis; if the nature of the sample itself limits the attainment of specifications, appropriate allowances must be made. The overriding concern of the Agency is to obtain data which are technically valid and legally defensible.

All data reviews must have, as a cover sheet, the Inorganic Regional Data Assessment (IRDA) form. (A copy is attached at the end of this document.) If mandatory actions are required, they should be specifically noted on this form. In addition, this form is to be used to summarize overall deficiencies requiring attention, as well as general laboratory performance and any discernible trends in the quality of the data. (This form is not a replacement for the data review.) Sufficient supplementary documentation must accompany the form to clearly identify the problems associated with a Case. The form and any attachments must be submitted to the Contract Laboratory Program Quality Assurance Coordinator (CLP QAC), the Regional Deputy Project Officer (DPO), and the Environmental Monitoring Systems Laboratory in Las Vegas (EMSL/LV).

It is the responsibility of the data reviewer to notify the Regional DPO concerning problems and shortcomings with regard to laboratory data. If there is an urgent requirement, the DPO may be contacted by telephone to expedite corrective action. It is recommended that all items for DPO action be presented at one time. In any case, the Inorganic Regional Data Assessment form must be completed and submitted.

1.0 IDENTIFICATIONS, CONCURRENCES, AND APPROVALS

Concurrences:

Randy Merker, Program Manager
Superfund Section
(505) 827-0078
Santa Fe, New Mexico

Signature _____ Date _____

Steve Cary, Chief
Groundwater Protection and Remediation Bureau
(505) 827-2919
Santa Fe, New Mexico

Signature _____ Date _____

Agency Approval:

Mark Satterwhite, EPA State Project Officer
(214) 655-6710
Dallas, Texas

Signature _____ Date _____

Charles R. Ritchey, EPA Regional Quality Assurance Officer
(214) 655-2217
Dallas, Texas

Signature _____ Date _____

LIST OF ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CPCA	Core Program Cooperative Agreement
DQO	Data Quality Objective
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
ESI	Expanded Site Inspection
FOIA	Freedom of Information Act
FS	Feasibility Study
HRS	Hazard Ranking System
HSP	Health and Safety Plan
IATA	International Air Transport Association
NMED	New Mexico Environment Department
NPL	National Priorities List
PA	Preliminary Assessment
PID	Photoionization Detector
PRP	Potential Responsible Party
QAPP	Quality Assurance Program Plan
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendment and Reauthorization Act
SI	Site Inspection
SMO	Sample Management Office
SOP	Standard Operating Procedure
SQL	Sample Quantitation Limit
TBD	To Be Determined
VOC	Volatile Organic Compound

2.0 INTRODUCTION

This Quality Assurance Program Plan (QAPP) states the Quality Assurance (QA) requirements applicable to the Superfund Section of the Groundwater Protection and Remediation Bureau of the New Mexico Environment Department.

Activities shall be planned, implemented, and maintained as required by this QAPP.

The Superfund Section provides the following services to the State and EPA Region VI:

1. Management Assistance of National Priority List Sites
2. Preliminary Assessments
3. Site Inspections
4. HRS Packages
5. RIs/FSs
6. Cost Accounting and Cost Recovery Documentation
7. Community Relations

The purpose of this QAPP is to define and describe the policies, objectives, concepts, systems, procedures, and responsibilities that the Superfund Section shall use in its QA Program. The QA requirements and procedures defined in this plan shall be applicable to all tasks under the program.

The following terms are defined for the purposes of this document:

Quality Assurance (QA) is an integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Control (QC) is the routine application of operations and procedures for obtaining prescribed standards of performance in the monitoring and measurement process.

3.0 QUALITY ASSURANCE POLICY STATEMENT

The Superfund Section's commitment is to provide adequate resources necessary to ensure development and implementation of the QA Program by requesting these resources from the EPA as part of the budgeting process.

The Superfund Section's goal is to generate and produce high-quality data that are valid, complete, traceable, and defensible and to ensure that data quality objectives (DQOs) are met. It is the Superfund Section's responsibility to provide this QAPP, along with appropriate implementing instructions, to all staff. It is also the responsibility of each person working in the Superfund Section to know and comply with the requirements and policies established by this QAPP.

The intent of the QA Program is to implement applicable requirements and to verify that activities affecting quality are performed correctly. Personnel shall have sufficient authority, access to work areas, and organizational freedom to identify quality-related problems; to recommend, initiate, or effect solutions through designated channels; and to verify implementation of the solutions to ensure that unsatisfactory conditions are corrected. Personnel shall have direct access to responsible management, at a level where the appropriate authority and organizational freedom, including sufficient independence from cost and schedule, can effect an appropriate action.

The key elements of the Superfund Section's QA Program include the following:

- The QA Program shall be designed and executed by personnel knowledgeable about QA practices. Periodic QA/QC training in each activity shall be provided for new and current staff.

- Equipment affecting data quality or integrity shall be routinely inspected and maintained, as defined by Standard Operating Procedures (SOPs) or manufacturer's instructions.

- An SOP document shall be developed and maintained to direct most routine activities performed by the Superfund Section.

- Chain-of-custody procedures shall be maintained for all samples as described in the "NEIC Policies and Procedures Manual," May 1978, revised 1986 (EPA-330/9-78-001-R).

- All field and laboratory measurements and related information shall be documented in a clear and consistent manner.

- Proper documentation and accounting shall be maintained for all expenses for the purpose of cost recovery.

- The intended use of the data and the associated acceptance criteria for data quality shall be determined before data collection efforts begin.
- Reported data shall include, when appropriate, statements of precision, accuracy, representativeness, completeness, and comparability.
- The QAPP will be reviewed at least annually and updated and revised as necessary.

Upon approval by the EPA, this plan shall be used by all Superfund Section personnel and its contractors and subcontractors.

4.0 QUALITY ASSURANCE MANAGEMENT

4.1 ORGANIZATION

The QA Program shall be implemented at every management and technical level and by all Superfund Section staff to ensure that effective quality management is achieved. A Quality Assurance Officer will be appointed at a future date to assume QA responsibilities for the Superfund Section. Implementation of the QAPP requires that the entire staff be cognizant of the plans, goals, and procedures.

The key management positions and their relationship with EPA Region VI personnel are shown in Exhibit 1.

4.2 RESPONSIBILITIES

4.2.1 Bureau Chief

The Chief of the Groundwater Protection and Remediation Bureau is responsible for directing the planning, management, and implementation of environmental programs and activities for the Bureau.

4.2.2 Program Manager

The Superfund Section Program Manager coordinates the overall management of the Superfund Section, including the following tasks:

- Communicates EPA and NMED policy to Superfund Section staff;
- ensures that the Superfund Section's activities are consistent with the goals and objectives of the EPA's and the State's program requirements;
- coordinates with Bureau Chief on NMED management, other NMED programs, and on site-specific and policy issues;
- manages cost, schedules, and performance;
- ensures the establishment, implementation, and support of the QA and Health and Safety Programs; and
- performs personnel actions.

4.2.3 Technical Supervisors

Technical Supervisors are responsible for:

- Oversight of day-to-day operations, including planning, scheduling, and reporting of technical and related activities;
- reviews all Superfund Section deliverables to EPA for technical content and composition;
- delegates projects and tasks;
- coordinates site-specific issues within program and bureau;
- peer review of reports generated by other supervisors;
- compliance with the Superfund Section's QA Plan; and
- interaction with the Superfund Section Program Manager to resolve quality concerns.

4.2.4 Project Manager

The responsibilities of the Project Managers include the following:

- Preparation of Work Plans, Health and Safety Plans, and Technical Reports;
- oversight of contractors, as appropriate;
- compliance with the Superfund Section's QA Plan;
- peer review of reports generated by other Project Managers; and
- maintenance of field and laboratory equipment.

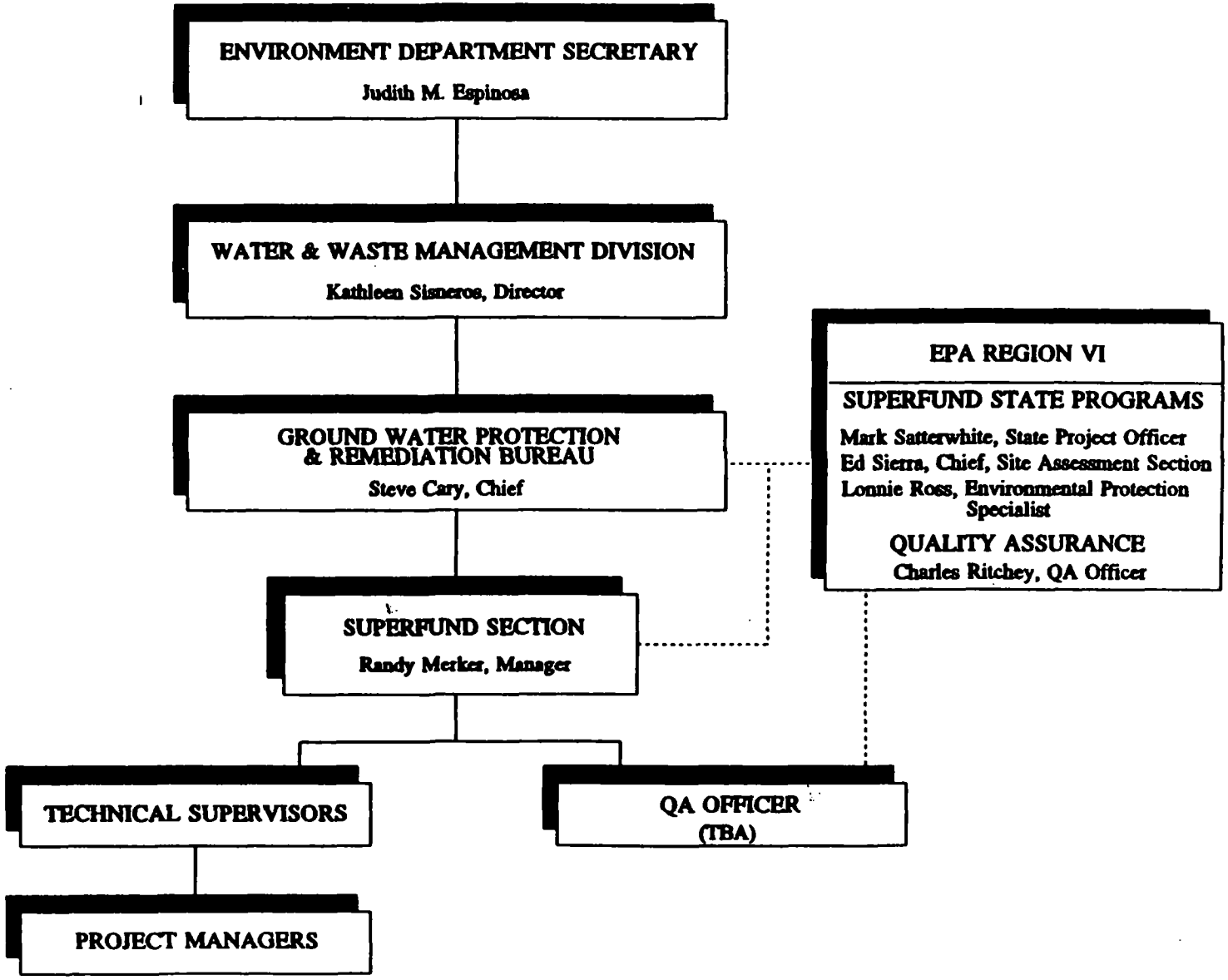
4.2.5 Quality Assurance Officer

The responsibilities of the QA Officer include the following:

- Contact for all QA matters internally and externally (i.e. subcontractor and EPA Regional QA Officer);
- liaison between the Superfund Section and the EPA's Regional Quality Assurance Officer and the CLP;

Exhibit 1

STATE OF NEW MEXICO ORGANIZATION CHART



- maintaining and initiating QA improvements;
- implementing corrective actions, peer review system, and document and information control for the Superfund Section;
- assisting Project Managers in the development of Work Plans;
- providing training, oversight, and QA guidance;
- verifying that personnel are qualified to conduct assigned work; and
- reporting to the Bureau Chief, if QA matters are not resolved within the Superfund Section.

4.3 DOCUMENT AND INFORMATION CONTROL

Document Control is required for each project so that hard copy documentation is included in the project files. The project files shall be cross-referenced with Cost Recovery files.

The Superfund Section Document Control System shall require that:

- All measurements, observations, and calculations be recorded in a clear and permanent manner at the time they are made;
- document custody be maintained through appropriate records and signatures;
- documentation be orderly and legible so that it can be easily interpreted by staff other than those responsible for its generation;
- all confidential site information shall be kept in separate files clearly labelled confidential. No confidential files shall be viewed by persons other than NMED personnel (i.e., persons making Freedom of Information Act (FOIA) requests);
- records contain complete documentation of any departure from an SOP or work plan specifications, including authorizations for such departures;
- corrections to documents be made by drawing a single line through the error, entering the correct information, initialing and dating the entry; and
- all documents, including photographic and electronic records, be protected from loss, damage, misuse, or deteriorization.

Documents to be maintained include sample identification and chain-of-custody documents, logbooks, laboratory data, calculations, field data records, correspondence, notes, references, photographs, maps, drawings, Health and Safety Plans, training records, and technical reports.

4.4 QUALITY ASSURANCE PROGRAM ASSESSMENT

The Superfund Section will continually review its QA program for effectiveness. Periodic assessments will be conducted and an annual written report will be submitted to the EPA Region VI QA Officer. This QA report will include the following information:

- Status of or changes to the QA Program Plan;
- measures of data quality;
- significant QA problems, corrective actions, and recommendations;
- results of performance or system audits;
- status of QA requirements for contracts and grants; and
- summary of QA training.

5.0 PERSONNEL QUALIFICATIONS AND TRAINING

The success of the Superfund Section's QA Program depends upon the skills and job knowledge of the program personnel. Specific qualifications of the New Mexico Environment Department personnel are provided in the following sections.

5.1 PROGRAM MANAGER QUALIFICATIONS

The Program Manager plans, directs, implements, and evaluates programs having significant public agency and financial impact; supervises a staff of professional and clerical personnel; determines program goals and objectives; and prepares and implements operating procedures.

The Program Manager must meet or exceed the following qualifications:

- A Bachelor's Degree in any field plus five years of graduate education and/or experience in a physical or natural science, engineering, business or public administration including industrial relations and/or law, public or environmental health.
- Extensive knowledge of the program areas to be managed.
- Ability to direct the operation of a large professional and clerical staff and to establish program policy.

5.2 GEOLOGIST III QUALIFICATIONS

A Geologist III must meet or exceed the following qualifications:

- A Bachelor's degree from an accredited college or university with a major in geology, geophysics, or a related geological field plus any combination of graduate education in the above fields and/or job-related geological experience equalling five years, three years of which must have been experience.
- Considerable knowledge of principles and practices of geology, and of supervison.
- Ability to supervise and to express ideas clearly, both orally and in writing; to maintain effective relations with businessmen, government officials and the public.

5.3 ENVIRONMENTAL SPECIALIST QUALIFICATIONS

An Environmental Specialist must meet or exceed the following qualifications:

- A Bachelor's Degree from an accredited college or university including or supplemented by thirty semester hours in a natural, physical, environmental, computer, or dairy science; engineering, mathematics, statistics, radiological, or public health, and any combination of additional education or experience in an environmental field totaling six years, four years of which must have been in hazardous waste management.

- In-depth knowledge of statistics, higher mathematics and physics, chemistry, and/or biology; of principles and research methods in a specialty (including environmental health microbiology, wildlife management, and epidemiology); of instrumentation; of the assessment of environmental problems; considerable knowledge of the techniques of program planning, evaluation, and training.

- Ability to design and conduct complex research, investigation, and/or regulatory activities and draw conclusions from results; to communicate effectively, orally, and in writing; to act as expert consultant in specialty.

5.4 QA OFFICER QUALIFICATIONS

The QA Officer for the Superfund Section must meet or exceed the qualifications of an Environmental Scientist.

5.5 ENVIRONMENTAL SCIENTIST QUALIFICATIONS

An Environmental Scientist must meet or exceed the following qualifications:

- A Bachelor's Degree from an accredited college or university including or supplemented by thirty semester hours in a natural, physical, environmental, computer, or dairy science; engineering, mathematics, statistics, radiological, or public health, and any combination of additional education or experience in an environmental field totaling two years, one year of which must have been in hazardous waste management.

- Good knowledge of higher mathematics and statistics; of environmental codes, standards, regulations, and enforcement procedures relating to specialty; of principles and research methods within field of specialization; of sampling survey, inspection, and investigative techniques; of scientific field and laboratory equipment and its calibration, maintenance, and use; of interpretation of laboratory results and principles.

- Ability to accurately collect samples and conduct tests for evaluations; to effectively communicate orally and in writing; to conduct research in the area of specialization; to effectively operate and maintain highly sensitive instruments; to determine control measures in specialty; to provide consultation services to associates and the public.

5.6 TRAINING

On-the-job training is performed by the Superfund Section. This training consists of observing the task, performing the task with supervision, and performing the task without supervision, but with close scrutiny. The observation period will give the employee time to become familiar with task procedures, including equipment location, technical protocols, and documentation procedures. All employees shall be 40-hour OSHA trained and will undergo an annual 8-hour Refresher Course to maintain OSHA Certification for working at hazardous waste sites. Employees will also receive an 8-hour OSHA Supervisor Training Course. Technical training will be provided to all employees as needed for specific needs.

Documentation of training, including Health and Safety training, will be maintained in the Document Control System.

6.0 EQUIPMENT AND SERVICES

The following subsections apply to all Superfund equipment, supplies, and services where quality or safety could be affected.

6.1 EQUIPMENT

General laboratory and field equipment must be present in sufficient quantity and condition and operationally consistent with their intended use to provide for the generation and processing of environmental data resulting in known and documented quality and integrity.

All equipment used for monitoring, measuring, or testing must have an established calibration and preventative maintenance schedule. Calibration and maintenance shall be performed according to the manufacturer's guidelines.

Permanent maintenance records for equipment, including detailed descriptions of adjustments made, parts replaced, etc., shall be kept in bound notebooks or logbooks. Each notebook entry should be signed and dated.

6.2 PROCURED ITEMS AND SERVICES

The procurement of items and services shall be controlled to assure conformance with specified requirements of the State of New Mexico. The extent to which these controls are applied is dependent on the importance, complexity, and cost of the item or service.

7.0 DATA GENERATION

All data generated in the Superfund Section must be scientifically valid, defensible, comparable, and of known precision and accuracy.

7.1 WORK PLANS AND TASK ACTIVITIES

Work plans shall be prepared and site activities will be conducted using the following guidance as necessary:

- New Mexico Environmental Improvement Division, Monitoring Well Construction and Abandonment Policy, dated December 1989;
- "Guidance for Performing Preliminary Assessments under CERCLA," dated November 1991 (EPA/540/P-91/013);
- "Guidance for Performing Site Inspections under CERCLA," Interim version, dated November 1991;
- "A Compendium of Superfund Field Operations Methods," dated December 1987;
- "Hazard Ranking System, Final Rule," Federal Register, Vol. 55, No. 241, December 1990;
- "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," dated October 1988 (EPA/540/P-89/004);
- "User's Guide to Contract Laboratory Program," dated January 1991 (EPA/ 540/P-91/002); and
- "Samplers Guide to the Contract Laboratory Program," dated December 1990 (EPA/540/P-90/006).

Quality Assurance Project Plans (QAPjPs) shall be prepared for conducting Remedial Investigation and Feasibility Studies (RI/FSs). The "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," dated December 1980 QAMS-005/80, will be used in completing the QAPjPs.

New guidance will be used accordingly as the existing versions are updated.

7.2 STANDARD OPERATING PROCEDURES

Standard Operating Procedures (SOPs) describe standard operations, analyses, or actions where mechanics are thoroughly prescribed and documented and which is commonly accepted as the usual or normal method for performing certain routine or repetitive tasks.

SOPs shall be developed for most routine activities performed within the Superfund Section and shall be made available to all relevant staff. The SOPs shall be detailed documents describing the procedures in a stepwise manner and will be contained in one bound document. The SOPs shall include all field activities, QC activities, equipment maintenance, documentation, sample custody and handling procedures, sample transportation, replicate sampling, etc.

SOPs shall be revised as needed.

8.0 DATA PROCESSING

Precautions shall be taken by the Superfund Section to ensure that data collection, validation, storage, transfer, and reduction will be performed in a manner to prevent errors or loss of information.

8.1 DATA COLLECTION

All field data shall be recorded by field personnel in bound logbooks for each site. Pages will be consecutively numbered. Data initially collected shall be converted to standard reporting units and recorded in standard formats. Data shall be reviewed by the site Project Manager for translation or transcription errors. An example of a Logbook Checklist is included in Appendix A.

Laboratory data shall be generated under the USEPA's Contract Laboratory Program (CLP). Field samples will be collected and shipped to various laboratories which participate in the program. Chain-of-custody and CLP documentation are strictly maintained as an integral part of the CLP system.

The CLP laboratory carries out requested analyses adhering to strict procedural and documentation requirements which are specified in the USEPA CLP Statement of Work (SOW) for Organic Analysis Multimedia, Multi-concentration, the USEPA CLP SOW for Inorganic Analysis Multimedia, Multi-concentration, and the USEPA CLP SOW for Organics Multimedia, High Concentration. These documents are used by CLP laboratories throughout the U.S. to maintain a high degree of comparability, to enforce documentation requirements and to obtain data which are technically valid, legally defensible and of known quality.

Procedures specified in these documents are used to analyze Routine Analytical Services (RAS) samples, for two specific lists of common pollutants: the Target Compound List (TCL) for organic analyses and the Target Analyte List (TAL) for inorganic analyses.

Analyses not covered under the RAS SOW are analyzed through the CLP system under Special Analytical Services (SAS) requests. In the SAS analysis, documentation, quantitation limits, laboratory procedures, analytical methods and QA/QC requirements are specified by the Project Manager in conjunction with EPA CLP technical personnel. SAS requests are used to handle samples of difficult matrices, high hazard samples, special quantitation limits, and analytes not on the TCL or TAL. The analytical methods most commonly used by the Superfund Section are included in Appendix B.

8.2 VALIDATION

Data validation is the process whereby data are determined to be of acceptable or unacceptable quality based on a set of predefined criteria. These criteria depend upon the type(s) of data involved and the purpose for which the data are collected.

Field data will be validated by the Technical Supervisor, who will review field reports for completeness. In addition, random checks of sampling and field conditions will be made to confirm the recorded observations.

All laboratory data generated through the CLP shall be validated by the Superfund Section and/or by contractors attached to the CLP system. Superfund Section personnel shall review the data validated to ensure that it is of adequate quality and is technically appropriate. All other laboratory data shall be validated by the NMED Project Manager according to the Functional Guidelines for Data Review (Appendix C).

The Functional Guidelines are designed to offer guidance on EPA CLP analytical data evaluation and review. Definitive performance criteria are included for some areas of data review, while in other more subjective areas, general guidance is provided. Both are designed to assist an experienced reviewer in the technical review of CLP data.

Specific areas of data review covered in the Functional Guidelines include: holding times, GC/MS performance, instrument calibrations, blanks, surrogates, matrix spikes, quantitation limits, internal standards, laboratory control samples, performance evaulation standards, system performance and overall assessment of data.

Using the Functional Guidelines in conjunction with CLP SOW documents, an experienced reviewer can qualify, accept or reject any or all portions of a CLP data package. The Functional Guidelines may also be used on a comparative basis for data generated outside of the CLP program.

All deliverables shall undergo both editorial and peer reviews to ensure that all work products are of sufficient quality in terms of technical content and composition. The Program Manager shall perform a final review before submitting the work to the EPA.

A review shall include the following:

- Spelling, punctuation, and grammar,
- technical accuracy,
- accuracy of transcription,
- format correctness; and
- fulfillment of intended purpose.

8.3 DATA STORAGE

All data shall be permanently stored in central files in the Superfund Section, which may be accessed by all NMED personnel. Public access to the files may be attained through FOIA request, however, the public may not remove the files from the building and shall not have access to confidential files within the project files.

8.4 REDUCTION

Data reduction is defined as those activities involving conversion of raw data to reportable units, transfer of data between recording media, and computation of summary statistics, standard errors, confidence intervals, tests of hypotheses relative to the parameters, and model validation. Statistically acceptable data analysis procedures will be implemented for all data reduction steps.

Field technical data collected during field activities can be characterized as either objective or subjective data. Objective data include all direct measurements, such as field screening, field analyses, and water level measurements. Subjective data include descriptions and observations.

As described in Section 8.1, all field data will be recorded in bound logbooks. For example, during drilling activities, the field team leader supervising the rig will maintain a chronological log of drilling activities, a vertical descriptive log of lithologies encountered, and other pertinent drilling information. At the completion of a task, copies of all field logs will be turned in to the Project Manager. After the data are reviewed, the data will be reduced to tabular form, wherever possible, to be included in the written report.

9.0 DATA QUALITY ASSESSMENT

The quality of measurement data generated and processed during field activities and during laboratory analysis shall be assessed for precision, accuracy, representativeness, comparability, and completeness. Precision, accuracy, and completeness are means of evaluating the consistency and validity of generated data.

9.1 PRECISION

Precision in the field is determined by replicate measurements (i.e., water conductivity measurements). Laboratory precision is determined by replicate analyses performed on each sample matrix. For organic parameters, matrix spike and matrix spike duplicate samples are analyzed. For inorganic parameters, sample duplicates are analyzed. Analytical precision will be calculated and reported by the laboratory for every data set.

The Superfund Section personnel will calculate field duplicate sample precision during the data validation process, given these samples are submitted blind to the laboratory.

Replicate samples data shall be within predetermined acceptance limits.

9.2 ACCURACY

Analytical accuracy is determined by the analysis of spiked samples and is normally reflected in the percent recovery of these spikes according to the following formula:

$$\% \text{ Recovery} = \left[(\text{Spiked sample result} - \text{sample result})/\text{spike added}\right] \times 100$$

Accuracy is assessed from measurements of spikes of known reference materials. Accuracy acceptance limits, frequency of measurements and the required reference materials shall be specified as part of the Data Quality Objectives (DQO). Analytical accuracy will be calculated and reported by the laboratory for every data set.

The measure of accuracy in the field is more difficult to demonstrate or to quantify. One aspect of sampling accuracy which may be demonstrated is that contamination reported in field samples is due to pollutants in the sample and not from other sources. Blanks are collected for this purpose at various stages in the sampling and analysis of environmental samples. Contaminant free blanks show that any pollutants detected in environmental samples are attributable to the samples themselves, rather than equipment or techniques of the sampling or analysis team. Conversely, quantification of contamination found in blanks enables the site Project Managers to attribute this contamination to specific sources. Ideally blanks show that sampling equipment, sample containers, preservatives, transportation of samples and sampling and laboratory techniques do not introduce pollutants into the field samples.

Trip blanks are deionized, contaminant free water collected in the same manner, with the same containers and subjected to the same preservation, transportation, storage and analyses as the field samples. Contaminant free trip blanks show that containers, preservatives and transportation and storage of samples did not introduce contamination to the field samples.

Decontamination blanks are collected by rinsing deionized, contaminant free water over sampling equipment after decontamination and before sample collection. Contaminant free decontamination blanks show that decontamination practices are sufficient and that pollutants were not introduced to the field samples by the sampling equipment.

Laboratory method blanks are similar to other blanks but are collected and analyzed by the laboratory along with the field samples. Samples of contaminant free water, oil or solid (depending on the matrix of the field samples) are subjected to the same preparation and analysis procedures as the field samples. Contaminant free laboratory method blanks show that pollutants were not introduced by the laboratory procedures.

Collection and analysis of the various blanks during the sampling program enables the Project Manager to attribute systematic contamination to some or all field samples to a specific source. Contaminant free blanks ensure that the analysis of field samples gives an accurate and defensible representation of field conditions.

9.3 COMPLETENESS

Completeness is defined as achieving a sufficient percentage of valid measurements. (See Section 9.6 for Data Quality Objectives.)

9.4 REPRESENTATIVENESS

Data obtained during site investigations must characterize the site conditions. Obtaining representative data requires strict adherence to the procedures for sample collection and analysis, which are included in the SOP manual. The details on the types, locations, and number of samples to be collected will be listed in the individual sampling work plan for each inspection. The following will serve as guidelines for ensuring representativeness of the samples:

- Where sample composition may vary with location (e.g., in sampling from soil or from waste treatment piles), a sufficient number of samples will be collected so that the identity and concentration of contaminants can be adequately characterized.

- Where sample composition may vary with time (e.g., in sampling of groundwater, surface water, or process streams), samples will be collected over a sufficient period of time so that the variation with time can be described.

- Composite samples may be collected to represent the average of several individual samples. Project objectives will determine the choice of individual samples or composite samples.

9.5 COMPARABILITY

Methods shall be standardized, reporting units shall be consistent, and data format shall be standardized so that data can be compared to other data sets.

9.6 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) for data collection activities describe the uncertainty that a decision maker is willing to accept in results derived from environmental data. This uncertainty is used to specify the quality of the measurement data required, usually in terms of precision, bias, representativeness, comparability, and completeness. The DQOs shall be defined and approved by Superfund Section Project Managers prior to the initiation of the field and laboratory work. Guidance documents which may be used for determination of DQOs include the following:

- "Data Quality Objectives for Remedial Response Activities," dated March 1987 (EPA/540/G-87/004) and

- "Data Quality Objectives for Remedial Response Activities - Development Process," dated March 1987 (EPA/540/G-87/003).

10.0 CORRECTIVE ACTION SYSTEM

Corrective action procedures provide an effective method for identifying and correcting deficiencies that are adverse to quality. Responsibility for identification of conditions adverse to quality is at all levels.

The requirements of the Superfund Section's effective corrective action program are to:

- Promptly investigate conditions that adversely affect quality to determine cause and initiate corrective action to prevent recurrence.

- Document and report the cause and corrective action taken to eliminate the adverse problems to the appropriate management levels.

Problems identified shall be resolved at the lowest management level. Superfund Section personnel shall be able to identify and correct out-of-control conditions. Personnel shall document the problem and the corrective action taken. Project Managers will report problems to their supervisors and the QA Officer. If the problem remains, or cannot be solved, the QA Officer will report to the Program Manager. If the problem still persists, the Program Manager will confer with the Bureau Chief. The QA Officer will report directly to the Bureau Chief if QA matters are not resolved within the Superfund Section. The problem and resolution shall be reported to the QA Officer as well as the Program Manager.

11.0 IMPLEMENTATION REQUIREMENTS AND SCHEDULE

Designation of QA Officer ..... TBD

QAPP (Draft) for NMED-Superfund Section Review ..... June 18, 1992

QAPP (Final) ..... August 27, 1992

QAPP to EPA, Region VI ..... TBD

Quality Assurance Program Implemented ..... _____, 1992

APPENDIX A

FIELD LOGBOOK CHECKLIST

Site Name: _____ Author: _____

Yes	No	
_	_	Was the cover page complete (site name, CERCLIS ID#, site address)?
_	_	Is the date on the top of each page?
_	_	Was arrival time documented?
_	_	Is the objective of the site visit indicated?
_	_	Were names of team members, their duties, and names of site representatives and other visitors recorded?
_	_	Was an on-site safety meeting conducted and logged?
_	_	Were current and changing weather conditions recorded?
_	_	Were changes in the Work Plan and rationale for the changes recorded?
_	_	Was equipment calibrated and logged?
_	_	Were all serial numbers and EPA decal numbers recorded?
_	_	Were all entries recorded by time based on a 24 hour clock?
_	_	Were on-site measurements recorded?
_	_	Were field observations recorded?
_	_	Were station numbers, locations and descriptions and samplers' names recorded?
_	_	Were sample matrix and type (grab or composite) recorded?

Yes	No	
—	—	Were preservatives used?
—	—	Were tag numbers, Chain-of-Custody numbers, sample sticker numbers and air bill numbers recorded?
—	—	Were bottle lot numbers and sampling equipment lot numbers recorded?
—	—	Were the CLP laboratory names recorded?
—	—	Were all conversations with site representatives and others recorded?
—	—	Was a site sketch drawn?
—	—	Were north arrow, scale and wind direction recorded?
—	—	Were sample locations shown on a sketch(s)?
—	—	Were photographs taken?
—	—	Were the photographer's name, the time, direction and rationale for the photo recorded?
—	—	Were breaks and length, including lunch, recorded?
—	—	Were telephone calls to the EPA, etc., recorded?
—	—	Were logbook entries legibly recorded in black ink?
—	—	Was each page of the logbook initialled at the bottom by the person recording the entry?
—	—	Were entries recorded by others initialled?
—	—	Were corrections lined through and initialled?
—	—	Was the last page of each day signed by the person recording the entry?
—	—	If IDW was drummed, were the drums labeled and recorded?
—	—	Were telephone calls to SMO and related information recorded?

APPENDIX B

SELECTED ANALYTICAL METHODS

CLP Analytical Methods

Analyte	Analytical Protocol	Method
TCL Volatile	GC/MS - Purge & Trap	EPA CLP SOW Organic Analysis[a]
TCL Semivolatiles	GC/MS	EPA CLP SOW Organic Analysis[a]
PCBs/pesticides	GC/EC - Dual Column	EPA CLP SOW Organic Analysis[a]
TAL metals	ICP, AA	EPA CLP SOW Inorganic Analysis[b]
2,3,7,8 - TCDD	GC/MS	EPA CLP SOW Dioxin Analysis[c]
Cyanide	Spectrophotometric	EPA CLP SOW Inorganic Analysis[b]

TCL - Target Compound List
CLP - Contract Laboratory Program
SOW - Statement of Work (U.S. EPA)
TAL - Target Analyte List

[a] EPA. 1987b. "Contract Laboratory Program, Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency. August 1990.

[b] EPA. 1987a. "Contract Laboratory Program, Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency. July 1987.

[c] EPA. 1987. "Contract Laboratory Program, Statement of Work for Dioxin Analysis, Multi-Media, Multi-Concentration." U.S. Environmental Protection Agency. August 1987.

In addition to the CLP methods, there are several non-CLP analyses that can be used by the Project Manager. These methods may be used for specific analytes not analyzed by the CLP method or provide lower detection limits for specific analytes. These methods can be used to prepare SAS requests for the CLP or at the Project Manager's descretion.

Non-CLP Analytical Methods

EPA. 1983. "Methods for Chemical Analysis of Water and Wastes." U.S. Environmental Protection Agency.

Analyte	Analytical Protocol	EPA Method
Chloride	Ion Chromatography	300.0
Fluoride	Ion Chromatography	300.0
Nitrate	Ion Chromatography	300.0
Nitrite	Ion Chromatography	300.0
Sulfate	Ion Chromatography	300.0
Phosphate	Ion Chromatography	300.0
Carbonate	Alkalinity Titrimetric	2320B
Bicarbonate	Alkalinity Titrimetric	2320B
Calcium	AA, direct aspiration	215.1
Magnesium	AA, direct aspiration	242.1
Potasium	AA, direct aspiration	258.1
Sodium	AA, direct aspiration	273.1
TDS	Filterable residue	160.1
Chloride	Non-automated titrimetric	325.3
Fluoride	Colorimetric with distillation	340.1
Nitrate	Colorimetric	352.1
Sulfate	Turbidimetric	375.4
Calcium	Titrimetric, EDTA	215.2

EPA. 1986. "Test Methods for Evaluating Solid Waste." Office of Solid Waste and Emergency Response, Washington, D.C., Volume 1A, 1B, 1C, 2: Laboratory Manual Physical/Chemical Methods, SW-846, third edition, November 1986.

Analytes	Analytical Protocol	EPA Method
Halogenated Volatile Organics	GC/MS - Purge & Trap	8010
Aromatic Volatile Organics	GC/MS - Purge & Trap	8020
Phenols	GC/MS	8040
Phthalate Esters	GC/MS	8060
Organochlorine Pesticides & PCBs	GC/EC	8080
Chlorinated Hydrocarbons	GC/MS	8120
Organophosphorus Pesticides	GC/EC	8140
Chlorinated Herbicides	GC/EC	8150
Volatile Organics	GC/MS - Purge & Trap	8240
Semi-volatile Organics	GC/MS	8270
Polynuclear Aromatic Hydrocarbons	GC/MS	8310

40 Code of Federal Regulations.

Analyte	Analytical Protocol	Method	EPA Method
TCLP Volatiles	GC/MS - Purge & Trap	40 CFR, Chapter 268, Appendix I	8260
TCLP Semi-volatiles	GC/MS	40 CFR, Chapter 268, Appendix I	8270
TCLP Metals	ICP	40 CFR, Chapter 268, Appendix I	7000
TCLP Mercury	Cold-vapor	40 CFR, Chapter 268, Appendix I	245.1
Asbestos	Polarized Light Microscopy	40 CFR, Chapter 1, Part 763, Subpart F, Appendix A	600/M4-82-020

APHA. 1985. "Standard Methods for the Examination of Water and Wastewater." American Public Health Association, American Water Works Association, Water Pollution Control Federation, 16th edition, Washington, D.C.

SAMPLE COLLECTION PROCEDURES
ORGANIC SECTION, CHEMISTRY BUREAU

SLD PROCEDURE NUMBER	ANALYSIS NAME	SAMPLE CONTAINER	VOLUME SAMPLE REQUIRED	PRESER-VATION REQUIRED	MAXIMUM HOLDING TIME	TURN AROUND TIME	GENERAL NOTES	REMARKS
751	Aliphatics, Extractable	B	G	K,L	Q	4 wks	d	
753	Aliphatics, Headspace (semi-quantitative)	A	F	K,L	P	3 wks	a,b,c,d	
754	Aromatic and Halogenated Purgeables	A	F	K,L	P	3 wks	a,b,c,d	
755	Base/Neutral Extractables	B	G	L	Q	4 wks	b,d	
756	Base/Neutral/ Acid Extractables	B	G	L	Q	4 wks	b,d	
758	Chlorophenoxy Acid Herbicides	B	G	L	Q	4 wks	b,d	
759	Triazine Herbi-cides	A	F	L	Q	4 wks	b,d	
760	Organochlorine Pesticides & PCB's	A	F	L	R	4 wks	b,d	
761	Organophosphate Pesticides	A	F	L	Q	4 wks	b,d	
762	Safe Drinking Water Pesticides	A & B	F & G	L	Q	4 wks	b,d	
763	Phenols (Acid Extractables)	B	G	L	Q	4 wks	b,d	
765	Purgeables, Mass Spectrometer	A	F	K,L	P	3 wks	a,b,c,d	

SLD PROCEDURE NUMBER	ANALYSIS NAME	SAMPLE CONTAINER	VOLUME SAMPLE REQUIRED	PRESER-VATION REQUIRED	MAXIMUM HOLDING TIME	TURN AROUND TIME	GENERAL NOTES	REMARKS
766	Trihalomethane	A	F	K,L	P	3 wks	a,b,c,d	
767	PCB's in Oil	A	F	None	P	3 wks	d	
774	SDWA VOC's-I (8 regulated compounds plus 50 unregulated compounds)	A	F	C,L	P	3 wks	a,b,c,d	
775	SDWA VOC's-II (EDB, DBCP)	A	F	L	P	3 wks	a,b,c,d	

NOTE:

With over eight million known organic compounds, the above screens will not eliminate the possibility of there being some unlooked for organic compound in the sample. If a specific compound is suspected and does not fall under one of the above screens, please check with the laboratory for sampling procedures, etc.

FOOTNOTES FOR ORGANIC COLLECTION PROCEDURES:

A. 40 ml Septum vial with teflon seal - cleaned and supplied by the laboratory. May require field blank prepared by the lab.

B. Amber, 1 liter or 1 qt glass container with teflon or aluminum foil seal and screw cap lid. Cleaned and supplied by the lab.

C. Add two drops of 1:1 Hydrochloric Acid (supplied by lab).

D. Undetermined or dependent on compound to be analyzed.

F. 40 ml samples in duplicate.

G. 800 ml sample in duplicate collected in 1L bottles.

DESCRIPTION OF ORGANIC ANALYSES BY SLD NO.

753 **Aliphatic Headspace:** This test is a qualitative test to determine the ratio of light (methane through pentane) hydrocarbons in water samples. Generally, anaerobic water caused by bacterial contamination will have low levels of methane; water contaminated by a natural gas pipeline leak will have high levels of methane with some ethane present; water contaminated by natural gas well will have high levels of methane, ethane, propane, butanes, and pentanes; and water contaminated with gasoline will have butanes and pentanes present. This analysis has no equivalent EPA procedure and should be used only to determine the probable source of hydrocarbon contamination.

754 **Aromatic and Halogenated purgeables (Volatile Organic Compounds - VOC's):** This analysis will detect Aromatic (benzene-xylenes) and 1-3 carbon halogenated (chlorine and bromine containing) compounds. It will also see some oxygen containing compounds like MTBE and ketones. This is a purge and trap, gas chromatographic method utilizing a photoionization detector (PID) in series with a "Hall" electrolytic conductivity detector. This method is equivalent to EPA methods 601 and 602, and is useful in cases involving contamination by solvents and/or gasoline.

755 **Base/Neutral Extractables:** This analysis is a screening test for basic and neutral organic compounds on the EPA Priority Pollutant list including compounds from the following classes: Polynuclear aromatic hydrocarbons, chlorinated hydrocarbons, phthalate esters, nitroaromatics, nitrosamines, haloethers, organochlorine pesticides, and polychlorinated biphenyls (PCB's). A tentative mass spec. identification will be made of the ten largest unidentified compounds detected. This analysis involves a liquid-liquid extraction followed by GC/MS analysis. The procedure is equivalent to EPA Method 625.

756 **Base/Neutral/Acid Extractables:** This analysis includes phenols as well as the compound classes listed for method 755. The analysis involves liquid-liquid extractions followed by GC/MS analysis. The procedure is equivalent to EPA Method 8270.

758 **Chlorophenoxy Acid Herbicides:** This analysis is a screening test for chlorophenoxy acid herbicides and their derivatives. The analysis involves a liquid-liquid extraction, derivatization, followed by gas chromatography with an electron capture detector. The procedure is equivalent to EPA Method 515.1

759 **Triazine Herbicides:** Screening analysis for triazine herbicides. This procedure utilizes a liquid-liquid extraction followed by gas chromatographic analysis using a thermionic detector specific for nitrogen containing compounds. This procedure is equivalent to EPA Procedure 507.

FOOTNOTES FOR HEAVY METALS SAMPLE COLLECTION PROCEDURES

All water samples for metals analysis should be collected in one-liter plastic cubitainers and preserved with nitric acid to a pH of 2 or less. Preservation will require 3-5 mL of concentrated acid per liter of water. Water samples will be digested in the laboratory, and results will be reported as total.

The following is a list of elements for which analysis by Atomic Absorption Spectrometry (AAS) may be requested: Al, Sb, Ba, Be, Bi, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Ag, Sr, Tl, V, and Zn.

Detection limits for the above depend on the element requested and the matrix involved, but are usually about 0.005 ug/mL (ppm).

Uranium is done by fluorometric analysis with a detection limit of 0.005 ug/mL (ppm).

ICP analysis is an emission spectroscopy method determining all of the following elements at a detection limit of about 0.1 ug/mL (ppm) each: Al, Ba, Be, B, Cd, Ca, Cr, Co,Cu, Fe, Pb, Mn, Mg, Mo, Ni, Si, Ag, Sr, V, and Zn.

For elements that are not listed, please contact the Section Supervisor for availability, etc.

Turn-around time is strongly dependent on sample load and any special features of the sample. Usually, samples analyzed by AAS are reported out in four weeks; ICP samples are usually reported out in three weeks. PRIORITY SAMPLES can be processed at added cost to the user.

Analysis for any or all of the elements listed may be requested on a variety of environmental (soils, air filters, etc.) and biological (blood, serum, tissue, etc.) samples.

Please contact the Section Supervisor at (505) 841-2553 for any special arrangements or pertinent information not given in this document.

760 **Pesticides, Organochlorine and Polychlorinated Biphenyls (PCB's):** This analysis screens for the more common Organochlorine Pesticides. This procedure utilizes a liquid-liquid extraction followed by gas chromatography with an electron capture detector. This procedure is equivalent to EPA Method 505.

761 **Pesticides, Organophosphate:** This analysis screens for organophosphate pesticides. This procedure utilizes a liquid-liquid extraction followed by gas chromatography using a phosphorous specific detector. This procedure is equivalent to EPA Method 507.

762 **SDWA Pesticides and Herbicides:** This analysis screens for all of the pesticides and herbicides specified by the Safe Drinking Water Act (SDWA). It uses SLD Procedures 760 and 761.

765 **Mass Spec. Purgeables:** This analysis screens for volatile organic compounds as listed under SLD-754 and SLD-775 and in addition will detect aliphatic and other compounds not detected by the PID and Hall detectors. This method is essentially the same as EPA Method 624. However, we do <u>not</u> currently perform all of the quality control associated with EPA-624. In most cases, samples are also analyzed by SLD-754 or SLD-774 with the associated QA/QC and the mass spectrometer analysis is performed to 1) look for volatile compounds not detectable by the other detectors, and 2) to confirm by mass spectrometry the identity of volatile compounds in the sample.

766 **SDWA Total Trihalomethanes:** This analysis screens drinking water samples from the distribution system for trihalomethanes generated by the chlorination of water containing organic compounds. This analysis is equivalent to EPA Method 501. The method utilizes purge and trap concentration followed by gas chromatography with a Hall detector to detect halogenated compounds.

767 **Polychlorinated Biphenyls (PCB's):** This analysis is designed to detect PCB's in samples of oil and/or solids containing large percentages of oils/hydrocarbons. The method is EPA Method Study 28. The method involves extraction/dilution of the sample, clean-up with sulfuric acid and analysis by gas chromatography with an electron capture detector. Quantitation is by comparison to the most similar arochlor standard.

774 **SDWA VOC's I:** This analysis screens for the regulated VOC's in drinking water plus approximately an additional 50 VOC's. These samples are to be collected at the well head before treatment. This analysis uses EPA Method 502.2 The analysis utilizes concentration of the sample by purge and trap followed using analysis by gas chromatography with a PID and Hall detectors in series.

775 **SDWA VOC's II:** This analysis screens for 1,2-dibromoethene (EDB) and 1,2-dibromo-3-chloropropane (DBCP) in drinking water samples. These samples are to be collected at the well head before treatment. This analysis uses EPA Method 504. The analysis utilizes liquid-liquid extraction followed by analysis by gas chromatography with an electron capture detector. A specific analysis for these compounds is needed because of the required low (0.02 ug/l) detection limit.

776 **Composite for SLD-774:** It is allowed, with EID permission, to composite up to 5 similar wells to be analyzed for VOC-I's. If compositing is requested, the samples will be composited in the laboratory and then analyzed as one sample by method SLD-774. If volatiles (other than THM's) are detected, then the individual samples will also be analyzed at the submitter's expense.

777 **Composite for SLD-775:** It is allowed, with EID permission, to composite up to 5 similar wells to be analyzed for VOC-II's. If compositing is requested, the samples will be composited in the laboratory and then analyzed as one sample by method SLD-775. If ECB or DBCP are detected, then the individual expense samples will also be analyzed at the submitter's expense.

SAMPLE COLLECTION PROCEDURES
RADIOCHEMISTRY, CHEMISTRY BUREAU

SLD PROCEDURE NUMBER	ANALYSIS NAME	SAMPLE CONTAINER	VOLUME SAMPLE REQUIRED	PRESER-VATION REQUIRED	MAXIMUM HOLDING TIME	TURN AROUND TIME	GENERAL NOTES	REMARKS
801	WATERS: NMWSR/SDWA Sequential	A	4 L.	B	C	3-6 wks	D,E	Consists of Procedures 811, 812, 813 as required by NMWSR/SDWA
811	Gross Alpha	A	1 L.	B	C	3 wks	D,E	Method of EPA 600/4-75-008
812	Ra-226 by Radon Emanation	A	2 L.	B	C	5 wks	D,E	Method of EPA 600/4-75-008
813	Ra-228 by Actinium Precipitation	A	2 L.	B	C	8 wks	D,E	Method of EPA 600/4-75-008
841/842	Gamma Screen	A	4 L.	B	C	3 wks	D,E	
802	Sequential Uranium-Radium Decay Chain	A	4 L.	B	C	8 wks	D,E	
814	U-234/238 by Alpha Spectroscopy	A	4 L.	B	C	8 wks	D,E	
815	Th-230/232 by Alpha Spectroscopy	A	4 L.	B	C	8 wks	D,E	

RADIOCHEMISTRY SECTION (continued)

SLD PROCEDURE NUMBER	ANALYSIS NAME	SAMPLE CONTAINER	VOLUME SAMPLE REQUIRED	PRESER-VATION REQUIRED	MAXIMUM HOLDING TIME	TURN AROUND TIME	GENERAL NOTES
816	Bi-210 for Pb-210	A	4 L.	B	C	6 wks after Bi-210 in growth	D,E
SOILS & SEDIMENTS:							
813	Sequential Uran-ium-Radium Decay Chain	F	20 G	-	C	8 wks	
814	U-234/238 by Alpha Spectroscopy	F	20 G	-	C	8 wks	
815	Th-230/232 by Alpha Spectroscopy	F	20 G	-	C	8 wks	
812	Ra-226 by radon emanation	F	20 G	-	C	8 wks	
816	Bi-210 for Pb-210	F	20 G	-	C	8 wks after Bi-210 in growth	
AIR FILTERS:							
802	Sequential Uran-ium Decay Chain	G	H	-	C	8 wks	

OTHER SPECIAL NEEDS: Contact Laboratory 841-2574

FOOTNOTES FOR RADIOCHEMISTRY SAMPLE COLLECTION PROCEDURES

A. Plastic Cubitainer.

B. To pH<2 with HNO_3, for which 5 ml conc. HNO_3 is routinely used.

C. Unspecified.

D. All water samples should be FREE of suspended or sedimentary material unless they are specifically collected as "non-filtered" samples.

E. All water samples should be preserved at the time of collection unless they are specifically collected as a "filtered" sample in which case they should be filtered ASAP and then immediately preserved.

F. Plastic bottle (wide mouth) or jar suitable for maintaining sample integrity during transport and handling.

G. Packaging suitable to maintain sample integrity during transport and handling.

H. 47mm Type A-E glass fiber filter, Gelman #61631 or equal.

SAMPLE COLLECTION PROCEDURES
WATER CHEMISTRY SECTION, CHEMISTRY BUREAU

SLD PROCEDURE NUMBER	ANALYSIS NAME	PRESERVATION REQUIRED	MAXIMUM HOLDING TIME[b]	AROUND TIME (weeks)[c]	REMARKS	METHOD(s)
14	Acidity	cool 4° C	14 days	4	D, E	EPA 305.2
1	Alkalinity	cool 4° C	14 days	4	E	EPA 310.1
2	Ammonia	cool 4° C, H_2SO_4 to pH <2	28 days	4	F	EPA 350.1
3	Bicarbonate	cool 4° C	14 days	4	E	EPA 310.1
4	BOD (Biological Oxygen Demand)	cool 4° C	48 hrs	2	D	EPA 405.1
50	Boron	none	28 days	4	D	EPA 212.3
38	Bromide	cool 4° C	28 days	4	D	EPA 320.1 & EPA 300.
5	Calcium	none; and HNO_3 to pH<2	7 days; and 6 mos.	4	F, G	EPA 215.2 & EPA 200.7
6	Carbonate	cool 4° C	14 days	4	E	EPA 310.1
7	COD (Chemical Oxygen Demand)	H_2SO_4 to pH<2, cool 4° C	28 days	4	F	HACH & EPA 410.4
8	Chloride	none	28 days	4		EPA 300 & ISE
9	Color	cool 4° C	48 hrs	4		EPA 110.2
10	Conductivity	cool 4° C	28 days	4	H	EPA 120.1
45	Corrosivity	cool 4° C	14 days	4	I	SM 203
11	Cyanide	cool 4° C, NaOH to pH>12	14 days	4	D, J	EPA 335.3

WATER CHEMISTRY SECTION
Page 2

SLD PROCEDURE NUMBER	ANALYSIS NAME	PRESERVATION REQUIRED[a]	MAXIMUM HOLDING TIME[b]	TURN AROUND TIME (weeks)[c]	REMARKS	METHOD(s)
	Dissolved Oxygen	none	analyze immediately	4	D,E,K	EPA 360.1
13	Fluoride	none	28 days	4		EPA 340.2 & EPA 300.
15	Hardness	none; and HNO_3 to pH<2	7 days; and 6 mos.	4	F, G	EPA 130.2 & EPA 200.7
37	Iodide	cool 4° C	24 hrs	4	D	EPA 345.1
18	Magnesium	none; and HNO_3 to pH<2	7 days; and 6 mos.	4	F, G	EPA 130.2 + EPA 215.2 & EPA 200.7
20	Nitrate plus Nitrite	cool 4° C, H_2SO_4 to pH <2	28 days	4	F, L	EPA 353.2 EPA 300.
21	Nitrite	cool 4° C	48 hrs	4		EPA 353.2 & EPA 300.
	Stack NOx (Oxides of Nitrogen)	phone lab	24 hrs	2		
22	Odor	cool 4° C	24 hrs	4	E, K	EPA 140.1
23	Oil and Grease	cool 4° C, 5ml HCl/Liter	28 days	4	K	EPA 413.1
24	Orthophosphate	cool 4° C, H_2SO_4 to pH <2	28 days	4	F, L	EPA 365.2
19	pH	none	analyze immediately	4	E	EPA 150.1

SLD PROCEDURE NUMBER	ANALYSIS NAME	PRESERVATION REQUIRED[a]	MAXIMUM HOLDING TIME[b]	TURN AROUND TIME (weeks)[c]	REMARKS	METHOD(s)
39	Phenolics	cool 4° C, 1g $CuSO_4$/Liter, H_3PO_4 to pH<4	24 hrs	4	D,F,K	EPA 420.1
25	Potassium	none; and HNO_3 to pH<2	7 days; and 6 mos.	4	F, G	SM322B & EPA 200.7 & ISE
17	Lithium in Serum	phone lab		2		
46	Residual Chlorine	none	analyze immediately	4	D, E	HACH
26	Residue, Settleable	cool 4° C	48 hrs	4	D	EPA 160.5
	Residue, Total	cool 4° C	7 days	4	D	EPA 160.3
	Residue, Volatile	cool 4° C	7 days	4	D	EPA 160.4
27	Silica	cool 4° C	28 days	4	D	EPA 370.1
28	Sodium	none; and HNO_3 to pH<2	7 days; and 6 mos.	4	F, G	SM325B & EPA 200.7 & ISE
	Stack Sulfur Dioxide	phone lab	24 hrs	2		
	Stack Particulants	phone lab	24 hrs	2		
29	Sulfate	cool 4° C	28 days	4		EPA 300.
16	Sulfide	cool 4° C add 4 ml 2N Zinc acetate plus 6N NaOH to pH>9	7 days	4	D, E	EPA 376.1

SLD PROCEDURE NUMBER	ANALYSIS NAME	PRESERVATION REQUIRED[a]	MAXIMUM HOLDING TIME[b]	TURN AROUND TIME (weeks)[c]	REMARKS	METHOD(s)
	Sulfite	none	analyze immediately	4	D	EPA 377.1
30	Surfactants (MBAS)	cool 4° C	48 hrs.	4		EPA 425.1
31	TDS (Total Dissolved Solids)	cool 4° C	7 days	4		EPA 160.1
32	TKN (Total Kjeldahl Nitrogen)	cool 4° C, H_2SO_4 to pH <2	28 days	4	F	EPA 351.2
33	TOC (Total Organic Carbon)	cool 4° C, HCl or H_2SO_4 to pH <2	28 days	4	F, M	EPA 415.1
34	Total Phosphorus	cool 4° C, H_2SO_4 to pH <2	28 days	4	F	EPA 365.2
35	TSS (Total Suspended Solids)	cool 4° C	7 days	4		EPA 160.2
36	Turbidity	cool 4° C	48 hrs.	4		EPA 180.1

a). The usual sample container is the polyethylene cubitainer. The usual sample size is 1 liter. A SDWA complete secondary requires 1 gallon sample.

b). Holding time is the maximum time that samples may be held before analysis.

c). In general, the sample turnaround time depends on laboratory workload and sample priority.

D). Phone lab to schedule analysis (505) 841-2555.

E). No headspace; sample container must be filled completely and sealed.

F). In general, use 2ml acid/liter sample for preservation.

G). Requires two samples, one preserved and one unpreserved.

H). If analysis is not completed within 24 hours of sample collection, sample should be filtered through a 0.45 micron filter.

I). Corrosivity includes pH, alkalinity, calcium, TDS, and temperature.

J). When residual chlorine is present, add 0.6 grams excess ascorbic acid per liter sample. When sulfide is present, the maximum holding time is 24 hours. Optionally, all samples may be tested with lead acetate paper before the pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

K). Requires glass container.

L). An alternate procedure is EPA 300; then, the holding time is 48 hours and the sample is preserved by cooling to 4° C.

M). Protect from sunlight and atmospheric oxygen.

PRELIMINARY REVIEW

In order to use this document effectively, the reviewer should have a general overview of the Case at hand. The exact number of samples, their assigned numbers, their matrix, and the number of laboratories involved in their analysis are essential information. Background information on the site is helpful but often this information is very difficult to locate. The site project officer is the best source for answers or further direction.

CCS is a source of a large quantity of summarized information. It can be used to alert the reviewer of problems in the Case or what may be sample-specific problems. This information may be utilized in data validation. If CCS is unavailable, those criteria affecting data validity must be addressed by the data reviewer.

Cases routinely have unique samples which require special attention by the reviewer. Field blanks, field duplicates, and performance audit samples need to be identified. The sampling records should provide:

1. Project Officer for site
2. Complete list of samples with notations on
   - a) sample matrix
   - b) blanks*
   - c) field duplicates*
   - d) field spikes*
   - e) QC audit sample*
   - f) shipping dates
   - g) labs involved

   * If applicable

The chain-of-custody record includes sample descriptions and date of sampling. Although sampling date is not addressed by contract requirements, the reviewer must take into account lag time between sampling and shipping while assessing sample holding times.

INORGANICS PROCEDURE

The requirements to be checked in validation are listed below. ("CCS" indicates that the contractual requirements for these items will also be checked by CCS; CCS requirements are not always the same as the data review criteria.)

I. Holding Times (CCS - Lab holding times only)

II. Calibration

- o Initial (CCS)
- o Initial and Continuing Calibration Verification (CCS)

III. Blanks (CCS)

IV. ICP Interference Check Sample (CCS)

V. Laboratory Control Sample (CCS)

VI. Duplicate Sample (CCS)

VII. Matrix Spike Sample (CCS)

VIII. Furnace Atomic Absorption QC (CCS)

IX. ICP Serial Dilution (CCS)

X. Sample Result Verification (CCS - 10%)

XI. Field Duplicates

XII. Overall Assessment of Data for a Case

I. HOLDING TIMES

A. Objective

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis.

Note: The holding time is based on the date of collection, rather than verified time of sample receipt, and date of digestion/distillation. It is a technical evaluation rather than a contractual requirement.

B. Criteria

Technical requirements for sample holding times have only been established for water matrices. The following holding time and preservation requirements were established under 40 CFR 136 (Clean Water Act) and are found in Volume 49, Number 209 of the Federal Register, page 43260, issued on October 26, 1984.

METALS:	6 months; preserved to pH < 2
MERCURY:	28 days; preserved to pH < 2
CYANIDE:	14 days; preserved to pH > 12

C. Evaluation Procedure

Actual holding times are established by comparing the sampling date on the EPA Sample Traffic Report with the dates of analysis found in the laboratory raw data (digestion logs and instrument run logs). Examine the digestion and/or distillation logs to determine if samples were preserved at the proper pH.

Analyte Holding Time (Days) = Analysis Date - Sampling Date

D. Action

1. If 40 CFR 136 criteria for holding times and preservation are not met, qualify all results > Instrument Detection Limit (IDL) as estimated (J) and results < IDL as estimated (UJ).

2. If holding times are exceeded, the reviewer must use professional judgment to determine the reliability of the data and the effects of additional storage on the sample results. The expected bias would be low and the reviewer may determine that results < IDL are unusable (R).

3. Due to limited information concerning holding times for soil samples, it is left to the discretion of the data reviewer whether to apply water holding time criteria to soil samples. If the data are qualified when water holding time criteria are applied to soil samples, it must be clearly documented in the review.

II. CALIBRATION

A. Objective

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

B. Criteria

1. Initial Calibration

Instruments must be calibrated daily and each time the instrument is set up.

a. ICP Analysis

A blank and at least one standard must be used in establishing the analytical curve.

b. Atomic Absorption Analysis (AA)

1) A blank and at least three standards, one of which must be at the Contract Required Detection Limit (CRDL), must be used in establishing the analytical curve.

2) The correlation coefficient must be ≥0.995.

Note: The correlation coefficient of 0.995 is a technical criterion and not contractual.

c. Mercury Analysis

1) A blank and at least four standards must be used in establishing the analytical curve.

2) The correlation coefficient must be ≥0.995.

d. Cyanide Analysis

1) A blank and at least three standards must be used in establishing the analytical curve.

2) A midrange standard must be distilled.

3) A correlation coefficient ≥0.995 is required for photometric determination.

2. Initial and Continuing Calibration Verification (ICV and CCV)

a. Analysis results must fall within the control limits of 90 -110 percent Recovery (%R) of the true value for all analytes except mercury and cyanide.

b. Analysis results for mercury must fall within the control limits of 80-120%R.

c. Analysis results for cyanide must fall within the control limits of 85-115%R.

C. Evaluation Procedure

1. Verify that the instrument was calibrated daily and each time the instrument was set up using the correct number of standards and blank.

2. Verify that the correlation coefficient is ≥0.995

3. Check the distillation log and verify that the midrange CN standard was distilled.

4. Recalculate one or more of the ICV and CCV %R per type of analysis (ICP, GFAA, etc.) using the following equation and verify that the recalculated value agrees with the laboratory reported values on Form IIA. Due to possible rounding discrepancies, allow results to fall within 1% of the contract windows (e.g., 89-111%).

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where,

Found = concentration (in ug/L) of each analyte measured in the analysis of the ICV or CCV solution

True = concentration (in ug/L) of each analyte in the ICV or CCV source

D. Action

1. If the minimum number of standards as defined in section B were not used for initial calibration, or if the instrument was not calibrated daily and each time the instrument was set up, qualify the data as unusable (R).

2. If the correlation coefficient is <0.995, qualify results > IDL as estimated (J), and results < IDL as estimated (UJ).

Note: For critical samples, further evaluation of the calibration curve may be warranted to determine if qualification is necessary.

3. If the midrange CN standard was not distilled, qualify all associated results as estimated (J).

4. If the ICV or CCV %R falls outside the acceptance windows, use professional judgment to qualify all associated data. If possible, indicate the bias in the review. The following guidelines are recommended:

   a. If the ICV or CCV %R falls outside the acceptance windows but within the ranges of 75-89% or 111-125% (CN, 70-84% or 116-130%; Hg, 65-79% or 121-135%), qualify results > IDL as estimated (J).

   b. If the ICV or CCV %R is within the range of 111-125% (CN, 116-130%; Hg, 121-135%), results < IDL are acceptable.

   c. If the ICV or CCV %R is 75-89% (CN, 70-84%; Hg, 65-79%), qualify results < IDL as estimated (UJ).

   d. If the ICV or CCV %R is <75%, (CN, <70%; Hg, <65%), qualify all positive results as unusable (R).

   e. If the ICV or CCV %R is >125%, (CN >130%; Hg >135%), qualify results > IDL as unusable (R); results < IDL are acceptable.

III. BLANKS

A. Objective

The assessment of blank analysis results is to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks applies to any blank associated with the samples. If problems with any blank exist, all data associated with the Case must be carefully evaluated to determine whether or not there is an inherent variability in the data for the Case, or if the problem is an isolated occurrence not affecting other data.

B. Criteria

No contaminants should be in the blank(s).

C. Evaluation Procedures

Review the results reported on the Blank Summary (Form III) as well as the raw data (ICP printouts, strip charts, printer tapes, bench sheets, etc.) for all blanks and verify that the results were accurately reported.

D. Action

Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. Sample results > IDL but <5 times the amount in any blank should be qualified as (U).

Any blank with a negative result whose absolute value is > IDL must be carefully evaluated to determine its effect on the sample data.

Note: The blank analyses may not involve the same weights, volumes, or dilution factors as the associated samples. In particular, soil sample results reported on Form I will not be on the same basis (units, dilution) as the calibration blank data reported on Form III. The reviewer may find it easier to work from the raw data when applying 5X criteria to soil sample data/calibration blank data.

In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

IV. ICP INTERFERENCE CHECK SAMPLE (ICS)

A. Objective

The ICP Interference Check Sample verifies the contract laboratory's interelement and background correction factors.

B. Criteria

1. An ICS must be run at the beginning and end of each sample analysis run (or a minimum of twice per 8 hour working shift, whichever is more frequent).

2. Results for the ICS solution AB analysis must fall within the control limits of ± 20% of the true value.

C. Evaluation Procedure

1. Recalculate from the raw data (ICP printout) one or more of the recoveries using the following equation (%R) and verify that the recalculated value agrees with the laboratory reported values on Form IV.

$$\text{ICS } \%R = \frac{\text{Found Solution AB}}{\text{True Solution AB}} \times 100$$

Where,

Found Solution AB = concentration (in ug/L) of each analyte measured in the analysis of solution AB

True Solution AB = concentration (in ug/L) of each analyte in solution AB

2. Check ICS raw data for results with an absolute value > IDL for those analytes which are not present in the ICS solution.

D. Action

1. For samples with concentrations of Al, Ca, Fe, and Mg which are comparable to or greater than their respective levels in the Interference Check Sample:

   a. If the ICS recovery for an element is >120% and the sample results are < IDL, this data is acceptable for use.

   b. If the ICS recovery for an element is >120% and the sample results are > IDL, qualify the affected data as estimated (J).

   c. If the ICS recovery for an element falls between 50 and 79% and the sample results are > IDL, qualify the affected data as estimated (J).

   d. If sample results are < IDL, and the ICS recovery for that analyte falls within the range of 50-79%, the possibility of false negatives may exist. Qualify the data for these samples as estimated (UJ).

   e. If ICS recovery results for an element fall <50%, qualify the affected data as unusable (R).

   Note: If possible, indicate the bias for the estimated results in the review.

2. If results > IDL are observed for elements which are not present in the EPA provided ICS solution, the possibility of false positives exists. An evaluation of the associated sample data for the affected elements should be made. For samples with comparable or higher levels of interferents and with analyte concentrations that approximate those levels found in the ICS (false positives), qualify sample results > IDL as estimated (J).

3. If negative results are observed for elements that are not present in the EPA ICS solutions, and their absolute value is > IDL, the possibility of false negatives in the samples may exist. If the absolute value of the negative results is > IDL, an evaluation of the associated sample data should be made. For samples with comparable or higher levels of interferents, qualify results for the affected analytes < IDL as estimated (UJ).

4. In general, the sample data can be accepted if the concentrations of Al, Ca, Fe and Mg in the sample are found to be less than or equal to their respective concentrations in the ICS. If these elements are present at concentrations greater than the level in the ICS, or other elements are present in the sample at >10 mg/L, the reviewer should investigate the possibility of other interference effects by using Table 2 given on page D-22 of the 7/87 SOW. These analyte concentration equivalents presented in the Table should be

considered only as estimated values, since the exact value of any analytical system is instrument specific. Therefore, estimate the concentration produced by an interfering element. If the estimate is >2X CRDL and also greater than 10% of the reported concentration of the affected element, qualify the affected results as estimated (J).

V. LABORATORY CONTROL SAMPLE (LCS)

A. Objective

The laboratory control sample serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation.

B. Criteria

1. All aqueous LCS results must fall within the control limits of 80-120%R, except Sb and Ag which have no control limits.

2. All solid LCS results must fall within the control limits established by the EPA. This information is available from EMSL/LV.

C. Evaluation Procedure

1. Review Form VII and verify that results fall within the control limits.

2. Check the raw data (ICP printout, strip charts, bench sheets) to verify the reported recoveries on Form VII. Recalculate one or more of the recoveries (%R) using the following equation:

$$\text{LCS \%R} = \frac{\text{LCS Found}}{\text{LCS True}} \times 100$$

Where,

LCS Found = concentration (in ug/L for aqueous; mg/kg for solid) of each analyte measured in the analysis of LCS solution

LCS True = concentration (in ug/L for aqueous; mg/kg for solid) of each analyte in the LCS source

D. Action

1. Aqueous LCS

a. If the LCS recovery for any analyte falls within the range of 50 - 79% or >120%, qualify results > IDL as estimated (J).

b. If results are < IDL and the LCS recovery is greater than 120%, the data are acceptable.

c. If results are < IDL and the LCS recovery falls within the range of 50-79%, qualify the data for the affected analytes as estimated (UJ).

d. If LCS recovery results are <50%, qualify the data for these samples as unusable (R).

2. Solid LCS

a. If the solid LCS recovery for any analyte falls outside the EPA control limits, qualify all sample results > IDL as estimated (J).

b. If the LCS results are higher than the control limits and the sample results are < IDL, the data are acceptable.

c. If the LCS results are lower than the control limits, qualify all sample results < IDL as estimated (UJ).

VI. DUPLICATE SAMPLE ANALYSIS

A. Objective

Duplicate analyses are indicators of laboratory precision based on each sample matrix.

B. Criteria

1. Samples identified as field blanks cannot be used for duplicate sample analysis.

2. A control limit of ± 20% (35% for soil) for the Relative Percent Difference (RPD) shall be used for sample values >5X CRDL.

3. A control limit of ±CRDL (±2X CRDL for soil) shall be used for sample values <5X CRDL, including the case when only one of the duplicate sample values is <5X CRDL.

C. Evaluation Procedure

1. Review Form VI and verify that results fall within the control limits.

2. Check the raw data and recalculate one or more RPD using the following equation to verify that results have been correctly reported on Form VI.

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where,

S = First Sample Value (original)
D = Second Sample Value (duplicate)

3. Verify that the field blank was not used for duplicate analysis.

D. Action

1. If duplicate analysis results for a particular analyte fall outside the appropriate control windows, qualify the results for that analyte in all associated samples of the same matrix as estimated (J).

2. If the field blank was used for duplicate analysis, all other QC data must be carefully checked and professional judgment exercised when evaluating the data.

Note: This information must be included on the IRDA form.

VII. MATRIX SPIKE SAMPLE ANALYSIS

A. Objective

The matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology.

B. Criteria

1. Samples identified as field blanks cannot be used for spiked sample analysis.

2. Spike recovery (%R) must be within the limits of 75-125%. However, spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or more.

C. Evaluation Procedure

1. Review Form V and verify that results fall within the specified limits.

2. Check raw data and recalculate one or more %R using the following equation to verify that results were correctly reported on Form V.

$$\%R = \frac{(SSR-SR)}{SA} \times 100$$

Where,

SSR = Spiked Sample Result
SR = Sample Result
SA = Spike Added

3. Verify that the field blank was not used for spike analysis.

D. Action

1. If the spike recovery is >125% and the reported sample results are < IDL, the data is acceptable for use.

2. If the spike recovery is >125% or <75% and the sample results are > IDL, qualify the data for these samples as estimated (J).

3. If the spike recovery falls within the range of 30-74% and the sample results are < IDL, qualify the data for these samples as estimated (UJ).

4. If spike recovery results fall <30% and the sample results are < IDL, qualify the data for these samples as unusable (R).

5. If the field blank was used for matrix spike analysis, all other QC data must be carefully checked and professional judgment exercised when evaluating the data.

Note: This information must be included on the IRDA form.

Note: If the matrix spike recovery does not meet criteria (except in Ag), a post digestion spike is required for all methods except furnace, but this data is not used to qualify sample results. However, this information must be included in the IRDA report.

VIII. FURNACE ATOMIC ABSORPTION QC

A. Objective

Duplicate injections and furnace post digestion spikes establish the precision and accuracy of the individual analytical determinations.

B. Criteria

1. **For sample concentrations > CRDL, duplicate injections must agree within ±20% Relative Standard Deviation (RSD), (or Coefficient of Variation (CV)), otherwise the sample must be rerun once (at least two additional injections).**

2. **Spike recovery must be ≥85% and ≤115%.**

3. **The Furnace Atomic Absorption Scheme must be followed as described in the 7/87 SOW, p. E-15.**

C. Evaluation Procedure

1. **Check raw data to verify that duplicate injections agree within ±20% RSD (or CV) for sample concentrations > CRDL.**

2. **Review Furnace AA raw data to verify that the Furnace Atomic Absorption Scheme has been followed.**

D. Action

1. **If duplicate injections are outside the ±20% RSD (or CV) limits and the sample has not been rerun once as required, qualify the data as estimated (J).**

2. **If the rerun sample results do not agree within ±20% RSD (or CV), qualify the data as estimated (J).**

3. **If the post digestion spike recovery is <40%, qualify results > IDL as estimated (J).**

4. **If the post digestion spike recovery is ≥10%, but <40%, qualify results < IDL as estimated (UJ).**

5. **If the post digestion spike recovery is <10%, qualify results < IDL as unusable (R).**

6. If sample absorbance is <50% of the post digestion spike absorbance then:

   a. If the furnace post digestion spike recovery is not within 85-115%, qualify the sample results > IDL as estimated (J).

   b. If the furnace post digestion spike recovery is not within 85-115%, qualify the sample results < IDL as estimated (UJ).

7. If Method of Standard Additions (MSA) is required but has not been done, qualify the data as estimated (J).

8. If any of the samples run by MSA have not been spiked at the appropriate levels, qualify the data as estimated (J).

9. If the MSA correlation coefficient is <0.995, qualify the data as estimated (J).

IX. ICP SERIAL DILUTION

A. Objective

The serial dilution determines whether significant physical or chemical interferences exist due to sample matrix.

B. Criteria

If the analyte concentration is sufficiently high (concentration in the original sample is minimally a factor of 50 above the IDL), an analysis of a 5-fold dilution must agree within 10% Difference (%D) of the original results.

C. Evaluation Procedures

1. Check the raw data and recalculate the %D using the following equation to verify that the dilution analysis results agree with results reported on Form IX.

$$\%D = \frac{|I-S|}{I} \times 100$$

Where,

I = Initial Sample Result
S = Serial Dilution Result (Instrument Reading x 5)

2. Check the raw data for evidence of negative interference, i.e., results of the diluted sample are significantly higher than the original sample.

D. Action

1. When criteria are not met, qualify the associated data as estimated (J).

2. If evidence of negative interference is found, use professional judgment to qualify the data.

X. SAMPLE RESULT VERIFICATION

A. Objective

The objective is to ensure that the reported quantitation results are accurate.

B. Criteria

Analyte quantitation must be calculated according to the appropriate SOW.

C. Evaluation Procedures

The raw data should be examined to verify the correct calculation of sample results reported by the laboratory. Digestion and distillation logs, instrument printouts, strip charts, etc. should be compared to the reported sample results.

1. Examine the raw data for any anomalies (i.e., baseline shifts, negative absorbances, omissions, legibility, etc.).

2. Verify that there are no transcription or reduction errors (e.g., dilutions, percent solids, sample weights) on one or more samples.

3. Verify that results fall within the linear range of the ICP (Form XIII) and within the calibrated range for the non-ICP parameters.

4. Verify that sample results are >5X ICP IDL, if ICP analysis results are used for As, Tl, Se, or Pb.

Note: When the laboratory provides both ICP and furnace results for an analyte in a sample and the concentration is > ICP IDL, the results can assist in identifying quantitation problems.

D. Action

If there are any discrepancies found, the laboratory may be contacted by the designated representative to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer may determine qualification of the data is warranted.

XI. FIELD DUPLICATES

A. Objective

Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and lab precision; therefore, the results may have more variability than lab duplicates which measure only lab performance. It is also expected that soil duplicate results will have a greater variance than water matrices due to difficulties associated with collecting identical field samples.

B. Criteria

There are no review criteria for field duplicate analyses comparability.

C. Evaluation Procedures

Samples which are field duplicates should be identified using EPA Sample Traffic Reports or sample field sheets. The reviewer should compare the results reported for each sample and calculate the Relative Percent Difference (RPD), if appropriate.

D. Action

Any evaluation of the field duplicates should be provided with the reviewer's comments.

XII. OVERALL ASSESSMENT OF DATA FOR A CASE

It is appropriate for the data reviewer to make professional judgments and express concerns and comments on the validity of the overall data for a Case. This is particularly appropriate when there are several QC criteria out of specification. The additive nature of QC factors out of specification is difficult to assess in an objective manner, but the reviewer has a responsibility to inform the user concerning data quality and data limitations in order to assist that user in avoiding inappropriate use of the data, while not precluding any consideration of the data at all. If qualifiers other than those used in this document are necessary to describe or qualify the data, it is necessary to thoroughly document/explain the additional qualifiers used. The data reviewer would be greatly assisted in this endeavor if the data quality objectives were provided. The cover form and supplementary documentation must be included with the review.

GLOSSARY A

Data Qualifier Definitions

For the purposes of this document the following code letters and associated definitions are provided.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

J - The associated value is an estimated quantity.

R - The data are unusable. (Note: Analyte may or may not be present.)

UJ - The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

GLOSSARY B

Additional Terms

Associated Samples	Any sample related to a particular QC analysis. For example: - For ICV, all samples run under the same calibration curve. - For duplicate RPD, all SDG samples digested/distilled of the same matrix.
AA	Atomic Absorption
Calibration Curve	A plot of absorbance versus concentration of standards
Case	A finite, usually predetermined number of samples collected in a given time period for a particular site. A Case consists of one or more Sample Delivery Groups.
CCB	Continuing Calibration Blank - a deionized water sample run every ten samples designed to detect any carryover contamination.
CCS	Contract Compliance Screening - process in which SMO inspects analytical data for contractual compliance and provides EMSL/LV, laboratories, and the Regions with their findings.
CCV	Continuing Calibration Verification - a standard run every ten samples designed to test instrument performance.
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
CV	Coefficient of Variation
DPO	Deputy Project Officer
EMSL/LV	Environmental Monitoring System Laboratory/ Las Vegas (P.O. Box 15027, Las Vegas, Nevada 89114)
Field Blank	Field blanks are intended to identify contaminants that may have been introduced in the field. Examples are trip blanks, travel blanks, rinsate blanks, and decontamination blanks.

Field Duplicate	A duplicate sample generated in the field, not in the laboratory.
Holding Time	The time from sample collection to laboratory analysis.
ICB	Initial Calibration Blank - first blank standard run to confirm the calibration curve.
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification - first standard run to confirm the calibration curve.
Initial Calibration	The establishment of a calibration curve with the appropriate number of standards and concentration range. The calibration curve plots absorbance or emission versus concentration of standards.
IRDA	Inorganic Regional Data Assessment
LCS	Laboratory Control Sample - supplied by EPA
MS	Matrix Spike - introduction of a known concentration of analyte into a sample to provide information about the effect of the sample matrix on the digestion and measurement methodology.
MSA	Method of Standard Addition
Post digestion Spike	The addition of a known amount of standard after digestion. (Also identified as analytical spike, or spike, for furnace analyses.)
QAC	Quality Assurance Coordinator
RPD	Relative Percent Difference
RSCC	Regional Sample Control Center
RSD	Relative Standard Deviation
Serial Dilution	A sample run at a specific dilution to determine whether any significant chemical or physical interferences exist due to sample matrix effects. (ICP only)

Region _____

INORGANIC REGIONAL DATA ASSESSMENT

CASE NO. _____ SITE _____

LABORATORY _____ NO. OF SAMPLES/ MATRIX _____

SDG# _____ REVIEWER (IF NOT ESD) _____

SOW# _____ REVIEWER'S NAME _____

DPO: ACTION _____ FYI _____ COMPLETION DATE _____

DATA ASSESSMENT SUMMARY

		ICP	AA	Hg	CYANIDE
1.	HOLDING TIMES	_____	_____	_____	_____
2.	CALIBRATIONS	_____	_____	_____	_____
3.	BLANKS	_____	_____	_____	_____
4.	ICS	_____			
5.	LCS	_____	_____		
6.	DUPLICATE ANALYSIS	_____	_____	_____	_____
7.	MATRIX SPIKE	_____	_____	_____	_____
8.	MSA		_____		
9.	SERIAL DILUTION	_____			
10.	SAMPLE VERIFICATION	_____	_____	_____	_____
11.	OTHER QC	_____	_____	_____	_____
12.	OVERALL ASSESSMENT	_____	_____	_____	_____

O = Data had no problems/or qualified due to minor problems.
M = Data qualified due to major problems.
Z = Data unacceptable.
X = Problems, but do not affect data.

ACTION ITEMS: _____

_____

_____

AREAS OF CONCERN: _____

_____

_____

NOTABLE PERFORMANCE: _____

_____

_____

USEPA CONTRACT LABORATORY PROGRAM

NATIONAL FUNCTIONAL GUIDELINES

FOR

ORGANIC DATA REVIEW

Multi-Media, Multi-Concentration (OLM01.0)

and

Low Concentration Water (OLC01.0)

DRAFT

December, 1990
Revised June, 1991

TABLE OF CONTENTS

		Page
INTRODUCTION		1
PRELIMINARY REVIEW		3
DATA QUALIFIER DEFINITIONS		4
VOLATILE DATA REVIEW		5
I.	Technical Holding Times	6
II.	GC/MS Instrument Performance Check	9
III.	Initial Calibration	12
IV.	Continuing Calibration	16
V.	Blanks	18
VI.	System Monitoring Compounds (Surrogate Spikes)	22
VII.	Matrix Spikes/Matrix Spike Duplicates	25
VIII.	*Laboratory Control Samples*	*27*
IX.	Regional Quality Assurance and Quality Control	29
X.	Internal Standards	30
XI.	Target Compound Identification	32
XII.	Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)	34
XIII.	Tentatively Identified Compounds (TICs)	36
XIV.	System Performance	40
XV.	Overall Assessment of Data	42
SEMIVOLATILE DATA REVIEW		43
I.	Technical Holding Times	44
II.	GC/MS Instrument Performance Check	46
III.	Initial Calibration	49
IV.	Continuing Calibration	53
V.	Blanks	55
VI.	Surrogate Spikes	58
VII.	Matrix Spikes/Matrix Spike Duplicates	61
VIII	*Laboratory Control Samples*	*63*
IX.	Regional Quality Assurance and Quality Control	65

X. Internal Standards 66
XI. Target Compound Identification 68
XII. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs) .. 70
XIII. Tentatively Identified Compounds (TICs) 71
XIV. System Performance 75
XV. Overall Assessment of Data 77

APPENDIX A: Contractual Requirements and Equations, Multi-media Multi-concentration A-1
APPENDIX B: Contractual Requirements and Equations, Low Concentration Water B-1
APPENDIX C: Contractual Requirement Comparison Tables C-1
APPENDIX D: Proposed Guidance for Tentatively Identified Compounds (VOA and SV) D-1
APPENDIX E: Glossary of Terms E-1

INTRODUCTION

This document is designed to offer guidance on EPA Contract Laboratory Program (CLP) analytical data evaluation and review. In some applications it may be used as a Standard Operating Procedure (SOP). In other, more subjective areas, only general guidance is offered due to the complexities and uniqueness of data relative to specific samples. For example, areas where the application of specific SOPs are possible are primarily those in which definitive performance criteria are established. These criteria are concerned with specifications that are not sample dependent; they specify performance requirements that should fully be under a laboratory's control. These specific areas include blanks, calibration standards, performance evaluation standard materials, and instrument performance checks (tuning).

These Guidelines have been updated to include the requirements in the Statement of Work (SOW) for Organic Analysis Multi-Media Multi-Concentration (SOW OLM01.0), and the SOW for Low Concentration Water Organic Analysis (SOW OLC01.0). *To ensure that the data review guidelines that are unique to the Low Concentration Water SOW are easily identified, these requirements and procedures are presented in italics and contained within brackets ([ ]) throughout the document.*

This update includes changes to instrument performance checks (formerly referred to as tuning) including changes to instrument performance checks and calibration criteria as a result of the Response Factor Workgroup. Minor revisions to the Data Qualifier Definitions from the previous National Functional Guidelines are also included in this document.

This document is intended to assist in the technical review of analytical data generated through the CLP. Determining contract compliance is not the intended objective of these guidelines or the regional data review process. The data review process provides information on analytical limitations of data based on specific quality control (QC) criteria. In order to provide more specific useability statements, the reviewer must have a complete understanding of the intended use of the data. For this reason, it is recommended that whenever possible the reviewer obtain usability issues from the user prior to reviewing the data. When this is not possible, the user should be encouraged to communicate any questions to the reviewer.

At times, there may be an urgent need to use data which do not meet all contract requirements and technical criteria. Use of these data does not constitute either a new requirement standard or full acceptance of the data. Any decision to utilize data for which performance criteria have not been met is strictly to facilitate the progress of projects requiring the availability of the data. A contract laboratory submitting data which are out of specification may be required to rerun samples or resubmit data even if the previously submitted data have been utilized due to urgent program needs; data which do not meet specified requirements are never fully acceptable. The only exception to this requirement is in the area of requirements for individual sample analysis; if the nature of the sample itself limits the attainment of specifications, appropriate allowances must be made. The overriding concern of the Agency is to obtain data which are technically valid and legally defensible.

Appendix A is based on the Multi-media Multi-concentration SOW and contains appropriate contractual requirements and equations for verifying various calculations. Appendix B contains the corresponding contractual requirements and equations from the Low Concentration Water SOW. Appropriate equations are presented for easy reference and to allow the reviewer to verify calculations as needed. Contractual requirements are provided to facilitate comparisons with the technical requirements. For each analytical fraction, Appendix C contains a table comparing contractual requirements of the Multi-media, Multi-concentration with those of the Low Concentration Water SOWs. Appendix D contains proposed guidance for Tentatively Identified Compounds (VOA and SV), and Appendix E contains a glossary of commonly used terms.

The data review should include comments that clearly identify the problems associated with a Case or Sample Delivery Group and to state the limitations of the data. Documentation should include the sample number, analytical method, extent of the problem, and assigned qualifiers.

A data review narrative generally accompanies the laboratory data forwarded to the intended data recipient (client) or user to promote communication. A copy of the data review narrative should be submitted to the CLP Quality Assurance Coordinator (QAC), the Regional CLP Technical Project Officer (TPO) assigned oversight responsibility for the laboratory producing the data, and the Environmental Monitoring Systems Laboratory in Las Vegas, Nevada (EMSL-LV).

It is the responsibility of the data reviewer to notify the appropriate Regional CLP TPO concerning problems and deficiencies with regard to laboratory data. If there is an urgent requirement, the TPO may be contacted by telephone to expedite corrective action. It is recommended that all items for TPO action be presented at one time.

PRELIMINARY REVIEW

In order to use this document effectively, the reviewer should have a general overview of the sample delivery group (SDG) or case at hand. The exact number of samples, their assigned numbers, their matrix, and the number of laboratories involved in their analysis are essential information. Background information on the site is helpful but often this information may be difficult to locate. The site manager is the best source for answers to questions or further direction.

Contract Compliance Screening (CCS) is a source of summarized information regarding contract compliance. If available, it can be used to alert the reviewer to problems in the SDG data package.

Sample cases (SDGs) routinely have unique samples which require special attention by the reviewer. These include field blanks, field duplicates, and performance audit samples which need to be identified. The sampling records should provide:

1. Project Officer for site.

2. Complete list of samples with information on:

    a. sample matrix,
    b. field blanks,
    c. field duplicates,
    d. field spikes,
    e. QC audit samples,
    f. shipping dates, and
    g. laboratories involved.

The chain-of-custody record includes sample descriptions and date(s) of sampling. The reviewer must take into account lag times between sampling and receipt for analysis when assessing technical sample holding times.

The laboratory's SDG Narrative is another source of general information. Notable problems with matrices, insufficient sample volume for analysis or reanalysis, samples received in broken containers, and unusual events should be found in the SDG Narrative.

The SDG Narrative for the sample data package must include a Laboratory Certification Statement (exactly as stated in the SOW), signed by the laboratory manager or his designee. This statement authorizes the validation and release of the sample data results. In addition, the laboratory must also provide comments in the SDG narrative describing in detail any problems encountered in processing the samples in the data package.

For every data package, the reviewer must verify that the laboratory certification statement is present, exactly stated as in the SOW (i.e., verbatim to the statement in the SOW), and signed by the Laboratory Manager or designee. The reviewer must further verify that the data package is consistent with the laboratory's certified narrative. Also, the reviewer should check the comments provided in the narrative to determine if they are sufficient to describe and explain the associated problem.

DATA QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the national qualifiers assigned to results in the data review process. If the Regions choose to use additional qualifiers, a complete explanation of those qualifiers should accompany the data review.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

VOLATILE DATA REVIEW

**** Data review guidelines that are unique to data generated through the Low Concentration Water SOW are contained within brackets ([ ]) and written in italics. ****

The volatile data requirements to be checked are listed below

I. Technical Holding Times (CCS - Contractual holding times only)

II. GC/MS Instrument Performance Check (CCS)

III. Initial Calibration (CCS)

IV. Continuing Calibration (CCS)

V. Blanks

VI. System Monitoring Compounds (Surrogate Spikes) (CCS)

VII. Matrix Spikes/Matrix Spike Duplicates

VIII. Laboratory Control Samples (CCS)

IX. Regional Quality Assurance and Quality Control

X. Internal Standards (CCS)

XI. Target Compound Identification

XII. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

XIII. Tentatively Identified Compounds

XIV. System Performance

XV. Overall Assessment of Data

NOTE: "CCS" indicates that the contractual requirements for these items will also be checked by CCS: CCS requirements are not always the same as the data review criteria.

I. Technical Holding Times

A. **Review Items:** Form I VOA *(Form I LCV)*, EPA Sample Traffic Report and/or chain-of-custody, raw data, and SDG Narrative.

B. **Objective**

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis.

C. **Criteria**

Technical requirements for sample holding times have only been established for water matrices. The holding times for soils (and other non-aqueous matrices such as sediments, oily wastes, and sludge) are currently under investigation. When the results are available they will be incorporated into the data evaluation process. Additionally, results of holding time studies will be incorporated into the data review criteria as the studies are conducted and approved.

The holding time criteria for water samples, as stated in the current 40 CFR Part 136 (Clean Water Act) is as follows:

> For non-aromatic volatile compounds in cooled (@ 4°C) water samples, the maximum holding time is 14 days from sample collection.
>
> Maximum holding times for purgeable aromatic hydrocarbons in cooled (@ 4°C ± 2°C), acid-preserved (pH 2 or below) water samples is 14 days from sample collection.
>
> Water samples that have not been maintained at 4°C (± 2°C) and preserved to a pH of 2 or below should be analyzed within 7 days from sample collection. If insufficient ice is used to ship samples, the laboratory may receive samples with no ice left in the cooler. Under these circumstanes, the temperature of the samples may exceed 4°C.

It is further recommended that volatile compounds in properly preserved non-aqueous samples be analyzed within 14 days of sample collection.

The contractual maximum holding times, which differ from the technical maximum holding times, state that water and soil samples are to be analyzed within 10 days from the validated time of sample receipt (VTSR) at the laboratory.

D. **Evaluation**

Technical holding times are established by comparing the sampling dates on the EPA Sample Traffic Report with dates of analysis on Form I VOA *(Form I LCV)* and the raw data. Information contained in the complete SDG file (formerly called the purge file) should also be considered in the determination of holding times. Verify that the analysis dates on the Form Is and the raw

data/SDG file are identical. Examine the sample records to determine if samples were preserved. If adequate documentation on sample preservation is not available, contact the sampler. If the sampler cannot be contacted, then it must be assumed that the samples are unpreserved. If there is no indication in the SDG narrative or the sample records that there was a problem with the samples (e.g., samples not maintained @ 4°C or containing headspace in the samples), then the integrity of samples can be assumed to be good. If it is indicated that there were problems with the samples, then the integrity of the sample may have been compromised and professional judgement should be used to evaluate the effect of the problem on the sample results.

E. Action

1. If technical holding times are exceeded, document in the data review narrative that holding times were exceeded and qualify the sample results as follows (also see Table 1):

   a. If there is no evidence that the samples were properly preserved and the technical holding times exceeded 7 days, qualify positive results for aromatic compounds with "J" and sample quantitation limits with "UJ". Use professional judgement to determine if and how non-aromatic volatile compounds should also be qualified.

   b. If the samples were properly preserved but the technical holding times exceeded 14 days, qualify positive results with "J" and sample quantitation limits with "UJ".

Table 1. Qualification of Volatile Analytes Based on Technical Holding Times

MATRIX	PRESERVED	> 7 DAYS	> 14 DAYS
Water	No	All Aromatics*	All Compounds
	Yes	None	All Compounds
Non-aqueous	No/Yes	Professional Judgement	Professional Judgement

* Reviewer should use professional judgement to determine if data for additional compounds require qualification.

2. If technical holding times are grossly exceeded (e.g., by greater than two times the required time for volatiles) either on the first analysis or upon re-analysis, the reviewer must use professional judgement to determine the reliability of the data and the effects of additional storage on the sample results. Should the reviewer determine that qualification is necessary, non-detected volatile target compounds may be qualified unusable (R). Positive results are considered approximates and are qualified with "J".

3. Due to limited information concerning holding times for non-aqueous samples, it is left to the discretion of the data reviewer to apply water holding times or other information that is available.

4. Whenever possible, the reviewer should comment on the effect of the holding time exceedance on the resulting data in the data review narrative.

5. When contractual and/or technical holding times are grossly exceeded, this should be noted for TPO action.

6. The reviewer should also be aware of the scenario in which the laboratory has exceeded the technical holding times, but met contractual holding times. In this case, the data reviewer should notify the Regional TPO (where samples were collected) and/or RSCC that shipment delays have occurred so that the field problem can be corrected. The reviewer may pass this information on to the laboratory's TPO, but should explain that contractually the laboratory met the requirements.

II. GC/MS Instrument Performance Check

A. **Review Items:** Form V VOA *[Form V LCV]*, BFB mass spectra and mass listing.

B. **Objective**

Gas chromatograph/mass spectrometer (GC/MS) instrument performance checks (formerly referred to as tuning) are performed to ensure mass resolution, identification, and to some degree, sensitivity. These criteria are not sample specific. Conformance is determined using standard materials, therefore, these criteria should be met in all circumstances.

C. **Criteria**

The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples or standards are analyzed. The instrument performance check, bromofluorobenzene (BFB) for volatile analysis, must meet the ion abundance criteria given below.

Bromofluorobenzene (BFB)

m/z	ION ABUNDANCE CRITERIA
50	8.0 - 40.0% of m/z 95
75	30.0 - 66.0% of m/z 95
95	Base peak, 100% relative abundance
96	5.0 - 9.0% of m/z 95
173	Less than 2.0% of m/z 174
174	50.0 - 120.0% of m/z 95
175	4.0 - 9.0% of mass 174
176	93.0 - 101.0% of m/z 174
177	5.0 - 9.0% of m/z 176

NOTE: All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120 percent that of m/z 95.

D. **Evaluation**

1. Compare the data presented for each Instrument Performance Check (Form V VOA *[Form V LCV]*) with each mass listing submitted to ensure the following:

   a. Form V VOA *[Form V LCV]* is present and completed for each 12-hour period during which samples were analyzed.

b. The laboratory has not made transcription errors between the data and the form. If there are major differences between the mass listing and the Form Vs, a more in-depth review of the data is required. This may include obtaining and reviewing additional information from the laboratory.

c. The appropriate number of significant figures has been reported (number of significant figures given for each ion in the ion abundance criteria column) and that rounding is correct.

d. The laboratory has not made calculation errors.

2. Verify from the raw data (mass spectral listing) that the mass assignment is correct and that the mass listing is normalized to m/z 95.

3. Verify that the ion abundance criteria was met. The criteria for m/z 173, 176, and 177 are calculated by normalizing to the specified m/z.

4. If possible, verify that spectra were generated using appropriate background subtraction techniques. Since the BFB spectrum is obtained from chromatographic peaks that should be free from coelution problems, background subtraction should be done in accordance with the following procedure. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged and background subtraction must be accomplished using a single scan prior to the elution of BFB.

NOTE: All instrument conditions must be identical to those used in the sample analysis. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting the contract specifications are contrary to the quality assurance objectives and are therefore unacceptable.

E. Action

1. If the laboratory has made minor transcription errors which do not significantly affect the data, the data reviewer should make the necessary corrections on a copy of the form.

2. If the laboratory has failed to provide the correct forms or has made significant transcription or calculation errors, the Region's designated representative should contact the laboratory and request corrected data. If the information is not available, then the reviewer must use professional judgement to assess the data. The laboratory's TPO should be notified.

3. If mass assignment is in error (such as m/z 96 is indicated as the base peak rather than m/z 95), classify all associated data as unusable (R).

4. If ion abundance criteria are not met, professional judgement may be applied to determine to what extent the data may be utilized. Guidelines to aid in the application of professional judgement to this topic are discussed as follows:

The most important factors to consider are the empirical results that are relatively insensitive to location on the chromatographic profile and the type of instrumentation. Therefore, the critical ion abundance criteria for BFB are the m/z 95/96, 174/175, 74/176, and 176/177 ratios. The relative abundances of m/z 50 and 75 are of lower importance.

5. Decisions to use analytical data associated with BFB instrument performance checks not meeting contract requirements should be clearly noted on the data review narrative.

6. If the reviewer has reason to believe that instrument performance check criteria were achieved using techniques other than those described in II.D.4, then additional information on the instrument performance checks should be obtained. If the techniques employed are found to be at variance with the contract requirements, the performance and procedures of the laboratory may merit evaluation. Concerns or questions regarding laboratory performance should be noted for TPO action. For example, if the reviewer has reason to believe that an inappropriate technique was used to obtain background subtraction (such as background subtracting from the solvent front or from another region of the chromatogram rather than the BFB peak), then this should be noted for TPO action.

III. Initial Calibration

A. **Review Items:** Form VI VOA *[Form VI LCV]*, quantitation reports, and chromatograms.

B. **Objective**

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for compounds on the volatile target compound list (TCL). Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve.

C. **Criteria**

1. Initial calibration standards containing both volatile target compounds and system monitoring compounds are analyzed at concentrations of 10, 20, 50, 100, and 200 ug/L at the beginning of each analytical sequence or as necessary if the continuing calibration acceptance criteria are not met. The initial calibration (and any associated samples and blanks) must be analyzed within 12 hours of the associated instrument performance check.

   [For data generated through the Low Concentration Water SOW: Initial calibration standards containing both volatile target compounds and surrogate are analyzed at concentrations of 1, 2, 5, 10, and 25 ug/L for non-ketones and 5, 10, 25, 50, and 125 ug/L for ketones at the beginning of each analytical sequence or as necessary if the continuing calibration acceptance criteria are not met. The initial calibration (and any associated samples and blanks) must be analyzed within 12 hours of the associated BFB tuning check.]

2. Separate initial calibrations must be performed for water samples (or medium level soil samples) and for low level soil samples. The calibration for water samples and medium level soil samples is performed with an unheated purge and the calibration for low level soil samples is performed with a heated purge.

3. Initial calibration standard Relative Response Factors (RRFs) for all volatile target compounds and system monitoring compounds (surrogates) must be greater than or equal to 0.05. (Contractual initial calibration RRF criteria are listed in Appendix A *[Appendix B])*

4. The Percent Relative Standard Deviation (%RSD) from the initial calibration must be less than or equal to 30.0% for all compounds.

D. **Evaluation**

1. Verify that the correct concentration of standards were used for the initial calibration (i.e., 10, 20, 50, 100, and 200 ug/L for water).

   [Verify that the correct concentration of standards were used for the initial calibration (i.e., 1, 2, 5, 10, and 25 ug/L for non-ketones and 5, 10, 25, 50, and 125 ug/L for ketones).]

2. Verify that the correct initial calibration was used for water and medium level soil samples (i.e., unheated purge) and for low level soil samples (i.e., heated purge).

3. If any sample results were calculated using an initial calibration, verify that the correct standard (i.e., the 50 ug/L standard) was used for calculating sample results and that the samples were analyzed within 12 hours of the associated instrument performance check.

   [If any sample results were calculated using an initial calibration, verify that the correct standard (i.e., the 5 ug/L for non-ketones and 25 ug/L for ketones) was used for calculating sample results and that the samples were analyzed within 12 hours of the associated instrument performance check.]

4. Evaluate the initial calibration RRFs and $\overline{RRF}$ for all volatile target compounds and system monitoring compounds (surrogates):

   a. Check and recalculate the RRFs and $\overline{RRF}$ for at least one volatile target compound associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

   b. Verify that for all volatile target compounds and system monitoring compounds (surrogates), the initial calibration RRFs are greater than or equal to 0.05.

NOTE: Because historical performance data indicate poor response and/or erratic behavior, the volatile compounds in Table 2 have no contractual maximum %RSD criteria. Contractually they must meet a minimum RRF criterion of 0.01, however, for data review purposes, the "greater than or equal to 0.05" criterion is applied to all volatile compounds.

Table 2. Volatile Target Compounds Exhibiting Poor Response

Acetone	1,2-Dichloropropane
2-Butanone	2-Hexanone
Carbon disulfide	Methylene chloride
Chloroethane	4-Methyl-2-pentanone
Chloromethane	Toluene-d8 †
1,2-Dichloroethene (total)†	1,2-Dichloroethane-d4†
trans-1,2-Dichloroethene ‡	*1,2-Dibromo-3-chloropropane ‡*
cis-1,2-Dichloroethene ‡	

† Multi-media, Multi-concentration only
‡ Low Concentration Water only

5. Evaluate the %RSD for all volatile target compounds and system monitoring compounds (surrogates):

   a. Check and recalculate the %RSD for one or more volatile target compound(s); verify that the recalculated value(s) agrees with the laboratory reported value(s).

b. Verify that all volatile target compounds have a %RSD of less than or equal to 30.0%. The contractual criteria for an acceptable initial calibration specifies that up to any 2 volatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%. For data review purposes, however, all compounds must be considered for qualification when the %RSD exceeds the ± 30.0% criterion.

c. If the %RSD is greater than 30.0%, then the reviewer should use professional judgement to determine the need to check the points on the curve for the cause of the non-linearity. This is checked by eliminating either the high point or the low point and recalculating the %RSD.

6. If errors are detected in the calculations of either the RRFs or the %RSD, perform a more comprehensive recalculation.

E. Action

1. All volatile target compounds, including the 12 "poor performers" will be qualified using the following criteria:

a. If the %RSD is greater than 30.0% and all initial calibration RRFs greater than or equal to 0.05, qualify positive results with "J", and non-detected volatile target compounds using professional judgement.

b. If any initial calibration RRF is less than 0.05, qualify positive results that have acceptable mass spectral identification with "J", using professional judgement, and non-detected analytes as unusable (R).

2. At the reviewer's discretion, a more in-depth review to minimize the qualification of data can be accomplished by considering the following:

a. If any of the required volatile compounds have a %RSD greater than 30.0%, and if eliminating either the high or the low point of the curve does not restore the %RSD to less than or equal to 30.0%:

i. Qualify positive results for that compound(s) with "J".

ii. Qualify non-detected volatile target compounds based on professional judgement.

b. If the high point of the curve is outside of the linearity criteria (e.g. due to saturation):

i. No qualifiers are required for positive results in the linear portion of the curve.

ii. Qualify positive results outside of the linear portion of the curve with a "J".

iii. No qualifiers are needed volatile target compounds that were not detected.

c. If the low end of the curve is outside of the linearity criteria:

i. No qualifiers are required for positive results in the linear portion of the curve.

ii. Qualify low level positive results in the area of non-linearity with "J".

iii. Qualify non-detected volatile target compounds based on professional judgement.

3. If the laboratory has failed to provide adequate calibration information, the designated representative should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgement to assess the data.

4. Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

5. If calibration criteria are grossly exceeded, this should be noted for TPO action.

IV. Continuing Calibration

A. **Review Items:** Form VII VOA *[Form VII LCV]*, quantitation reports, and chromatograms.

B. **Objective**

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data. Continuing calibration establishes the 12-hour relative response factors on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis.

C. **Criteria**

1. Continuing calibration standards containing both target compounds and system monitoring compounds (surrogates) are analyzed at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of the method blank and samples.

2. The continuing calibration RRF for volatile target compounds and system monitoring compounds (surrogates) must be greater than or equal to 0.05.

3. The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF must be within $\pm$ 25.0%.

   [For data generated through the Low Concentration Water SOW: The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF must be within $\pm$ 30.0%.]

D. **Evaluation**

1. Verify that the continuing calibration was run at the required frequency and that the continuing calibration was compared to the correct initial calibration.

2. Evaluate the continuing calibration RRF for all volatile target compounds and system monitoring compounds:

   a. Check and recalculate the continuing calibration RRF for at least one volatile target compounds associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

   b. Verify that all volatile target compounds and system monitoring compounds meet the RRF specifications.

NOTE: Because historical performance data indicate poor response and/or erratic behavior, the compounds listed in Table 2 (Section III.D.4) have no contractual maximum %D criteria. Contractually they must meet a minimum RRF criterion of 0.01, however, for data review purposes, the "greater than or equal to 0.05" criterion is applied to all volatile compounds.

3. Evaluate the %D between initial calibration RRF and continuing calibration RRF for one or more compound(s).

   a. Check and recalculate the %D for one or more volatile target compound(s) associated with each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

   b. Verify that the %D is within ± 25.0% for all volatile target compounds and system monitoring compounds. Note those compounds which have a %D outside the ± 25.0% criterion. The contractual criteria for an acceptable continuing calibration specifies that up to any 2 volatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%. For data review purposes, however, all compounds must be considered for qualification when the %D exceeds the ± 25.0% criterion.

4. If errors are detected in the calculations of either the continuing calibration RRF or the %D, perform a more comprehensive recalculation.

E. Action

1. The reviewer should use professional judgement to determine if it is necessary to qualify the data for any volatile target compound. If qualification of data is required, it should be performed using the following guidelines:

   a. If the %D is outside the ± 25.0% criterion and the continuing calibration RRF is greater than or equal to 0.05, qualify positive results with "J".

   b. If the %D is outside the ± 25.0% criterion and the continuing calibration RRF is greater than or equal to 0.05, qualify non-detected volatile target compounds with "UJ".

   c. If the continuing calibration RRF is less than 0.05, qualify positive results that have acceptable mass spectral identifications with "J" or use professional judgement.

   d. If the continuing calibration RRF is less than 0.05, qualify non-detected volatile target compounds as unusable (R).

2. If the laboratory has failed to provide adequate calibration information, the designated representative should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgement to assess the data.

3. Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

4. If calibration criteria are grossly exceeded, this should be noted for TPO action.

V. Blanks

A. **Review Items:** Form I VOA *[Form I LCV]*, Form IV VOA *[Form IV LCV]*, chromatograms, and quantitation reports.

B. **Objective**

The purpose of laboratory (or field) blank analysis is to determine the existence and magnitude of contamination resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples (e.g., method blanks, instrument blanks, trip blanks, and equipment blanks). If problems with any blank exist, all associated data must be carefully evaluated to determine whether or not there is an inherent variability in the data, or if the problem is an isolated occurrence not affecting other data.

C. **Criteria**

1. No contaminants should be found in the blanks.

2. A method blank analysis must be performed after the calibration standards and once for every 12-hour time period beginning with the injection of BFB.

3. The method blank must be analyzed on each GC/MS system used to analyze samples for each type of analysis, i.e., unheated purge (water and medium level soil) and heated purge (low level soil).

4. An instrument blank should be analyzed after any sample that has saturated ions from a given compound to check that the blank is free of interference and the system is not contaminated.

[5. For data generated through the Low Concentration Water SOW: A storage blank must be prepared upon receipt of the first samples from an SDG, and stored with samples until analysis. The storage blank must be analyzed once per SDG.]

D. **Evaluation**

1. Review the results of all associated blanks on the forms and raw data (chromatograms and quantitation reports) to evaluate the presence of target and non-target compounds in the blanks.

2. Verify that a method-blank analysis has been reported per matrix, per concentration level, for each 12-hour time period on each GC/MS system used to analyze volatile samples. The reviewer can use the Method Blank Summary (Form IV VOA *[Form IV LCV]*) to identify the samples associated with each method blank.

3. Verify that the instrument blank analysis has been performed following any sample analysis where a target analyte(s) is reported at high concentration(s).

[4. Verify that a storage blank has been analyzed and included with each SDG and that the storage blanks are free of contamination.]

E. Action

If the appropriate blanks were not analyzed with the frequency described in Criteria 2, 3, and 4, *[and 5]* then the data reviewer should use professional judgement to determine if the associated sample data should be qualified. The reviewer may need to obtain additional information from the laboratory. The situation should be noted for TPO action.

Action regarding unsuitable blank results depends on the circumstances and origin of the blank. Positive sample results should be reported unless the concentration of the compound in the sample is less than or equal to 10 times (10x) the amount in any blank for the common volatile laboratory contaminants (methylene chloride, acetone, and 2-butanone), or 5 times (5x) the amount for other volatile target compounds. In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must <u>not</u> be corrected by subtracting any blank value.

Specific actions are as follows:

1. If a volatile compound is found in a blank but <u>not</u> found in the sample, no action is taken. If the contaminants found are volatile target compounds (or interfering non-target compounds) at significant concentrations above the CRQL, then this should be noted for TPO action.

2. Any volatile compound detected in the sample (other than the common volatile laboratory contaminants), that was also detected in any associated blank, is qualified if the sample concentration is less than five times (5x) the blank concentration. The quantitation limit may also be elevated. Typically, the sample CRQL is elevated to the concentration found in the sample. The reviewer should use professional judgement to determine if further elevation of the CRQL is required. For the common volatile laboratory contaminants, the results are qualified by elevating the quantitation limit to the concentration found in the sample when the sample concentration is less than 10 times (10x) the blank concentration.

   The reviewer should note that blanks may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the "5x" and "10x" criteria, such that a comparison of the total amount of contamination is actually made.

   Additionally, there may be instances where little or no contamination was present in the associated blanks, but qualification of the sample is deemed necessary. If the reviewer determines that the contamination is from a source other than the sample, he/she should qualify the data. Contamination introduced through dilution water is one example. Although it is not always possible to determine, instances of this occurring can be detected when contaminants are found in the diluted sample result, but are absent in the undiluted sample result. Since both results are not routinely reported, it may be impossible to verify this source of contamination. In this case, the "5x" or "10x" rules may

not apply; the target compound should be reported as not detected. and an explanation of the data qualification should be provided in the data review narrative.

3. If gross contamination exists (i.e., saturated peaks by GC/MS), all affected compounds in the associated samples should be qualified as unusable (R) due to interference. This should be noted for TPO action if the contamination is suspected of having an effect on the sample results.

4. If inordinate numbers of other target compounds are found at low levels in the blank(s), it may be indicative of a problem and should be noted for TPO action.

5. The same consideration given to the target compounds should also be given to Tentatively Identified Compounds (TICs), which are found in both the sample and associated blank(s). (See VOA Section XII for TIC guidance.)

6. If an instrument blank was not analyzed following a sample analysis which contained an analyte(s) at high concentration(s), sample analysis results after the high concentration sample must be evaluated for carryover. Professional judgement should be used to determine if instrument cross-contamination has affected any positive compound identification(s). If instrument cross-contamination is suggested, then this should be noted for TPO action if the cross-contamination is suspected of having an effect on the sample results.

[7. If contaminants are found in the storage blanks, the following action is recommended.

a. The associated method blank data should be reviewed to determine if the contaminant(s) was also present in the method blank. If the analyte was present at a comparable level in the method blank, then the source of the contamination may be in the analytical system and the action recommended for the method blank would apply.

If the analyte was not present in the method blank, then the source of contamination may be in the storage and all associated samples should be considered for possible cross-contamination.

b. If the storage blank contains a volatile TCL compound(s) at a concentration greater than the CRQL, then all positive results for that compounds(s) should be qualified with "J". If the concentration level in the blank is significantly high, then positive sample results may require rejection and be qualified with "R". Non-detected volatile target compounds should not require qualification unless the contamination is so high that it interferes with the analysis of the non-detect compounds.]

The following are examples of applying the blank qualification guidelines. Certain circumstances may warrant deviations from these guidelines.

Example 1: Sample result is greater than the Contract Required Quantitation Limit (CRQL), but is less than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	7	7
CRQL	5	5
Sample Result	60	30
Final Sample Result	60U	30U

In the example for the "10x" rule, sample results less than 70 (or 10 x 7) would be qualified as not detected. In the case of the "5x" rule, sample results less than 35 (or 5 x 7) would be qualified as not detected.

Example 2: Sample result is less than the CRQL, and is also less than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	6	6
CRQL	5	5
Sample Result	4J	4J
Final Sample Result	5U	5U

Note that data are not reported as 4U, as this would be reported as a detection limit below the CRQL.

Example 3: Sample result is greater than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	10	10
CRQL	5	5
Sample Result	120	60
Final Sample Result	120	60

For both the "10x" and "5x" rules, sample results exceeded the adjusted blank results of 100 (or 10x10) and 50 (or 5x10), respectively.

VI. System Monitoring Compounds
(Surrogate Spikes)

A. **Review Items:** Form II VOA *[Form II LCV]*, quantitation reports, and chromatograms.

B. **Objective**

Laboratory performance on individual samples is established by means of spiking activities. All samples are spiked with system monitoring compounds (formerly referred to as surrogates) prior to sample purging. The evaluation of the results of these system monitoring compounds is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the evaluation and review of data based on specific sample results is frequently subjective and demands analytical experience and professional judgement. Accordingly, this section consists primarily of guidelines, in some cases with several optional approaches suggested.

C. **Criteria**

1. Three system monitoring compounds (1,2-dichloroethane-d4, bromofluorobenzene, and toluene-d8) are added to all samples and blanks to measure their recovery in environmental samples in sample and blank matrices.

   [For data generated through the Low Concentration Water SOW: A single surrogate, bromofluorobenzene, is added to all samples and blanks to measure the recovery in sample and blank matrices.]

2. Recoveries for system monitoring compounds *[surrogates]* in volatile samples and blanks must be within the limits specified in Appendix A *[Appendix B]* and the SOW.

D. **Evaluation**

1. Check raw data (e.g., chromatograms and quantitation reports) to verify the recoveries on the System Monitoring Compound Recovery Form - Form II VOA *[Surrogate Recovery Form - Form II LCV]*. Check for any calculation or transcription errors.

2. Check that the system monitoring compound *[surrogate]* recoveries were calculated correctly. The equation can be found in Appendix A *[Appendix B]*.

3. The following should be determined from the System Monitoring Compound *[Surrogate]* Recovery form(s):

   a. If any system monitoring *[surrogate]* compound(s) in the volatile fraction is out of specification, there should be a reanalysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.

<u>NOTE</u>: When there are unacceptable system monitoring compound *[surrogate]* recoveries followed by successful re-analyses, the laboratories are required to report only the successful run.

b. The laboratory failed to perform acceptably if system monitoring compounds *[surrogate]* are outside criteria with no evidence of re-analysis. Medium soils must first be re-extractracted prior to re-analysis when this occurs.

c. Verify that no blanks have system monitoring compounds *[surrogate]* outside the criteria.

4. Any time there are two or more analyses for a particular sample, the reviewer must determine which are the best data to report. Considerations should include but are not limited to:

a. System monitoring compound *[surrogate]* recovery (marginal versus gross deviation).

b. Technical holding times.

c. Comparison of the values of the target compounds reported in each sample analysis.

d. Other QC information, such as performance of internal standards.

E. **Action**

Data are qualified based on system monitoring compounds *[surrogate]* results if the recovery of any volatile system monitoring compound *[surrogate]* is out of specification. For system monitoring compound *[surrogate]* recoveries out of specification, the following approaches are suggested based on a review of all data from the package, especially considering the apparent complexity of the sample matrix.

1. If a system monitoring compound *[surrogate]* in the volatile sample has a recovery greater than the upper acceptance limit (UL):

a. Detected volatile target compounds are qualified "J.".

b. Results for non-detected volatile target compounds should not be qualified.

2. If a system monitoring compound *[surrogate]* in the volatile sample has a recovery greater than or equal to 10% but less than the lower acceptance limit (LL):

a. Detected volatile target compounds are qualified "J."

b. For non-detected volatile target compounds, the sample quantitation limit is qualified as approximated (UJ).

3. If a system monitoring compound *(surrogate)* in a volatile sample shows less than 10% recovery:

   a. Detected volatile target compounds are qualified "J".

   b. Non-detected volatile target compounds may be qualified as unusable (R).

Table 3. Qualification of Volatile Analytes Based on System Monitoring Compound *(Surrogate)* Recoveries

	SMC/Surrogate Recovery		
	> UL	10% to LL	< 10%
Detected analytes	J	J	J
Non-detected analytes	No Qualification	UJ	R

4. In the special case of a blank analysis with system monitoring compounds *(surrogate)* out of specification, the reviewer must give special consideration to the validity of associated sample data. The basic concern is whether the blank problems represent an isolated problem with the blank alone, or whether there is a fundamental problem with the analytical process. For example, if one or more samples in the batch show acceptable system monitoring compound *(surrogate)* recoveries, the reviewer may choose to consider the blank problem to be an isolated occurrence. However, even if this judgment allows some use of the affected data, analytical problems should be noted for TPO action. Also note if there are potential contractual problems associated with the lack of reanalysis of samples that were out of specification.

5. Whenever possible, potential effects of the data resulting from system monitoring recoveries not meeting the advisory limits should be noted in the data review narrative.

VII. Matrix Spikes/Matrix Spike Duplicates
(Not Required for Low Concentration Water Data)

A. **Review Items:** Form III VOA-1 and VOA-2, chromatograms, and quantitation reports.

B. **Objective**

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. These data alone cannot be used to evaluate the precision and accuracy of individual samples. However, when exercising professional judgement, this data should be used in conjunction with other available QC information.

C. **Criteria**

1. Matrix spikes (MS) and matrix spike duplicate (MSD) samples are analyzed at frequency of one MS and MSD per 20 samples of similar matrix.

2. Spike recoveries should be within the advisory limits provided on Form III VOA-1 and 2.

3. Relative percent difference (RPD) between MS and MSD recoveries must be within the advisory limits provided on Form III VOA-1 and VOA-2.

D. **Evaluation**

1. Verify that MS and MSD samples were analyzed at the required frequency and that results are provided for each sample matrix.

2. Inspect results for the MS/MSD Recovery on Form III VOA-1 and VOA-2 and verify that the results for recovery and RPD are within the advisory limits.

3. Verify transcriptions from raw data and verify calculations.

4. Check that the matrix spike recoveries and RPD were calculated correctly.

5. Compare %RSD results of non-spiked compounds between the original result, MS, and MSD.

E. **Action**

1. No action is taken on MS/MSD data alone. However, using informed professional judgment the data reviewer may use the MS and MSD results in conjunction with other QC criteria and determine the need for some qualification of the data.

2. The data reviewer should first try to determine to what extent the results of the MS/MSD affect the associated data. This determination should be made with regard to the MS/MSD sample itself as well as specific analytes for all samples associated with the MS/MSD.

3. In those instances where it can be determined that the results of the MS/MSD affect only the sample spiked, then qualification should be limited to this sample alone. However, it may be determined through the MS/MSD results that a laboratory is having a systematic problem in the analysis of one or more analytes, which affects all associated samples.

4. The reviewer must use professional judgement to determine the need for qualification of positive results of non-spiked compounds.

NOTE: If a field blank was used for the MS/MSD, a statement to that effect must be included for the TPO.

VIII. Laboratory Control Samples
(Low Concentration Water)

[A. Review Items: Form III LCV-1, LCS chromatograms and quantitation reports.

B. Objective

Data for laboratory control samples (LCS) are generated to provide information on the accuracy of the analytical method and on the laboratory performance.

C. Criteria

1. A laboratory control sample (LCS) must be analyzed once per SDG and concurrently with the samples in the SDG.

2. The LCS contains the following volatile compounds, in addition to the required surrogate:

Vinyl chloride	*Benzene*
1,2-Dichloroethane	*cis-1,3-Dichloropropene*
Carbon tetrachloride	*Bromoform*
1,2-Dichloropropane	*Tetrachloroethene*
Trichloroethene	*1,2-Dibromoethane*
1,1,2-Trichloroethane	*1,4-Dichlorobenzene*

3. The percent recoveries for the LCS compounds must be within 60-140%. The LCS must meet this recovery criteria for the sample data to be accepted.

4. The criteria for surrogate recovery and internal standard performance also apply.

D. Evaluation

1. Verify that LCS samples were analyzed at the required frequency and that results are provided for each SDG.

2. Inspect results for the LCS Recovery on Form III LCV-1 and verify that the results for recovery are within the QC limits of 60 to 140 percent.

3. Verify transcriptions from raw data and verify calculations.

4. Check that the LCS recovery was calculated correctly by using the correct equation.

E. Action

If the LCS criteria are not met, then the laboratory performance and method accuracy are in question. Professional judgement should be used to determine if the data should be qualified or rejected. The following guidance is suggested for qualifying sample data for which the associated LCS does not meet the required criteria.

1. Action on the LCS recovery should be based on both the number of compounds that are outside of the recovery criteria and the magnitude of the exceedance of the criteria.

2. If the LCS recovery criteria are not met, then the LCS results should be used to qualify sample data for the specific compounds that are included in the LCS solution. Professional judgement should be used to

qualify data for compounds other than those compounds that are included in the LCS. Professional judgement to qualify non-LCS compounds should take into account the compound class, compound recovery efficiency, analytical problems associated with each compound, and comparability in performance of the LCS compound to the non-LCS compound.

3. *If the LCS recovery is greater than 140%, then positive sample results for the affected compound(s) should be qualified with a "J".*

4. *If the mass spectral criteria are met but the LCS recovery is less than 60%, then the associated detected target compounds should be qualified "J" and the associated non-detected target compounds should be qualified "R".*

5. *If more than half of the compounds in the LCS are not within the required recovery criteria, then all of the associated detected target compounds should be qualified "J" and all associated non-detected target compounds should be qualified "R."*

6. *Action on non-compliant surrogate recovery and internal standard performance should follow the procedures provided in VI.E and X.E, respectively. Professional judgement should be used to evaluate the impact that non-compliance for surrogate recovery and internal standard performance in the LCS has on the associated sample data.*

7. *It should be noted for TPO action if a laboratory fails to analyze an LCS with each SDG, or if a laboratory consistently fails to generate acceptable LCS recoveries.]*

IX. Regional Quality Assurance and Quality Control

A. **Review Items:** Form I VOA *[Form I LCV]*, chromatograms, and quantitation reports.

B. **Objective**

Regional Quality Assurance and Quality Control (QA/QC) refer to any QA and/or QC samples initiated by the Region, including field duplicates, Performance Evaluation (PE) samples, blind spikes, and blind blanks. It is highly recommended that Regions adopt the use of these.

C. **Criteria**

Criteria are determined by each Region.

1. Performance evaluation sample frequency may vary.

   [For data generated through the Low Concentration Water SOW: A performance evaluation (PE) sample may be required as frequently as once per SDG.]

2. The analytes present in the PE sample must be correctly identified and quantified.

D. **Evaluation**

Evaluation procedures must follow the Region's SOP for data review. Each Region will handle the evaluation of PE samples on an individual basis. Results for PE samples should be compared to the acceptance criteria for the specific PE samples, if available.

E. **Action**

Any action must be in accordance with Regional specifications and the criteria for acceptable PE sample results. Unacceptable results for PE samples should be noted for TPO action.

X. Internal Standards

A. **Review Items:** Form VIII VOA *[Form VIII LCV]*, quantitation reports, and chromatograms.

B. **Objective**

Internal Standards (IS) performance criteria ensures that GC/MS sensitivity and response are stable during each analysis.

C. **Criteria**

1. Internal standard area counts must not vary by more than a factor of two (-50% to +100%) from the associated calibration standard.

   [For data generated through the Low Concentration Water SOW: Internal standard area counts must not vary by more than a factor of ± 40.0% from the associated calibration standard.]

2. The retention time of the internal standard must not vary more than ±30 seconds from the retention time of the associated calibration standard.

   [For data generated through the Low Concentration Water SOW: The retention time of the internal standard must not vary more than ± 20.0 seconds from the retention time of the associated calibration standard.]

D. **Evaluation**

1. Check raw data (e.g., chromatograms and quantitation lists) to verify the internal standard retention times and areas reported on the Internal Standard Area Summary (Form VIII VOA *[Form VIII LCV]*).

2. Verify that all retention times and IS areas are within criteria.

3. If there are two analyses for a particular fraction, the reviewer must determine which are the best data to report. Considerations should include:

   a. Magnitude and direction of the IS area shift.

   b. Magnitude and direction of the IS retention time shift.

   c. Technical holding times.

   d. Comparison of the values of the target compounds reported in each fraction.

   e. Other QC.

E. Action

1. If an IS area count for a sample or blank is outside -50% or +100% of the area for associated standard:

   a. Positive results for compounds quantitated using that IS should be qualified with "J".

   b. Non-detected compounds quantitated using an IS area count greater than 100% should not be qualified.

   c. Non-detected compounds quantitated using an IS area count less than 50% are reported as the associated sample quantitation limit and qualified with "UJ".

   d. If extremely low area counts are reported, or if performance exhibits a major abrupt drop-off, then a severe loss of sensitivity is indicated. Non-detected target compounds should then be qualified as unusable (R).

   [If an IS area count for a sample or blank is outside ± 40.0% of the area for associated standard:

   a. Positive results for compounds quantitated using that IS should be qualified with "J".

   b. Non-detected compounds quantitated using an IS area count greater than 40% should not be qualified.

   c. Non-detected compounds quantitated using an IS area count less than 40% are reported as the associated sample quantitation limit and qualified with "UJ".

   d. If extremely low area counts are reported, or if performance exhibits a major abrupt drop-off, then a severe loss of sensitivity is indicated. Non-detected target compounds should then be qualified as unusable (R).]

2. If an IS retention time varies by more than 30 seconds:

   [If an IS retention time varies by more than 20.0 seconds:]

   The chromatographic profile for that sample must be examined to determine if any false positives or negatives exist. For shifts of a large magnitude, the reviewer may consider partial or total rejection of the data for that sample fraction. Positive results should not need to be qualified as "R" if the mass spectral criteria are met.

3. If the internal standards performance criteria are grossly exceeded, then this should be noted for TPO action. Potential effects on the data resulting from unacceptable internal standard performance should be noted in the data review narrative.

XI. Target Compound Identification

A. **Review Items:** Form I VOA *[Form I LCV]*, quantitation reports, mass spectra, and chromatograms.

B. **Objective**

The objective of the criteria for GC/MS qualitative analysis is to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not) or a false negative (not reporting a compound that is present).

The identification criteria can be applied more easily in detecting false positives than false negatives. More information is available for false positives due to the requirement for submittal of data supporting positive identifications. Negatives, or non-detected compounds, on the other hand represent an absence of data and are, therefore, more difficult to assess. One example of detecting false negatives is the not reporting of a Target Compound that is reported as a TIC.

C. **Criteria**

1. The relative retention times (RRTs) must be within ±0.06 RRT units of the standard RRT.

2. Mass spectra of the sample compound and a current laboratory-generated standard (i.e., the mass spectrum from the associated calibration standard) must match according to the following criteria:

   a. All ions present in the standard mass spectrum at a relative intensity greater than 10% must be present in the sample spectrum.

      [For data generated through the Low Concentration Water SOW: All ions present in the standard mass spectrum at a relative intensity greater than 25% must be present in the sample spectrum.]

   b. The relative intensities of these ions must agree within ± 20% between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30% and 70%.)

   c. Ions present at greater than 10% in the sample mass spectrum but not present in the standard spectrum must be considered and accounted for.

      [For data generated through the Low Concentration Water SOW: Ions present at greater than 25% in the sample mass spectrum but not present in the standard spectrum must be considered and accounted for.]

D. Evaluation

1. Check that the RRT of reported compounds is within ± 0.06 RRT units of the standard RRT.

2. Check the sample compound spectra against the laboratory standard spectra to see that it meets the specified criteria.

3. The reviewer should be aware of situations (e.g., high concentration samples preceding low concentration samples) when sample carryover is a possibility and should use judgment to determine if instrument cross-contamination has affected any positive comp und identification. The SOW specifies that an instrument blank must be run after samples in which a target analyte ion(s) saturates the detector.

   [The reviewer should be aware of situations when sample carryover is a possibility and should use judgment to determine if instrument cross-contamination has affected any positive compound identification. The SOW specifies that an instrument blank must be run after samples which contain target compounds at levels exceeding the initial calibration range (25 ug/L for non-ketones, 125 ug/L for ketones) or non-target compounds at concentrations greater than 100 ug/L or saturated ions from a compound (excluding the compound peaks in the solvent front).]

4. Check the chromatogram to verify that peaks are accounted for, i.e., major peaks are either identified as target compounds, TICs, system monitoring compounds *[surrogate]*, or internal standards.

E. Action

1. The application of qualitative criteria for GC/MS analysis of target compounds requires professional judgement. It is up to the reviewer's discretion to obtain additional information from the laboratory. If it is determined that incorrect identifications were made, all such data should be qualified as not detected (U) or unusable (R).

2. Professional judgement must be used to qualify the data if it is determined that cross-contamination has occurred.

3. Any changes made to the reported compounds or concerns regarding target compound identifications should be clearly indicated in the data review narrative. The necessity for numerous or significant changes should be noted for TPO action.

XII. Compound Quantitation and Reported CRQLs

A. **Review Items:** Form I VOA *[Form I LCV]*, sample preparation sheets, SDG narrative, quantitation reports, and chromatograms.

B. **Objective**

The objective is to ensure that the reported quantitation results and Contract Required Quantitation Limits (CRQLs) are accurate.

C. **Criteria**

1. Compound quantitation, as well as the adjustment of the CRQLs, must be calculated according to the correct equation.

2. Compound RRFs must be calculated based on the internal standard (IS) associated with that compound, as listed in Appendix A *[Appendix B]* (also as specified in the Statement of Work) for packed column analyses. For analyses performed by capillary column method (EPA Method 524.2), the target compounds will not necessarily be associated with the same internal standard as in the packed column, depending on the compound elution order. Quantitation must be based on the quantitation ion (m/z) specified in the SOW for both the IS and target analytes. The compound quantitation must be based on the RRF from the appropriate daily standard.

D. **Evaluation**

1. For all fractions, raw data should be examined to verify the correct calculation of all sample results reported by the laboratory. Quantitation lists and chromatograms should be compared to the reported positive sample results and quantitation limits. Check the reported values.

2. Verify that the correct internal standard, quantitation ion, and RRF were used to quantitate the compound. Verify that the same internal standard, quantitation ion, and RRF are used consistently throughout, in both the calibration as well as the quantitation process. For analyses performed by capillary column, the reviewer should use professional judgement to determine that the laboratory has selected the appropriate internal standard.

3. Verify that the CRQLs have been adjusted to reflect all sample dilutions and dry weight factors that are not accounted for by the method.

E. **Action**

1. If any discrepancies are found, the laboratory may be contacted by the designated representative to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer must use professional judgement to decide which value is the best value. Under these circumstances, the reviewer may determine

qualification of data is warranted. A description of the reasons for data qualification and the qualification that is applied to the data should be documented in the data review narrative.

2. Numerous or significant failures to accurately quantify the target compound or to properly evaluate and adjust CRQLs should be noted for TPO action.

XIII. Tentatively Identified Compounds

A. **Review Items:** Form I VOA-TIC *[Form I LCV-TIC]*, chromatograms, and library search printout and spectra for three TIC candidates.

B. **Objective**

Chromatographic peaks in volatile fraction analyses that are not target analytes, system monitoring compounds *[surrogate]*, or internal standards are potential tentatively identified compounds (TICs). TICs must be qualitatively identified by a National Institute of Standards and Technology (NIST) mass spectral library search and the identifications assessed by the data reviewer.

C. **Criteria**

For each sample, the laboratory must conduct a mass spectral search of the NIST library and report the possible identity for the 10 largest volatile fraction peaks which are not system monitoring compound, internal standard, or target compounds, but which have area or height greater than 10 percent of the area or height of the nearest internal standard. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I VOA-TIC).

[For data generated through the Low Concentration Water SOW: For each sample, the laboratory must conduct a mass spectral search of the NIST library and report the possible identity for the 10 largest volatile fraction peaks which are not surrogate, internal standard, or TCL compounds, but which have area greater than or equal to 40 percent of the area of the nearest internal standard. Estimated concentrations for TICs are calculated similarly to the TCL compounds, using total ion areas for the TIC and the internal standard, and assuming a relative response factor of 1.0. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I LCV-TIC).]

NOTE: Since the SOW revision of October 1986, the CLP does not allow the laboratory to report as tentatively identified compounds any target compound which is properly reported in another fraction. For example, late eluting volatile target compounds should not be reported as semivolatile TICs.

D. **Evaluation**

1. Guidelines for tentative identification are as follows:

   a. Major ions (greater than 10% relative intensity) in the reference spectrum should be present in the sample spectrum.

      [Major ions (greater than 25% relative intensity) in the reference spectrum should be present in the sample spectrum.]

   b. The relative intensities of the major ions should agree within ±20% between the sample and the reference spectra.

   c. Molecular ions present in the reference spectrum should be present in the sample spectrum.

d. Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination, interference, or coelution of additional TIC or target compounds.

e. When the above criteria are not met, but in the technical judgement of the data reviewer or mass spectral interpretation specialist the identification is correct, the data reviewer may report the identification.

f. If in the data reviewer's judgement the identification is uncertain or there are extenuating factors affecting compound identifications, the TIC result may be reported as "unknown".

2. Check the raw data to verify that the laboratory has generated a library search for all required peaks in the chromatograms for samples and blanks.

3. Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-target compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 10 percent of the internal standard height, but present in the blank chromatogram at similar relative retention time.

[Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-TCL compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 40 percent of the internal standard area but present in the blank chromatogram at similar relative retention time.]

4. All mass spectra for every sample and blank must be examined.

5. Since TIC library searches often yield several candidate compounds having a close matching score, all reasonable choices must be considered.

6. The reviewer should be aware of common laboratory artifacts/contaminants and their sources (e.g., aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs.

Examples:

a. Common laboratory contaminants: CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluorotrichloromethane), and phthalates at levels less than 100 ug/L or 4000 ug/Kg.

b. Solvent preservatives such as cyclohexene which is a methylene chloride preservative. Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol condensation reaction products of acetone include: 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

7. Occasionally, a target compound may be identified in the proper analytical fraction by non-target library search procedures, even though it was not found on the quantitation list. If the total area quantitation method was used, the reviewer should request that the laboratory recalculate the result using the proper quantitation ion. In addition, the reviewer should evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine whether the false negative result is an isolated occurrence or whether additional data may be affected.

8. Target compounds could be identified in more than one fraction. Verify that quantitation is made from the proper fraction.

9. Library searches should not be performed on internal standards or system monitoring compounds.

10. TIC concentration should be estimated assuming a RRF of 1.0.

E. Action

1. All TIC results should be qualified "NJ", tentatively identified, with approximated concentrations.

2. General actions related to the review of TIC results are as follows:

   a. If it is determined that a tentative identification of a non-target compound is not acceptable, the tentative identification should be changed to "unknown" or an appropriate identification.

   b. If all contractually required peaks were not library searched and quantitated, the designated representative could request these data from the laboratory.

3. TIC results which are not sufficiently above 10x the level in the blank should not be reported. (Dilutions and sample size must be taken into account when comparing the amounts present in blanks and samples.)

4. When a compound is not found in any blanks, but is a suspected artifact of common laboratory contaminant, the result may be qualified as unusable (R).

5. In deciding whether a library search result for a TIC represents a reasonable identification, professional judgment must be exercised. If there is more than one possible match, the result may be reported as "either compound X or compound Y." If there is a lack of isomer specificity, the TIC result may be changed to a non-specific isomer result (e.g., 1,3,5-trimethyl benzene to trimethyl benzene isomer) or to a compound class (e.g., 2-methyl, 3-ethyl benzene to substituted aromatic compound).

6. The reviewer may elect to report all similar compounds as a total. (e.g., All alkanes may be summarized and reported as total hydrocarbons.)

7. Other case factors may influence TIC judgements. If a sample TIC match is poor but other samples have a TIC with a good library match, similar relative retention time, and the same ions, identification information may be inferred from the other sample TIC results.

8. Physical constants, such as boiling point, may be factored into professional judgement of TIC results.

9. Any changes made to the reported data or any concerns regarding TIC identifications should be indicated in the data review narrative.

10. Failure to properly evaluate and report TICs should be noted for TPO action.

XIV. System Performance

A. **Review Items:** Form VIII VOA *[Form VIII LCV]*, Form III VOA-1 and VOA-2 *[Form III LCV-1]*, and chromatograms.

B. **Objective**

During the period following Instrument Performance QC checks (e.g. blanks, tuning, calibration), changes may occur in the system that degrade the quality of the data. While this degradation would not be directly shown by QC checks until the next required series of analytical QC runs, a thorough review of the ongoing data acquisition can yield indicators of instrument performance.

C. **Criteria**

There are no specific criteria for system performance. Professional judgement should be applied to assess the system performance.

D. **Evaluation**

1. Abrupt, discrete shifts in the reconstructed ion chromatogram (RIC) baseline may indicate a change in the instrument's sensitivity or the zero setting. A baseline "shift" could indicate a decrease in sensitivity in the instrument or an increase in the instrument zero, possibly causing target compounds, at or near the detection limit, to miss detection. A baseline "rise" could indicate problems such as a change in the instrument zero, a leak, or degradation of the column.

2. Poor chromatographic performance affects both qualitative and quantitative results. Indications of substandard performance include:

   a. High RIC background levels or shifts in absolute retention times of internal standards.

   b. Excessive baseline rise at elevated temperature.

   c. Extraneous peaks.

   d. Loss of resolution.

   e. Peak tailing or peak splitting that may result in inaccurate quantitation.

[3. A drift in instrument sensitivity may occur during the 12-hour time period. This could be discerned by examination of the IS area on Form VIII LCV for trends such as a continuous or near-continuous increase or decrease in the IS area over time.

4. The results of the LCS analysis (Form III LCSV) may also be used to assess instrument performance.]

E. **Action**

Professional judgement must be used to qualify the data if it is determined that system performance has degraded during sample analyses. Any degradation of system performance which significantly affected the data should be documented for TPO action.

XV. Overall Assessment of Data

A. **Review Items:** Entire data package, data review results, and (if available) Quality Assurance Project Plan (QAPjP), and Sampling and Analysis Plan (SAP).

B. **Objective**

The overall assessment of a data package is a brief narrative in which the data reviewer expresses concerns and comments on the quality and, if possible, the useability of the data.

C. **Criteria**

Assess the overall quality of the data.

Review all available materials to assess the overall quality of the data, keeping in mind the additive nature of analytical problems.

D. **Evaluation**

1. Evaluate any technical problems which have not been previously addressed.

2. If appropriate information is available, the reviewer may assess the useability of the data to assist the data user in avoiding inappropriate use of the data. Review all available information, including the QAPjP (specifically the Data Quality Objectives), SAP, and communication with data user that concerns the intended use and desired quality of these data.

E. **Action**

1. Use professional judgement to determine if there is any need to qualify data which were not qualified based on the QC criteria previously discussed.

2. Write a brief narrative to give the user an indication of the analytical limitations of the data. Any inconsistency of the data with the SDG narrative should be noted for TPO action. If sufficient information on the intended use and required quality of the data are available, the reviewer should include his/her assessment of the useability of the data within the given context.

SEMIVOLATILE DATA REVIEW

**** Data review guidelines that are unique to data generated through the Low Concentration Water SOW are contained within brackets ([ ]) and written in italics. ****

The semivolatile data requirements to be checked are listed below:

I. Technical Holding Times (CCS - Contractual holding times only)

II. GC/MS Instrument Performance Check (CCS)

III. Initial Calibration (CCS)

IV. Continuing Calibration (CCS)

V. Blanks (CCS)

VI. Surrogate Spikes (CCS)

VII. Matrix Spikes/Matrix Spike Duplicates

VIII. Laboratory Control Samples (CCS)

IX. Regional Quality Assurance and Quality Control

X. Internal Standards (CCS)

XI. Target Compound Identification

XII. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

XIII. Tentatively Identified Compounds

XIV. System Performance (CCS)

XV. Overall Assessment of Data

NOTE: "CCS" indicates that the contractual requirements for these items will also be checked by CCS: CCS requirements are not always the same as the data review criteria.

I. Technical Holding Times

A. **Review Items:** Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]*, EPA Sample Traffic Report and/or chain-of-custody, raw data, and sample extraction sheets.

B. **Objective**

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis.

C. **Criteria**

Technical requirements for sample holding times have only been established for water matrices. The holding times for soils (and other non-aqueous matrices such as sediments, oily wastes, and sludge) are currently under investigation. When the results are available they will be incorporated into the data evaluation process. Additionally, results of holding time studies will be incorporated into the data review criteria as the studies are conducted and approved.

The holding time criteria for water samples, as stated in the current 40 CFR Part 136 (Clean Water Act) is as follows:

> For semivolatile compounds in cooled (@ 4°C) water samples the maximum holding time is 7 days from sample collection to extraction and 40 days from sample extraction to analysis.

It is recommended that semivolatile compounds in non-aqueous samples be extracted within 14 days of sample collection.

The contractual holding times, which differ from the technical holding times, state that water samples are to be extracted within 5 days from the validated time of sample receipt (VTSR) at the laboratory, and soil samples are to be extracted within 10 days from the VTSR. Also, contractually both water and soil sample extracts must be analyzed within 40 days of sample extraction. However, the contractual delivery due date is 35 days from the VTSR.

[For data generated through the Low Concentration SOW: The contractual delivery due date is 14 days from the VTSR.]

D. **Evaluation**

Technical holding times for sample extraction are established by comparing the sampling date on the EPA Sample Traffic Report with the dates of extraction on Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]* and the sample extraction sheets. To determine if the samples were analyzed within the holding time after extraction, compare the dates of extraction on the sample extraction sheets with the dates of analysis on Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]*.

Verify that the traffic report indicates that the samples were received intact and iced. If the samples were not iced or there were any problems with the samples upon receipt, then discrepancies in the sample condition could effect the data.

E. Action

1. If technical holding times are exceeded, flag all positive results as estimated "J" and sample quantitation limits as estimated "UJ" and document that holding times were exceeded.

2. If technical holding times are grossly exceeded, either on the first analysis or upon re-analysis, the reviewer must use professional judgement to determine the reliability of the data and the effects of additional storage on the sample results. The reviewer may determine that positive results or the associated quantitation limits are approximates and should be qualified with "J" or "UJ", respectively. The reviewer may determine that non-detect data are unusable (R).

3. Due to limited information concerning holding times for soil samples, it is left to the discretion of the data reviewer to apply water holding time criteria to soil samples. Professional judgement is required to evaluate holding times for soil samples.

4. Whenever possible, the reviewer should comment on the effect of the holding time exceedance on the resulting data in the data review narrative.

5. When contractual and/or technical holding times are exceeded, this should be noted as an action item for the TPO.

6. The reviewer should also be aware of the scenario in which the laboratory has exceeded the technical holding times, but met contractual holding times. In this case, the data reviewer should notify the Regional TPO (where samples were collected) and/or RSCC that shipment delays have occurred so that the field problem can be corrected. The reviewer may pass this information on to the laboratory's TPO, but should explain that contractually the laboratory met the requirements.

II. GC/MS Instrument Performance Check

A. **Review Items:** Form V SV *[Form V LCSV]*, and DFTPP mass spectra and mass listing.

B. **Objective**

Gas chromatograph/mass spectrometer (GC/MS) instrument performance checks (formerly referred to as tuning) are performed to ensure mass resolution, identification and, to some degree, sensitivity. These criteria are not sample specific. Conformance is determined using standard materials, therefore, these criteria should be met in all circumstances.

C. **Criteria**

The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples or standards are analyzed. The instrument performance check, decafluorotriphenylphosphine (DFTPP) for volatile analysis, must meet the ion abundance criteria given below.

Decafluorotriphenylphosphine (DFTPP)

m/z	ION ABUNDANCE CRITERIA
51	30.0 - 80.0% of m/z 198
68	Less than 2.0% of m/z 69
69	Present
70	Less than 2.0% of m/z 69
127	25.0 - 75.0% of m/z 198
197	Less than 1.0% of m/z 198
198	Base peak, 100% relative abundance
199	5.0 - 9.0% of m/z 198
275	10.0 - 30.0% of m/z 198
365	Greater than 0.75% of m/z 198
441	Present, but less than m/z 443
442	40.0 - 110.0% of m/z 198
443	15.0 - 24.0% of m/z 442

NOTE: All ion abundances must be normalized to m/z 198, the nominal base peak, even though the ion abundances of m/z 442 may be up to 110 percent that of m/z 198.

D. **Evaluation**

1. Compare the data presented on each GC/MS Instrument Performance Check (Form V SV *[Form V LCSV]*) with each mass listing submitted and ensure the following:

   a. Form V SV *[Form V LCSV]* is present and completed for each 12-hour period during which samples were analyzed.

b. The laboratory has not made any transcription errors between the data and the form. If there are major differences between the mass listing and the Form Vs, a more in-depth review of the data is required. This may include obtaining and reviewing additional information from the laboratory.

c. The appropriate number of significant figures has been reported (number of significant figures given for each ion in the ion abundance criteria column) and that rounding is correct.

d. The laboratory has not made any calculation errors.

2. Verify from the raw data (mass spectral listing) that the mass assignment is correct and that the mass is normalized to m/z 198.

3. Verify that the ion abundance criteria was met. The criteria for m/z 68, 70, 441, and 443 are calculated by normalizing to the specified m/z.

4. If possible, verify that spectra were generated using appropriate background subtraction techniques. Since the DFTPP spectrum is obtained from chromatographic peaks that should be free from coelution problems, background subtraction should be done in accordance with the following procedure. Three scans (the peak apex scan and the scans immediately preceding and following the apex) are acquired and averaged and background subtraction must be accomplished using a single scan prior to the elution of DFTPP.

NOTE: All instrument conditions must be identical to those used in the sample analysis. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting the contract specifications are contrary to the quality assurance objectives and are therefore unacceptable.

E. Action

1. If the laboratory has made minor transcription errors which do not significantly affect the data, the data reviewer should make the necessary corrections on a copy of the form.

2. If the laboratory has failed to provide the correct forms or has made significant transcription or calculation errors, the Region's designated representative should contact the laboratory and request corrected data. If the information is not available, then the reviewer must use professional judgement to assess the data. The laboratory's TPO should be notified.

3. If mass assignment is in error (such as m/z 199 is indicated as the base peak rather than m/z 198), classify all associated data as unusable (R).

4. If ion abundance criteria are not met, professional judgement may be applied to determine to what extent the data may be utilized. Guidelines to aid in the application of professional judgement in evaluating ion abundance criteria are discussed as follows:

a. Some of the most critical factors in the DFTPP criteria are the non-instrument specific requirements that are also not unduly affected by the location of the spectrum on the chromatographic profile. The m/z ratios for 198/199 and 442/443 are critical. These ratios are based on the natural abundances of carbon 12 and carbon 13 and should always be met. Similarly, the relative abundances for m/z 68, 70, 197, and 441 indicate the condition of the instrument and the suitability of the resolution adjustment and are very important. Note that all of the foregoing abundances relate to adjacent ions; they are relatively insensitive to differences in instrument design and position of the spectrum on the chromatographic profile.

b. For the ions at m/z 51, 127, and 275, the actual relative abundance is not as critical. For instance, if m/z 275 has 40% relative abundance (criteria: 10.0-30.0%) and other criteria are met, then the deficiency is minor.

c. The relative abundance of m/z 365 is an indicator of suitable instrument zero adjustment. If relative abundance for m/z 365 is zero, minimum detection limits may be affected. On the other hand, if m/z 365 is present, but less than the 0.75% minimum abundance criteria, the deficiency is not as serious.

5. Decisions to use analytical data associated with DFTPP instrument performance checks not meeting contract requirements should be clearly noted in the data review narrative.

6. If the reviewer has reason to believe that instrument performance check criteria were achieved using techniques other than those specified in the SOW and II.D.4 above, additional information on the DFTPP instrument performance checks should be obtained. If the techniques employed are found to be at variance with contract requirements, the procedures of the laboratory may merit evaluation. Concerns or questions regarding laboratory performance should be noted for TPO action. For example, if the reviewer has reason to believe that an inappropriate technique was used to obtain background subtraction (such as background subtracting from the solvent front or from another region of the chromatogram rather than the DFTPP peak), then this should be noted for TPO action.

III. Initial Calibration

A. **Review Items:** Form VI SV-1 and SV-2 *[Form VI LCSV-1 and LCSV-2]*, quantitation reports, and chromatograms.

B. **Objective**

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for compounds on the semivolatile Target Compound List (TCL). Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve.

C. **Criteria**

1. Initial calibration standards containing both semivolatile target compounds and surrogates are analyzed at concentrations of 20, 50, 80, 120, and 160 ug/L at the beginning of each analytical sequence or as necessary if the continuing calibration acceptance criteria are not met. The initial calibration (and any associated samples and blanks) must be analyzed within 12 hours of the associated instrument performance check.

   [For data generated through the Low Concentration SOW: Initial calibration standards containing both semivolatile TCL compounds and surrogates are analyzed at concentrations of 5, 10, 20, 50, and 80 ug/L at the beginning of each analytical sequence or as necessary if the continuing calibration acceptance criteria are not met. The initial calibration (and any associated samples and blanks) must be analyzed within 12 hours of the associated DFTPP tuning check. The following nine compounds require initial calibration at 20, 50, 80, 100, and 120 ug/L: 2,4-dinitrophenol, 2,4,5-trichlorophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, 4,6-dinitro-2-methylphenol, pentachlorophenol, and 2,4,6-tribromophenol (surrogate).]

2. Minimum Relative Response Factor (RRF) criteria must be greater than or equal to 0.05. Contractual RRF criteria are listed in Appendix A *[Appendix B]*.

3. The Percent Relative Standard Deviations (%RSD) for the RRFs in the initial calibration must be less than or equal to 30%.

D. **Evaluation**

1. Verify that the correct concentration of standards were used for the initial calibration (i.e., 20, 50, 80, 120, and 160 ug/L). For the eight compounds with higher CRQLs, only a four-point initial calibration is required (i.e., 50, 80, 120, and 160 ug/L).

   [Verify that the correct concentration of standards were used for the initial calibration (i.e., 5, 10, 20, 50, and 80 ug/L). For the nine compounds listed in III.C.1. with higher CRQLs, verify that a five point initial calibration at 20, 50, 80, 100, and 120 ug/L was performed.]

2. If any sample results were calculated using an initial calibration, verify that the correct standard (i.e., the 50 ppb standard) was used for calculating sample results and that the samples were analyzed within 12 hours of the associated instrument performance check.

[If any sample results were calculated using an initial calibration, verify that the correct standard (i.e., the 20 ug/L standard or 80 ug/L for the compounds listed in III.C.1.) was used for calculating sample results and that the samples were analyzed within 12 hours of the associated DFTPP tuning check.]

3. Evaluate the RRFs for all semivolatile target compounds and surrogates:

   a. Check and recalculate the RRF and $\overline{RRF}$ for at least one semivolatile target compound associated with each internal standard. Verify that the recalculated value(s) agrees with the laboratory reported value(s).

   b. Verify that all semivolatile target compounds and surrogates have RRFs that are greater than or equal to 0.05.

NOTE: Because historical performance data indicate poor response and/or erratic behavior, the semivolatile compounds in Table 4 have no contractual maximum %RSD criteria. Contractually they must meet a minimum RRF criteria of 0.01, however, for data review purposes, the "greater than or equal to 0.05" criterion is applied to all semivolatile compounds.

Table 4. Semivolatile Target Compounds Exhibiting Poor Response

2,2'-oxybis(1-Chloropropane)	Diethylphthalate
4-Chloroaniline	4-Nitroaniline
Hexachlorobutadiene	4,6-Dinitro-2-methylphenol
Hexachlorocyclopentadiene	N-Nitrosodiphenylamine
2-Nitroaniline	Di-n-butylphthalate
Dimethylphthalate	Butylbenzylphthalate
3-Nitroaniline	3-3'-Dichlorobenzidine
2,4-Dinitrophenol	bis(2-Ethylhexyl)phthalate
4-Nitrophenol	Di-n-octylphthalate
Carbazole†	*2,4,6-Tribromophenol (surr)‡*
Nitrobenzene-d_5 (surr)‡	

† Multi-media, Multi-concentration only
‡ Low Concentration Water only

4. Evaluate the %RSD for all semivolatile target compounds and surrogates.

   a. Check and recalculate the %RSD for one or more semivolatile target compound(s); verify that the recalculated value(s) agrees with the laboratory reported value(s).

b. Verify that all semivolatile target compounds have a %RSD of less than 30%. The contractual criteria for an acceptable initial calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%. For data review purposes, however, all compounds must be considered for qualification when the %RSD exceeds the ± 30.0% criterion.

c. If the %RSD is greater than 30.0%, then the reviewer should use professional judgement to determine the need to check the points on the curve for the cause of the non-linearity. This is checked by eliminating either the high point or the low point and recalculating the %RSD.

5. If errors are detected in the calculations of either the $\overline{RRF}$ or the %RSD, perform a more comprehensive recalculation.

E. Action

1. All semivolatile target compounds, including the 19 "poor performers" will be qualified using the following criteria:

a. If the %RSD is greater than or equal to 30.0% and the RRF is greater than 0.05, qualify positive results with "J", and non-detected semivolatile target compounds using professional judgement.

b. If the RRF is less than 0.05, qualify positive results that have acceptable mass spectral identification with "J" using professional judgement, and non-detects as unusable (R).

2. At the reviewer's discretion, a more in-depth review to minimize the qualification of data can be accomplished by considering the following:

a. If any of the required semivolatile compounds have a %RSD greater than 30.0%, and if eliminating either the high or the low point of the curve does not restore the %RSD to less than or equal to 30.0%:

i. Qualify positive results for that compound(s) with "J".

ii. Qualify non-detected semivolatile target compounds based on professional judgement.

b. If the high point of the curve is outside of the linearity criteria (e.g. due to saturation):

i. No qualifiers are required for positive results in the linear portion of the curve.

ii. Qualify positive results outside of the linear portion of the curve with "J".

iii. No qualifiers are needed for non-detected target compounds.

c. If the low end of the curve is outside of the linearity criteria:

i. No qualifiers are required for positive results in the linear portion of the curve.

ii. Qualify low level positive results in the area of non-linearity with "J".

iii. Qualify non-detected semivolatile target compounds using professional judgement.

3. If the laboratory has failed to provide adequate calibration information, the designated representative should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgement to assess the data.

4. Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

5. If calibration criteria are grossly exceeded, this should be noted for TPO action.

IV. Continuing Calibration

A. **Review Items:** Form VII SV-1 and SV-2 *[Form VII LCSV-1 and LCSV-2]*, quantitation reports, and chromatograms.

B. **Objective**

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for semivolatile target compounds. Continuing calibration establishes the 12-hour relative response factors on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis.

C. **Criteria**

1. Continuing calibration standards containing both target compounds and surrogates are analyzed at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of blanks and samples.

2. The minimum Relative Response Factors (RRF) for semivolatile target compounds and surrogates must be greater than or equal to 0.05.

3. The percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within $\pm$ 25.0% for all target compounds.

D. **Evaluation**

1. Verify that the continuing calibration was run at the required frequency and that the continuing calibration was compared to the correct initial calibration.

2. Evaluate the continuing calibration RRF for all semivolatile target compounds and surrogates.

   a. Check and recalculate the continuing calibration RRF for at least one semivolatile target compound for each internal standard; verify that the recalculated value(s) agrees with the laboratory reported value(s).

   b. Verify that all semivolatile target compounds and surrogates have RRFs within specifications.

NOTE: Because historical performance data indicate poor response and/or erratic behavior, the compounds in Table 4 (Section III.D.3) have no contractual maximum %D criteria. Contractually they must meet a minimum RRF criterion of 0.01, however, for data review purposes, the "greater than or equal to 0.05" criterion is applied to all semivolatile compounds.

3. Evaluate the %D between initial calibration RRF and continuing calibration RRF for one or more semivolatile compounds.

   a. Check and recalculate the %D for at least one semivolatile target compound for each internal standard; verify that the recalculated value agrees with the laboratory reported value(s).

   b. Verify that the %D is within the ± 25.0% criterion, for all semivolatile target compounds and surrogates. Note those compounds which have a %D outside the ± 25.0% criterion. The contractual criteria for an acceptable continuing calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%. For data review purposes, however, all compounds must be considered for qualification when the %D exceeds the ± 25.0% criterion.

4. If errors are detected in the calculations of either the continuing calibration RRF or the %D, perform a more comprehensive recalculation.

E. Action

1. The reviewer should use professional judgement to determine if it is necessary to qualify the data for any semivolatile target compound. If qualification of data is required, it should be performed using the following guidelines:

   a. If the %D is outside the ± 25.0% criterion and the continuing calibration RRF is greater than or equal to 0.05, qualify positive results "J".

   b. If the %D is outside the ± 25.0% criterion and the continuing calibration RRF is greater than or equal to 0.05, qualify non-detected semivolatile target compounds "UJ".

   c. If the continuing calibration RRF is less than 0.05, qualify positive results that have acceptable mass spectral identification with "J" or use professional judgement.

   d. If the continuing calibration RRF is less than 0.05, qualify non-detected semivolatile target compounds as unusable (R).

2. If the laboratory has failed to provide adequate calibration information, the designated representative should contact the laboratory and request the necessary information. If the information is not available, the reviewer must use professional judgement to assess the data.

3. Whenever possible, the potential effects on the data due to calibration criteria exceedance should be noted in the data review narrative.

4. If calibration criteria are grossly exceeded, this should be noted for TPO action.

V. Blanks

A. **Review Items:** Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]*, Form IV SV *[Form IV LCSV]*, chromatograms, and quantitation reports.

B. **Objective**

The purpose of laboratory (or field) blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory (or field) activities. The criteria for evaluation of blanks apply to any blank associated with the samples (e.g., method blanks, instrument blanks, trip blanks, and equipment blanks). If problems with any blank exist, all associated data must be carefully evaluated to determine whether or not there is an inherent variability in the data, or if the problem is an isolated occurrence not affecting other data.

C. **Criteria**

1. No contaminants should be found in the blanks.

2. The method blank must be analyzed on each GC/MS system used to analyze that specific group or set of samples.

D. **Evaluation**

1. Review the results of all associated blank, Form I SV-1 and SV-2, and raw data (chromatograms and quantitation reports) to evaluate the presence of target and non-target compounds in the blanks.

2. Verify that a method blank analysis has been reported per matrix, per concentration level, for each extraction batch and for each GC/MS system used to analyze semivolatile samples. The reviewer can use the Method Blank Summary (Form IV SV) to assist in identifying samples associated with each method blank.

E. **Action**

If the appropriate blanks were not analyzed with the frequency described above, then the data reviewer should use professional judgement to determine if the associated sample data should be qualified. The reviewer may need to obtain additional information from the laboratory. The situation should be noted for TPO action.

Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. Positive sample results should be reported unless the concentration of the compound in the sample is less than or equal to 10 times (10x) the amount in any blank for the common phthalate contaminants, or 5 times the amount for other compounds. In instances where more than one blank is associated with a given sample, qualification should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

Specific actions are as follows:

1. If a semivolatile compound is found in a blank but not found in the sample, no action is taken. If the contaminants found are volatile target compounds (or interfering non-target compounds) at significant concentrations above the CRQL, then this should be noted for TPO action.

2. Any semivolatile compound detected in the sample (other than the common phthalate contaminants), that was also detected in any associated blank, is qualified if the sample concentration is less than five times (5x) the blank concentration. The quantitation limit may also be elevated. Typically, the sample CRQL is elevated to the concentration found in the sample. The reviewer should use professional judgement to determine if further elevation of the CRQL is required. For phthalate contaminants, the results are qualified "U" by elevating the sample quantitation limit to the sample concentration when the sample result is less than 10x the blank concentration.

   The reviewer should note that blanks may not involve the same weights, volumes, or dilution factors as the associated samples. These factors must be taken into consideration when applying the "5x" and "10x" criteria, such that a comparison of the total amount of contamination is actually made.

   Additionally, there may be instances where little or no contamination was present in the associated blanks, but qualification of the sample was deemed necessary. Contamination introduced through dilution is one example. Although it is not always possible to determine, instances of this occurring can be detected when contaminants are found in the diluted sample result, but are absent in the undiluted sample result. Since both results are not routinely reported, it may be impossible to verify this source of contamination. However, if the reviewer determines that the contamination is from a source other than the sample, he/she should qualify the data. In this case, the "5x" or "10x" rules may not apply; the sample value should be reported as a non-detect. An explanation of the rationale used for this determination should be provided in the narrative accompanying the Regional Data Assessment Summary.

3. If gross contamination exists (i.e., saturated peaks by GC/MS), all affected compounds in the associated samples should be qualified as unusable (R), due to interference. This should be noted for TPO action if the contamination is suspected of having an effect on the sample results.

4. If inordinate amounts of other target compounds are found at low levels in the blank(s), it may be indicative of a problem and should be noted for TPO action.

5. The same consideration given to the target compounds should also be given to Tentatively Identified Compounds (TICs) which are found in both the sample and associated blank(s). (See SV Section XII for TIC guidance.)

6. If an instrument blank was not analyzed following a sample analysis which contained an analyte(s) at high concentration(s), sample analysis results after the high concentration sample must be evaluated for carryover. Professional judgement should be used to determine if instrument cross-contamination has affected any positive compound

identification(s). If instrument cross-contamination is suggested, then this should be noted for TPO action if the cross-contamination is suspected of having an effect on the sample results.

The following are examples of applying the blank qualification guidelines. Certain circumstances may warrant deviations from these guidelines.

Example 1: Sample result is greater than the Contract Required Quantitation Limit (CRQL), but is less than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	7	7
CRQL	5	5
Sample Result	60	30
Qualified Sample Result	60U	30U

In the example for the "10x" rule, sample results less than 70 (or 10 x 7) would be qualified as non-detects. In the case of the "5x" rule, sample results less than 35 (or 5 x 7) would be qualified as non-detects.

Example 2: Sample result is less than CRQL, and is also less than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	6	6
CRQL	5	5
Sample Result	4J	4J
Qualified Sample Result	5U	5U

Note that data are not reported as 4U, as this would be reported as a detection limit below the CRQL.

Example 3: Sample result is greater than the 5x or 10x multiple of the blank result.

	Rule	
	10x	5x
Blank Result	10	10
CRQL	5	5
Sample Result	120	60
Qualified Sample Result	120	60

For both the "10x" and "5x" rules, sample results exceeded the adjusted blank results of 100 (or 10x10) and 50 (or 5x10), respectively.

VI. Surrogate Spikes

A. **Review Items:** Form II SV-1 and SV-2 *[Form II LCSV]*, chromatograms, and quantitation reports.

B. **Objective**

Laboratory performance on individual samples is established by means of spiking activities. All samples are spiked with surrogate compounds prior to sample preparation. The evaluation of the results of these surrogate spikes is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the evaluation and review of data based on specific sample results is frequently subjective and demands analytical experience and professional judgment. Accordingly, this section consists primarily of guidelines, in some cases with several optional approaches suggested.

C. **Criteria**

1. Surrogate spikes, 4 acid compounds (3 required and 1 advisory) and 4 base/neutral compounds (3 required and 1 advisory) are added to all samples and blanks to measure their recovery in sample and blank matrices.

   [For data generated through the Low Concentration SOW: Surrogate spikes, 3 acid compounds and 3 base/neutral compounds, are added to all samples and blanks to measure their recovery in sample and blank matrices.]

2. Surrogate spike recoveries for semivolatile samples and blanks must be within the limits specified on in Appendix A and on Form II SV-1 and SV-2.

   [For data generated through the Low Concentration SOW: Surrogate spike recoveries for semivolatile samples and blanks must be within the limits specified in Appendix B and on Form II LCSV.]

D. **Evaluation**

1. Check raw data (e.g., chromatograms and quantitation reports) to verify the surrogate spike recoveries on the Surrogate Recovery Form II SV-1 and SV-2 *[Form II LCSV]*. Check for any transcription or calculation errors.

2. Check that the surrogate spike recoveries were calculated correctly. The equation can be found in Appendix A *[Appendix B]*.

3. The following should be determined from the Surrogate Recovery form(s):

   a. If any two base/neutral <u>or</u> acid surrogates are out of specification, or if any one base/neutral or acid extractable surrogate has a recovery of less than 10%, then there should be a reanalysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.

NOTE: When there are unacceptable surrogate recoveries followed by successful re-analyses, the laboratories are required to report only the successful run.

b. The laboratory has failed to perform satisfactorily if surrogate recoveries are out of specification and there is no evidence of reinjection of the extract, or reextraction and reanalysis (if reinjection fails to resolve the problem).

c. Verify that no blanks have surrogates recoveries outside the criteria.

4. Any time there are two or more analyses for a particular fraction the reviewer must determine which are the best data to report. Considerations should include but are not limited to:

a. Surrogate recovery (marginal versus gross deviation).

b. Technical holding times.

c. Comparison of the values of the target compounds reported in each fraction.

d. Other QC information, such as performance of internal standards.

E. Action

Data are not qualified with respect to surrogate recovery unless two or more semivolatile surrogates, within the same fraction (base/neutral or acid fraction), are out of specification. For surrogate spike recoveries out of specification, the following approaches are suggested based on a review of all data from the case, especially considering the apparent complexity of the sample matrix.

1. If two or more surrogates in either semivolatile fraction (base/neutral or acid fraction) have a recovery greater than the upper acceptance limit (UL):

a. Specify the fraction that is being qualified, i.e. acid, base/neutral, or both.

b. Detected semivolatile target compounds are qualified "J."

c. Results for non-detected semivolatile target compounds should not be qualified.

2. If two or more surrogates in either semivolatile fraction have a recovery greater than or equal to 10% but less than the lower acceptance limit (LL):

a. Specify the fraction that is being qualified, i.e. acid, base/neutral, or both.

b. Detected semivolatile target compounds are qualified "J."

c. For non-detected semivolatile target compounds, the sample quantitation limit is qualified as approximated (UJ).

3. If any surrogate in either semivolatile fraction show less than 10% recovery:

   a. Specify the fraction that is being qualified, i.e. acid, base/neutral, or both.

   b. Detected semivolatile target compounds are qualified "J".

   c. Non-detected semivolatile target compounds may be qualified as unusable (R).

Table 5. Qualification of Semivolatile Analytes Based on Surrogate Recoveries

	Surrogate Recovery		
	> UL	10% to LL	< 10%
Detected analytes	J	J	J
Non-detected analytes	No Qualification	UJ	R

4. In the special case of a blank analysis with surrogates out of specification, the reviewer must give special consideration to the validity of associated sample data. The basic concern is whether the blank problems represent an isolated problem with the blank alone, or whether there is a fundamental problem with the analytical process. For example, if one or more samples in the batch show acceptable surrogate recoveries, the reviewer may choose to consider the blank problem to be an isolated occurrence. However, even if this judgement allows some use of the affected data, analytical problems should be noted for TPO action. Also note if there are potential contractual problems associated with the lack of re-analysis of samples that were out of specification.

5. Whenever possible, the potential effects of the data resulting from system monitoring recoveries not meeting the advisory limits should be noted in the data review narrative.

VII. Matrix Spikes/Matrix Spike Duplicates
(Not Required for Low Concentration Water Data)

A. **Review Items:** Form III SV-1 and SV-2, chromatograms, and quantitation reports.

B. **Objective**

Data for matrix spikes/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. These data alone cannot be used to evaluate the precision and accuracy of individual samples. However, when exercising professional judgement, this data should be used in conjunction with other available QC information.

C. **Criteria**

1. Matrix spikes and matrix spike duplicate samples are analyzed at frequency of one MS and MSD per 20 samples of similar matrix.

2. Matrix spike and matrix spike duplicate recoveries should be within the advisory limits established on Form III SV-1 and SV-2.

3. The Relative Percent Differences (RPDs) between matrix spike and matrix spike duplicate recoveries should be within the advisory limits listed on Form III SV-1 and SV-2.

D. **Evaluation**

1. Verify that MS and MSD samples were analyzed at the required frequency and that results are provided for each sample matrix.

2. Inspect results for the MS/MSD Recovery on Form III SV-1 and SV-2 and verify that the results for recovery and RPD are within the advisory limits.

3. Verify transcriptions from raw data and verify calculations.

4. Check that the recoveries and RPD were calculated correctly.

5. Compare results (%RSD) of non-spiked compounds between the original result, MS, and MSD.

E. **Action**

1. No action is taken on MS/MSD data alone. However, using informed professional judgment the data reviewer may use the matrix spike and matrix spike duplicate results in conjunction with other QC criteria and determine the need for some qualification of the data.

2. The data reviewer should first try to determine to what extent the results of the MS/MSD effect the associated data. This determination should be made with regard to the

MS/MSD sample itself as well as specific analytes for all samples associated with the MS/MSD.

3. In those instances where it can be determined that the results of the MS/MSD effect only the sample spiked, then qualification should be limited to this sample alone. However, it may be determined through the MS/MSD results that a laboratory is having a systematic problem in the analysis of one or more analytes, which affects all associated samples.

4. The reviewer must use professional judgement to determine the need for qualification of positive results of non-spiked compounds.

NOTE: If a field blank was used for the MS/MSD, a statement to that effect must be included for TPO action.

VIII. Laboratory Control Samples
(Low Concentration Water)

A. Review Items: Form III LCSV, LCS chromatograms and quantitation reports.

B. Objective

Data for laboratory control samples (LCS) are generated to provide information on the accuracy of the analytical method and the laboratory performance.

C. Criteria

1. *Laboratory control samples are analyzed at frequency of once per 20 samples per SDG. The LCS must be prepared and analyzed concurrently with the samples in the SDG.*

2. *LCS percent recoveries must be within the QC limits provided on Form III LCSV. The LCS must meet the recovery criteria for the sample data to be accepted.*

3. *The LCS contains the following semivolatile target compounds, in addition to the required surrogates:*

Phenol	*1,2,4-Trichlorobenzene*
2-Chlorophenol	*Naphthalene*
4-Chloroaniline	*2,4-Dinitrotoluene*
2,4,6-Trichlorophenol	*Diethylphthalate*
bis(2-Chloroethyl)ether	*N-Nitrosodiphenylamine*
N-Nitroso-di-n-propylamine	*Hexachlorobenzene*
Hexachloroethane	*Benzo(a)pyrene*
Isophorone	

4. *The criteria for surrogate recovery and internal standard performance also apply.*

D. Evaluation

1. *Verify that LCS samples were analyzed at the required frequency.*

2. *Inspect the results for LCS Recovery on Form III LCSV and verify that the results for recovery are within the advisory limits.*

3. *Verify transcriptions from raw data and verify calculations.*

4. *Check that the recoveries were calculated correctly.*

E. Action

If the LCS criteria are not met, then the laboratory performance and method accuracy are in question. Professional judgement should be used to determine if the data should be qualified or rejected. The following guidance is suggested for qualifying sample data for which the associated LCS does not meet the required criteria.

1. *Action on the LCS recovery should be based on both the number of compounds that are outside of the recovery criteria and the magnitude of the exceedance of the criteria.*

2. *If the LCS recovery criteria are not met, then the LCS results should be used to qualify sample data for the specific compounds that are included in the LCS solution. Professional judgement should be used to*

qualify data for compounds other than those compounds that are included in the LCS. Professional judgement to qualify non-LCS compounds should take into account the compound class, compound recovery efficiency, analytical problems associated with each compound, and comparability in performance of the LCS compound to the non-LCS compound.

3. *If the LCS recovery is greater than 140%, then positive sample results for the affected compound(s) should be qualified with a "J".*

4. *If the mass spectral criteria are met but the LCS recovery is less than 60%, then the associated detected target compounds should be qualified "J" and the associated non-detected target compounds should be qualified "R".*

5. *If more than half of the compounds in the LCS are not within the required recovery criteria, then all of the associated detected target compounds should be qualified "J" and all associated non-detected target compounds should be qualified "R."*

6. *Action on non-compliant surrogate recovery and internal standard performance should follow the procedures provided in VI.E and X.E, respectively. Professional judgement should be used to evaluate the impact that non-compliance for surrogate recovery and internal standard performance in the LCS has on the associated sample data.*

7. *It should be noted for TPO action if a laboratory fails to analyze an LCS with each SDG, or if a laboratory consistently fails to generate acceptable LCS recoveries.]*

IX. Regional Quality Assurance and Quality Control

A. **Review Items:** Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]*, chromatograms, quantitation report, traffic report and raw data for Regional QC samples.

B. **Objective**

Regional Quality Assurance and Quality Control (QA/QC) refer to any QA and/or QC initiated by the Region, including field duplicates, Regional Performance Evaluation (PE) samples, blind spikes, and blind blanks. It is highly recommended that Regions adopt the use of these.

C. **Criteria**

Criteria are determined by each Region.

1. Performance evaluation sample frequency may vary.

   [For data generated through the Low Concentration SOW: A performance evaluation (PE) sample may be required as frequently as once per SDG.]

2. The analytes present in the PE sample must be correctly identified and quantified.

D. **Evaluation**

Evaluation procedures must follow the Region's SOP for data review. Each Region will handle the evaluation of PE samples on an individual basis. Results for PE samples should be compared to the acceptance criteria for the specific PE samples, if available.

E. **Action**

Any action must be in accordance with Regional specifications and the criteria for acceptable PE sample results. Unacceptable results for PE samples should be noted for TPO action.

X. Internal Standards

A. **Review Items:** Form VIII SV-1 and SV-2 *[Form VIII LCSV-1 and LCSV-2]*, quantitation reports, and chromatograms.

B. **Objective**

Internal Standards (IS) performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run.

C. **Criteria**

1. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated calibration standard.

   [For data generated through the Low Concentration Water SOW: Internal standard area counts must not vary by more than a factor of ± 40.0% from the associated calibration standard.]

2. The retention time of the internal standards in samples and blanks must not vary by more than ± 30 seconds from the retention time of the associated calibration standard.

   [For data generated through the Low Concentration SOW: The retention time of the internal standards in samples and blanks must not vary by more than ±20.0 seconds from the retention time of the associated calibration standard.]

D. **Evaluation**

1. Check raw data (e.g., chromatograms and quantitation lists) for samples and blanks to verify the internal standard retention times and areas reported on the Internal Standard Area Summary (Forms VIII SV-1, VIII SV-2 *[Form VIII LCSV-1 and LCSV-2]*).

2. Verify that all retention times and IS areas are within the required criteria.

3. If there are two analyses for a particular fraction, the reviewer must determine which are the best data to report. Considerations should include:

   a. Magnitude and direction of the IS area shift.

   b. Magnitude and direction of the IS retention time shift.

   c. Technical holding times.

   d. Comparison of the values of the target compounds reported in each fraction.

E. **Action**

1. If an IS area count for a sample or blank is outside - 50% or + 100% of the area for the associated standard:

a. Positive results for compounds quantitated using that IS should be qualified with "J".

b. Non-detected compounds quantitated using an IS area count greater than 100% should not be qualified.

c. Non-detected compounds quantitated using an IS area count less than 50% are reported as the associated sample quantitation limit and qualified with "UJ".

d. If extremely low area counts are reported, or if performance exhibits a major abrupt drop-off, then a severe loss of sensitivity is indicated. Non-detected target compounds should then be qualified as unusable (R).

[If an IS area count for a sample or blank is outside ± 40.0% of the area for associated standard:

a. Positive results for compounds quantitated using that IS should be qualified with "J".

b. Non-detected compounds quantitated using an IS area count greater than 40% should not be qualified.

c. Non-detected compounds quantitated using an IS area count less than 40% are reported as the associated sample quantitation limit and qualified with "UJ".

d. If extremely low area counts are reported, or if performance exhibits a major abrupt drop-off, then a severe loss of sensitivity is indicated. Non-detected target compounds should then be qualified as unusable (R).]

2. If an IS retention time varies by more than 30 seconds:

[If an IS retention time varies by more than 20.0 seconds:]

The chromatographic profile for that sample must be examined to determine if any false positives or negatives exist. For shifts of a large magnitude, the reviewer may consider partial or total rejection (R) of the data for that sample fraction. Positive results should not need to be qualified with "R" if the mass spectral criteria are met.

3. If the internal standards performance criteria are grossly exceeded, then this should be noted for TPO action. Potential effects on the data resulting from unacceptable internal standard performance should be noted in the data review narrative.

XI. Target Compound Identification

A. **Review Items:** Form I SV-1 and SV-2 *[Form I LCSV-1 and LCSV-2]*, quantitation reports, mass spectra, and chromatograms.

B. **Objective**

Qualitative criteria for compound identification have been established to minimize the number of erroneous identifications of compounds. An erroneous identification can either be a false positive (reporting a compound present when it is not) or a false negative (not reporting a compound that is present).

The identification criteria can be applied much more easily in detecting false positives than false negatives. More information is available due to the requirement for submittal of data supporting positive identifications. Negatives, or non-detected compounds, on the other hand represent an absence of data and are, therefore, much more difficult to assess. One example of detecting false negatives is the reporting of a Target Compound as a TIC.

C. **Criteria**

1. Compound must be within ± 0.06 relative retention time (RRT) units of the standard RRT.

2. Mass spectra of the sample compound and a current laboratory-generated standard must match according to the following criteria:

   a. All ions present in the standard mass spectrum at a relative intensity greater than 10% <u>must</u> be present in the sample spectrum

   [For data generated through the Low Concentration SOW: All ions present in the standard mass spectrum at a relative intensity greater than 25% <u>must</u> be present in the sample spectrum.]

   b. The relative intensities of these ions must agree within ±20% between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectrum, the corresponding sample ion abundance must be between 30% and 70%.)

   c. Ions present at greater than 10% in the <u>sample</u> mass spectrum but not present in the <u>standard</u> spectrum must be considered and accounted for.

   [For data generated through the Low Concentration SOW: Ions present at greater than 25% in the <u>sample</u> mass spectrum but not present in the <u>standard</u> mass spectrum must be considered and accounted for.]

D. **Evaluation**

1. Check that the RRT of reported compounds is within ± 0.06 RRT units of the standard relative retention time.

2. Check that the sample compound spectra against the laboratory standard spectra to verify that its meets the specified criteria.

3. The reviewer should be aware of situations (e.g., high concentration samples preceding low concentration samples) when sample carryover is a possibility and should use judgment to determine if instrument cross-contamination has affected any positive compound identification.

4. Check the chromatogram to verify that peaks are accounted for, i.e., major peaks are either identified as target compounds, TICs, surrogates, or internal standards.

E. Action

1. The application of qualitative criteria for GC/MS analysis of target compounds requires professional judgement. It is up to the reviewer's discretion to obtain additional information from the laboratory. If it is determined that incorrect identifications were made, all such data should be qualified as not detected (U) or unusable (R).

2. Professional judgement must be used to qualify the data if it is determined that cross-contamination has occurred.

3. Any changes made to the reported compounds or concerns regarding target compound identifications should be clearly indicated in the data review narrative. The necessity for numerous or significant changes should be noted for TPO action.

XII. Compound Quantitation and Reported CRQLS

A. **Review Items:** Form I SV-1 and SV-2 *(Form I LCSV-1 and LCSV-2)*, sample preparation sheets, case narrative, sample clean-up sheets, quantitation reports, and chromatograms.

B. **Objective**

The objective is to ensure that the reported quantitation results and Contract Required Quantitation Limits (CRQLs) for semivolatile target compounds are accurate.

C. **Criteria**

1. Compound quantitation, as well as the adjustment of the CRQL, must be calculated according to the correct equation.

2. Compound area responses must be calculated based on the internal standard (IS) associated with that compound, as listed in Appendix A *(Appendix B)* (also as specified in the Statement of Work). Quantitation must be based on the quantitation ion (m/z) specified in the SOW for both the IS and target analytes. The compound quantitation must be based on the RRF from the appropriate daily calibration standard.

D. **Evaluation**

1. For all fractions, raw data should be examined to verify the correct calculation of all sample results reported by the laboratory. Quantitation lists, chromatograms, and sample preparation log sheets should be compared to the reported positive sample results and quantitation limits. Check the reported values.

2. Verify that the correct internal standard, quantitation ion, and RRF were used to quantitate the compound. Verify that the same internal standard, quantitation ion, and RRF are used consistently throughout the calibration and quantitation processes.

3. Verify that the CRQLs have been adjusted to reflect all sample dilutions, concentrations, splits, clean-up activities, and dry weight factors that are not accounted for by the method.

E. **Action**

1. If there are any discrepancies found, the laboratory may be contacted by the designated representative to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer must use professional judgement to decide which value is the best value. Under these circumstances, the reviewer may determine qualification of data is warranted. Decisions made on data quality should be included in the data review narrative. A description of the reasons for data qualification and the qualification that is applied to the data should be documented in the data review narrative.

2. Numerous or significant failures to accurately quantify the target compound or to properly evaluate and adjust CRQLs should be noted for TPO action.

XIII. Tentatively Identified Compounds

A. **Review Items:** Form I SV-TIC *[Form I LCSV-TIC]*, chromatograms, and library search printout with spectra for three TIC candidates.

B. **Objective**

Chromatographic peaks in semivolatile fraction analyses that are not target analytes, surrogates, or internal standards are potential tentatively identified compounds (TICs). TICs must be qualitatively identified by a National Institute of Standards and Technology (NIST) mass spectral library search and the identifications assessed by the data reviewer.

C. **Criteria**

For each sample, the laboratory must conduct a mass spectral search of the NIST library and report the possible identity for the 20 largest semivolatile fraction peaks which are not surrogate, internal standard, or target compounds, but which have area or height greater than 10 percent of the area or height of the nearest internal standard. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I SV-TIC).

[For data generated through the Low Concentration SOW: For each sample, the laboratory must conduct a mass spectral search of the NIST library and report the possible identity for the 20 largest semivolatile fraction peaks which are not surrogates, internal standards, or TCL compounds, but which have an area greater than 50 percent of the area of the nearest internal standard. Estimated concentrations for TICs are calculated similarly to the TCL compounds, using total ion areas for the TIC and the internal standard, and assuming a relative response factor of 1.0. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I LCSV-TIC).]

NOTE: Since the SOW revision of October 1986, the CLP does not allow the laboratory to report as tentatively identified compounds any target compound which is properly reported in another fraction. For example, late eluting volatile target compounds should not be reported as semivolatile TICs.

D. **Evaluation**

1. Guidelines for tentative identification are as follows:

   a. Major ions (greater than 10% relative intensity) in the reference spectrum should be present in the sample spectrum.

      [Major ions (greater than 25% relative intensity) in the reference spectrum should be present in the sample spectrum.]

   b. The relative intensities of the major ions should agree within ±20% between the sample and the reference spectra.

   c. Molecular ions present in the reference spectrum should be present in the sample spectrum.

d. Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination, interference, or coelution of additional TIC or target compounds.

e. When the above criteria are not met, but in the technical judgment of the data reviewer or mass spectral interpretation specialist the identification is correct, the data reviewer may report the identification.

f. If in the data reviewer's judgment the identification is uncertain or there are extenuating factors affecting compound identifications, the TIC result may be reported as "unknown".

2. Check the raw data to verify that the laboratory has generated a library search for all required peaks in the chromatograms for samples and blanks.

[Check the raw data to verify that the laboratory has generated a library search for all required peaks in the chromatograms for samples and blanks with areas greater than or equal to 50 percent of the area of the nearest internal standard.]

3. Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-target compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 10 percent of the internal standard height, but present in the blank chromatogram at a similar relative retention time.

[Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-TCL compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which have areas less than 50 percent of the internal standard area, but present in the blank chromatogram at a similar relative retention time.]

4. All mass spectra for each sample and blank must be examined.

5. Since TIC library searches often yield several candidate compounds having a close matching score, all reasonable choices should be considered.

6. The reviewer should be aware of common laboratory artifacts/contaminants and their sources (e.g., aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs.

Examples:

a. Common laboratory contaminants: CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluorotrichloromethane), and phthalates at levels less than 100 ug/L or 4000 ug/Kg.

b. Solvent preservatives, such as cyclohexene which is a methylene chloride preservative. Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol reaction products of acetone include: 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

7. Occasionally, a target compound may be identified as a TIC in the proper analytical fraction by non-target library search procedures, even though it was not found on the quantitation list. If the total area quantitation method was used, the reviewer should request that the laboratory recalculate the result using the proper quantitation ion. In addition, the reviewer should evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine whether the false negative result is an isolated occurrence or whether additional data may be affected.

8. Target compounds may be identified in more than one fraction. Verify that quantitation is made from the proper fraction.

9. Library searches should not be performed on internal standards or surrogates.

10. TIC concentration should be estimated assuming a RRF of 1.0.

E. Action

1. All TIC results should be qualified "NJ", tentatively identified, with approximated concentrations.

2. General actions related to the review of TIC results are as follows:

a. If it is determined that a tentative identification of a non-target compound is not acceptable, the tentative identification should be changed to "unknown" or an appropriate identification.

b. If all contractually required peaks were not library searched and quantitated, the designated representative could request these data from the laboratory.

3. TIC results which are not sufficiently above the level in the blank should not be reported. (Dilutions and sample size must be taken into account when comparing the amounts present in blanks and samples.)

4. When a compound is not found in any blanks, but is a suspected artifact of common laboratory contamination, the result may be qualified as unusable (R).

5. In deciding whether a library search result for a TIC represents a reasonable identification, professional judgment must be exercised. If there is more than one possible match, the result may be reported as "either compound X or compound Y." If there is a lack of isomer specificity, the TIC result may be changed to a non-specific isomer result (e.g., 1,3,5-trimethyl benzene to trimethyl benzene isomer) or to a compound class (e.g., 2-methyl, 3-ethyl benzene to substituted aromatic compound).

6. The reviewer may elect to report all similar isomers as a total. (All alkanes may be summarized and reported as total hydrocarbons.)

7. Other case factors may influence TIC judgments. If a sample TIC match is poor but other samples have a TIC with a good library match, similar relative retention time, and the same ions, identification information may be inferred from the other sample TIC results.

8. Physical constants, such as boiling point, may be factored into professional judgment of TIC results.

9. Any changes made to the reported data or any concerns regarding TIC identifications should be indicated in the data review narrative.

10. Failure to properly evaluate and report TICs should be noted for TPO action.

XIV. System Performance

A. **Review Items:** Form III SV-1 and SV-2 *[Form III LCSV]*, Form VIII SV-1 and SV-2 *[Form VIII LCSV-1 and LCSV-2]*, and chromatograms.

B. **Objective**

During the period following Instrument Performance QC checks (e.g. blanks, tuning, calibration), changes may occur in the system that degrade the quality of the data. While this degradation would not be directly shown by QC checks until the next required series of analytical QC runs, a through review of the ongoing data acquisition can yield indicators of instrument performance.

C. **Criteria**

There are no specific criteria for system performance. Professional judgement should be used to assess the system performance.

D. **Evaluation**

1. Abrupt, discrete shifts in the reconstructed ion chromatogram (RIC) baseline may indicate a change in the instrument's sensitivity or the zero setting. A baseline shift could indicate a decrease in sensitivity in the instrument or an increase in the instrument zero, possibly causing target compounds at or near the detection limit to be non-detects. A baseline "rise" could indicate problems such as a change in the instrument zero, a leak, or degradation of the column.

2. Poor chromatographic performance affects both qualitative and quantitative results. Indications of substandard performance include:

   a. High RIC background levels or shifts in absolute retention times of internal standards.

   b. Excessive baseline rise at elevated temperature.

   c. Extraneous peaks.

   d. Loss of resolution as suggested between by factors such as non-resolution of 2,4- and 2,5- dinitrotoluene.

   e. Peak tailing or peak splitting that may result in inaccurate quantitation.

[3. A drift in instrument sensitivity may occur during the 12-hour time period. This could be discerned by examination of the IS area on Form VIII LCSV-1 and LCSV-2 for trends such as a continuous or near-continuous increase or decrease in the IS area over time.

4. The results of the LCS analysis (Form III LCSV) may also be used to assess instrument performance.]

E. Action

Professional judgement must be used to qualify the data if it is determined that system performance has degraded during sample analyses. Any degradation of system performance which significantly affected the data should be documented for TPO action.

XV. Overall Assessment of Data

A. **Review Items:** Entire data package, data review results, and (if available) Quality Assurance Project Plan (QAPjP), and Sampling and Analysis Plan (SAP).

B. **Objective**

The overall assessment of a data package is a brief narrative in which the data reviewer expresses concerns and comments on the quality and, if possible, the useability of the data.

C. **Criteria**

Assess the overall quality of the data.

Review all available materials to assess the overall quality of the data, keeping in mind the additive nature of analytical problems.

D. **Evaluation**

1. Evaluate any technical problems which have not been previously addressed.

2. Review all available materials to assess the overall quality of the data, keeping in mind the additive nature of analytical problems.

3. If appropriate information is available, the reviewer may assess the useability of the data to assist the data user in avoiding inappropriate use of the data. Review all available information, including the QAPjP (specifically the Data Quality Objectives), SAP, and communication with data user that concerns the intended use and desired quality of the data.

E. **Action**

1. Use professional judgement to determine if there is any need to qualify data which were not qualified based on the QC criteria previously discussed.

2. Write a brief narrative to give the user an indication of the analytical limitations of the data. Any inconsistency of that data with the SDG Narrative should be noted for TPO action. If sufficient information on the intended use and required quality of the data are available, the reviewer should include his/her assessment of the useability of the data within the given context.

MULTI-MEDIA, MULTI-CONCENTRATION CONTRACTUAL REQUIREMENTS AND EQUATIONS FOR VOLATILE DATA REVIEW

II. GC/MS Instrument Performance Check

Use equation II.1 to verify that the laboratory has not made errors the calculation of the percent relative abundance.

$$\%\ Relative\ Abundance = \frac{abundance\ of\ X}{abundance\ of\ Y} \times 100\% \qquad \text{(II.1)}$$

For example, the percent relative abundance of m/z 96 (X) relative to m/z 95 (Y) is calculated as follows:

$$\%\ Relative\ Abundance = \frac{abundance\ of\ m/z\ 96}{abundance\ of\ m/z\ 95} \times 100\%$$

III. Initial Calibration

Data Review Criteria: All volatile target compounds and system monitoring compounds must have a Relative Response Factor (RRF) of greater than or equal to 0.05 and a percent relative standard deviation (%RSD) of less than or equal to 30%.

Contractual Criteria: The maximum %RSD for volatile compounds is 20.5% and the minimum RRF criteria vary as specified in the Table A.1 (The volatile compounds listed separately in Table 2 on page 13 are not contractually required to meet a maximum %RSD but do have to meet a contractual minimum RRF of 0.010). The contractual criteria for an acceptable initial calibration specifies that up to any 2 volatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%.

Table A.1 Minimum RRF Criteria for Volatile Target Compunds

Volatile Compound	Minimum RRF
Bromomethane	0.100
Vinyl chloride	0.100
1,1-Dichloroethene	0.100
1,1-Dichloroethane	0.200
Chloroform	0.200
1,2-Dichloroethane	0.100
1,1,1-Trichloroethane	0.100
Carbon tetrachloride	0.100
Bromodichloromethane	0.200
cis-1,3-Dichloropropene	0.200

APPENDIX A

CONTRACTUAL REQUIREMENTS AND EQUATIONS

MULTI-MEDIA, MULTI-CONCENTRATION - MM/MC
(OLM01.0)

Table A.1 Minimum RRF Criteria for Volatile Target Compunds (continued)

Volatile Compound	Minimum RRF
Trichloroethene	0.300
Dibromochloromethane	0.100
1,1,2-Trichloroethane	0.100
Benzene	0.500
trans-1,3-Dichloropropene	0.100
Bromoform	0.100
Tetrachloroethene	0.200
1,1,2,2-Tetrachloroethane	0.500
Toluene	0.400
Chlorobenzene	0.500
Ethylbenzene	0.100
Styrene	0.300
Xylenes (total)	0.300
Bromofluorobenzene	0.200

Initial calibration RRFs and $\overline{RRF}$ are calculated using equations III.1 and III.2.

$$RRF = \frac{A_s}{A_{is}} \times \frac{C_{is}}{C_s} \qquad \text{(III.1)}$$

$$\overline{RRF} = \frac{\sum_{i=1}^{5} RRF_i}{5} \qquad \text{(III.2)}$$

where:

RRF_i = "i"th Relative Response Factor
A = Area of the characteristic ion (EICP) measured
C = Concentration
is = Internal standard
x = Analyte of interest

The %RSD is calculated using equations III.3 and III.4.

$$\sigma = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{(n-1)}} \qquad \text{(III.3)}$$

$$\%RSD = \frac{\sigma}{\bar{x}} \times 100 \qquad \text{(III.4)}$$

where:

σ = Standard deviation of 5 relative response factors
$\bar{x}$ = Mean of 5 relative response factors

IV. Continuing Calibration

Data Review Criteria: All compounds must be considered for qualification when the %D exceeds the ± 25.0% criterion.

Contratual Criteria: The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF is ± 25% for all compounds listed in Table A.1. The contractual criteria for an acceptable continuing calibration specifies that up to any 2 volatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%.

Check the continuing calibration RRF calculations for volatile target compounds using equation III.1. The %D between initial calibration $\overline{RRF}$ and continuing calibration RRF is calculated using equation IV.1.

$$\% D = \frac{\overline{RRF_I} - RRF_C}{\overline{RRF_I}} \times 100\% \qquad \text{(IV.1)}$$

where:

$\overline{RRF_I}$ = average relative response factor from initial calibration.
RRF_C = relative response factor from continuing calibration standard.

VI. System Monitoring Compounds

The volatile system monitoring compounds (surrogates) and their contractual recovery limits are listed in Table A.2.

Table A.2 System Monitoring Compound Contractual Requirements

System Monitoring Compound		%Recovery Limits	
		Water Samples	Soil Samples
SMC1	Toluene-d_8	88 - 110	84 - 138
SMC2	Bromofluorobenzene	86 - 115	59 - 113
SMC3	1,2-Dichloroethane-d_4	76 - 114	70 - 121

Use equation VI.1 to check that the system monitoring compound recoveries were calculated correctly:

$$\% \ Recovery = \frac{Concentration/amount\ found}{Concentration/amount\ spiked} \times 100\% \qquad \text{(VI.1)}$$

VII. Matrix Spikes/Matrix Spike Duplicates

The matrix spike/matrix spike duplicate contractual requirements are listed in Table A.3.

Table A.3 MS/MSD Contractual Requirements

Compound	%R - Water	%R - Soil	RPD - Water	RPD - Soil
1,1-Dichloroethene	61 - 145	59 - 172	≤14	≤22
Trichloroethene	71 - 120	62 - 137	≤14	≤24
Benzene	76 - 127	66 - 142	≤11	≤21
Toluene	76 - 125	59 - 139	≤13	≤21
Chlorobenzene	75 - 130	60 - 133	≤13	≤21

Verify that the matrix spike recoveries and RPD were calculated correctly using equations VII.1 and VII.2.

$$\% \ Recovery = \frac{SSR - SR}{SA} \times 100\% \qquad \text{(VII.1)}$$

where:

SSR = Spiked sample result
SR = Sample result
SA = Spike added

$$RPD = \frac{|MSR - MSDR|}{1/2\ (MSR + MSDR)} \times 100\% \qquad \text{(VII.2)}$$

where:

RPD = Relative percent difference
MSR = Matrix spike recovery
MSDR = Matrix spike duplicate recovery

IX. Internal Standards

Table A.4 contains the volatile internal standards and their corresponding target compounds. These criteria have been established for packed columns only. Specific criteria for capillary columns have not been included in the SOW at this time.

Table A.4 Internal Standards and Their Corresponding Target Compounds

Bromochloromethane	1,4-Difluorobenzene	Chlorobenzene-d_5
Chloromethane	1,1,1-Trichloroethane	2-Hexanone
Bromomethane	Carbon Tetrachloride	4-Methyl-2-Pentanone
Vinyl Chloride	Bromodichloromethane	Tetrachloroethene
Chloroethane	Bromoform	1,1,2,2-Tetrachloroethane
Methylene Chloride	1,2-Dichloropropane	Toluene
Acetone	trans-1,3-Dichloropropene	Chlorobenzene
Carbon Disulfide	Trichloroethene	Ethylbenzene
1,1-Dichloroethene	Dibromochloromethane	Styrene
1,1-Dichloroethane	1,1,2-Trichloroethane	Total Xylenes
1,2-Dichloroethene(total)	Benzene	Bromofluorobenzene (SMC)
Chloroform	cis-1,3-Dichloropropene	Toluene-d_8 (SMC)
1,2-Dichloroethane	Bromoform	
2-Butanone		
1,2-Dichloroethane-d_4 (SMC)		

SMC = System Monitoring Compound

XI. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

Check the reported positive sample results and quantitation limits with the quantitation lists and chromatograms using equations XI.1, XI.2, or XI.3. Characteristic ions for the volatile target compounds are contained in Table A.5. Characteristic ions for System Monitoring Compounds and Internal Standards are contained in Table A.6.

Concentration for waters:

$$ug/L = \frac{A_s \times I_s \times Df}{A_{is} \times RRF \times V_o} \qquad \text{(XI.1)}$$

Concentration for low level soils:
(Dry weight basis)

$$ug/Kg = \frac{A_x \times I_s}{A_{is} \times RRF \times W_s \times D} \qquad (XI.2)$$

Concentration for medium level soils:
(Dry weight basis)

$$ug/Kg = \frac{A_x \times I_s \times V_t \times 1000 \times Df}{A_{is} \times RRF \times V_o \times W_s \times D} \qquad (XI.3)$$

where:

Ax = area of characteristic ion (EICP) for compound being measured
A_{is} = area of characteristic ion (EICP) for the internal standard
I_s = amount of internal standard added (ng)
RRF = daily response factor for compound being measured
V_o = volume of water purged (mL)
W_s = weight of sample (g)
D = (100 - % moisture)/100% - conversion to dry weight
V_t = volume of methanol (mL)†
V_i = volume of extract added (uL) for purging
Df = dilution factor‡
V_a = volume of the aliquot of the methanol extract (uL) added to reagent water for purging

† This volume is typically 10.0 mL, even though only 1.0 mL is transferred to the vial. See the SOW for more details.

‡ The dilution factor for analysis of soil/sediment samples for volatiles by the medium level method is defined as the ratio of the number of microliters (uL) of methanol added to the reagent water for purging (V_a) to the number of microliters of the methanol extract of the sample contained in volume V_t. If no dilution is performed, then the dilution factor equals 1.0.

The CRQL for a diluted sample should be calculated as follows:

Adjusted CRQL = Non-adjusted CRQL x Sample Dilution Factor (XI.4)

For example, the adjusted CRQL for a water sample with a 10U non-diluted CRQL and a 1 to 100 dilution (100.0 dilution factor) would be 1000U, according to the following calculation:

$$1000U = 10U \times 100$$

The CRQL adjustment for dry weight for a soil sample should be calculated as follows:

$$\textit{Dry Weight CRQL} = \frac{\textit{Non-adjusted CRQL}}{\left(\frac{100 - \%moisture}{100}\right)} \qquad \text{(XI.5)}$$

For example, the dry weight CRQL for a soil sample with a 10U non-adjusted CRQL and a 10% moisture would be 11U, according to the following calculation:

$$11U = \frac{10U}{\left(\frac{100 - 10}{100}\right)}$$

Table A.5 Characteristic Ions for Volatile Target Compounds

Analyte	Primary Ion*	Secondary Ion(s)
Chloromethane	50	52
Bromomethane	94	96
Vinyl chloride	62	64
Chloroethane	64	66
Methylene chloride	84	49, 51, 86
Acetone	43	58
Carbon disulfide	76	78
1,1-Dichloroethene	96	61, 98
1,1-Dichloroethane	63	65, 83, 85, 98, 100
1,2-Dichloroethene	96	61, 98
Chloroform	83	85
1,2-Dichloroethane	62	64, 100, 98
2-Butanone	43**	57
1,1,1-Trichloroethane	97	99, 117, 119
Carbon tetrachloride	117	119, 121
Bromodichloromethane	83	85
1,1,2,2-Tetrachloroethane	83	85, 131, 133, 166
1,2-Dichloropropane	63	65, 114
trans-1,3-Dichloropropene	75	77
Trichloroethene	130	95, 97, 132
Dibromochloromethane	129	208, 206
1,1,2-Trichloroethane	97	83, 85, 99, 132, 134
Benzene	78	---
cis-1,3-Dichloropropene	75	77
Bromoform	173	171, 175, 250, 252, 254, 256
2-Hexanone	43	58, 57, 100
4-Methyl-2-pentanone	43	58, 100

Table A.5 Characteristic Ions for Volatile Target Compounds (Continued)

Analyte	Primary Ion*	Secondary Ion(s)
Tetrachloroethene	164	129, 131, 166
Toluene	92	92
Chlorobenzene	112	114
Ethyl benzene	106	91
Styrene	104	78, 103
Total Xylenes	106	91

** While m/z 43 is used for quantitation of 2-Butanone, m/z 72 must be present for positive identification.

* The primary ion should be used unless interferences are present, in which case, a secondary ion may be used.

Table A.6 Characteristic Ions for System Monitoring Compounds and Internal Standards for Volatile Organic Compounds

Compound	Primary Ion	Secondary Ion(s)
SYSTEM MONITORING COMPOUNDS		
4-Bromofluorobenzene	95	174, 176
1,2-Dichloroethane-d_4	65	102
Toluene-d_8	98	70, 100
INTERNAL STANDARDS		
Bromochloromethane	128	49, 130, 51
1,4-Difluorobenzene	114	63, 88
Chlorobenzene-d_5	117	82, 119

MULTI-MEDIA, MULTI-CONCENTRATION
CONTRACTUAL REQUIREMENTS AND EQUATIONS FOR SEMIVOLATILE DATA REVIEW

II. GC/MS Instrument Performance Check

Use equation II.1 to verify that the laboratory has not made errors in the calculation of the percent relative abundance.

For example, the percent relative abundance of m/z 443 (X) relative to m/z 442 (Y) is calculated as follows:

$$\%\ Relative\ Abundance = \frac{abundance\ of\ m/z\ 443}{abundance\ of\ m/z\ 442} \times 100\%$$

III. Initial Calibration

Data Review Criteria: All semivolatile target compounds and surrogates must have a Relative Response Factor (RRF) of greater than or equal to 0.05 and a percent relative standard deviation (%RSD) of less than or equal to 30%.

Contractual Criteria: The maximum %RSD for most semivolatile compounds is 20.5% and the minimum RRF criteria vary as specified in Table A.7 (The semivolatile compounds listed separately in Table 4 on page 52 are not contractually required to meet a maximum %RSD but do have to meet a contractual minimum RRF of 0.010). The contractual criteria for an acceptable initial calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%.

Table A.7 Minimum RRF Criteria for Semivolatile Target Compounds

Semivolatile Compounds	Minimum RRF
Phenol	0.800
bis(-2-Chloroethyl)ether	0.700
2-Chlorophenol	0.800
1,3-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.500
1,2-Dichlorobenzene	0.400
2-Methylphenol	0.700
4-Methylphenol	0.600
N-Nitroso-di-propylamine	0.500
Hexachloroethane	0.300
Nitrobenzene	0.200
Isophorone	0.400
2-Nitrophenol	0.100
2,4-Dimethylphenol	0.200
bis(-2-Chloroethoxy)methane	0.300

Table A.7 Minimum RRF Criteria for Semivolatile Target Compounds (Continued)

Semivolatile Compounds	Minimum RRF
2,4-Dichlorophenol	0.200
1,2,4-Trichlorobenzene	0.200
Naphthalene	0.700
4-Chloro-3-methylphenol	0.200
2-Methylnaphthalene	0.400
2,4,6-Trichlorophenol	0.200
2,4,5-Trichlorophenol	0.200
2-Chloronaphthalene	0.800
Acenaphthylene	1.300
2,6-Dinitrotoluene	0.200
Acenaphthene	0.800
Dibenzofuran	0.800
2,4-Dinitrotoluene	0.200
4-Chlorophenyl-phenylether	0.400
Fluorene	0.900
4-Bromophenyl-phenylether	0.100
Hexachlorobenzene	0.100
Pentachlorophenol	0.050
Phenanthrene	0.700
Anthracene	0.700
Fluoranthene	0.600
Pyrene	0.600
Benzo(a)anthracene	0.800
Chrysene	0.700
Benzo(b)fluoranthene	0.700
Benzo(k)fluoranthene	0.700
Benzo(a)pyrene	0.700
Indeno(1,2,3-cd)pyrene	0.500
Dibenz(a,h)anthracene	0.400
Benzo(g,h,i)perylene	0.500
Nitrobenzene-d_5	0.200
2-Fluorobiphenyl	0.700
Terphenyl-d_{14}	0.500
Phenol-d_5	0.800
2-Fluorophenol	0.600
2-Chlorophenol-d_4	0.800
1,2-Dichlorobenzene-d_4	0.400

Initial calibration RRF and $\overline{RRF}$ are calculated using equations III.1 and III.2; %RSD is calculated using equations III.3 and III.4.

IV. Continuing Calibration

Data Review Criteria: All semivolatile target compounds should meet a %D criterion of ± 25%.

Contractual Criteria: The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF is ± 25.0% for the compounds listed in Table A.4. The contractual criteria for an acceptable continuing calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%.

Check the continuing calibration RRF calculations for semivolatile target compounds using equation III.1, and evaluate the %D between initial calibration $\overline{RRF}$ and continuing calibration RRF using equation IV.1.

VI. Surrogate Spikes

The semivolatile surrogate compounds and their contractual recovery limits are listed in Table A.8.

Table A.8 Semivolatile Surrogate Requirements

Surrogate	%Recovery Limits	
	Water Samples	Soil Samples
S1 Nitrobenzene-d_5	35 - 114	23 - 120
S2 2-Fluorobiphenyl	43 - 116	30 - 115
S3 Terphenyl-d_{14}	33 - 141	18 - 137
S4 Phenol-d_5	10 - 110	24 - 113
S5 2-Fluorophenol	21 - 110	25 - 121
S6 2,4,6-Tribromophenol	10 - 123	19 - 122
S7 2-Chlorophenol-d_4	33 - 110*	20 - 130*
S8 1,2-Dichlorobenzene-d_4	16 - 110*	20 - 130*

* Advisory limits

Use equation VI.1 to verify that the surrogate recoveries were calculated correctly.

VII. Matrix Spikes/Matrix Spike Duplicates

The matrix spike/matrix spike duplicate contractual requirements are listed in Table A.9.

Verify that the matrix spike recoveries and RPD were calculated correctly using equations VII.1 and VII.2.

IX. Internal Standards

Table A.10 contains the semivolatile internal standards and their corresponding target compounds.

APPENDIX E

GLOSSARY OF TERMS

Table A.10 Semivolatile Internal Standards and Their Corresponding Target Compounds

1,4-Dichlorobenzene-d_4	Naphthalene-d_8	Acenaphthene-d_{10}
Phenol	Nitrobenzene	Hexachlorocyclopentadiene
bis(2-Chloroethyl)ether	Isophorone	2,4,6-Trichlorophenol
2-Chlorophenol	2-Nitrophenol	2,4,5-Trichlorophenol
1,3-Dichlorobenzene	2,4-Dimethylphenol	2-Chloronaphthalene
1,4-Dichlorobenzene	bis(2-Chloroethoxy)methane	2-Nitroaniline
1,2-Dichlorobenzene	2,4-Dichlorophenol	Dimethyl phthalate
2-Methylphenol	1,2,4-Trichlorobenzene	Acenaphthylene
2,2'-oxybis-(1-Chloropropane)	Naphthalene	3-Nitroaniline
4-Methylphenol	4-Chloroaniline	Acenaphthene
N-Nitroso-Di-n-propylamine	Hexachlorobutadiene	2,4-Dinitrophenol
Hexachloroethane	4-Chloro-3-methylphenol	4-Nitrophenol
2-Fluorophenol (surr)	2-Methylnaphthalene	Dibenzofuran
Phenol-d_5 (surr)	Nitrobenzene-d_5 (surr)	2,4-Dinitrotoluene
2-Chlorobenzene-d_4 (surr)		2,6-Dinitrotoluene
1,2-Dichlorobenzene-d_4 (surr)		Diethyl phthalate
		4-Chlorophenyl-phenyl ether
		Fluorene
		4-Nitroaniline
		2-Fluorobiphenyl (surr)
		2,4,6-Tribromophenol (surr)

Phenanthrene-d_{10}	Chrysene-d_{12}	Perylene-d_{12}
4,6-Dinitro-2-methylphenol	Pyrene	Di-n-octyl phthalate
N-Nitrosodiphenylamine	Butylbenzyl phthalate	Benzo(b)fluoranthene
4-Bromophenyl phenyl ether	3,3'-Dichlorobenzidine	Benzo(k)fluoranthene
Hexachlorobenzene	Benzo(a)anthracene	Benzo(a)pyrene
Pentachlorophenol	bis(2-Ethylhexyl)phthalate	Indeno(1,2,3-cd)pyrene
Phenanthrene	Chrysene	Dibenz(a,h)anthracene
Carbazole	Terphenyl-d_{14} (surr)	Benzo(g,h,i)perylene
Anthracene		
Di-n-butyl phthalate		
Fluoranthene		

surr = surrogate compound

XI. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

Check the reported positive sample results and quantitation limits with the quantitation lists and chromatograms using equations XI.6, XI.7 or XI.8. Equation XI.4 should be used to adjust the CRQL for a diluted sample, and equation XI.5 should be used to adjust the CRQL for a soil sample. Characteristic ions for semivolatile target compounds are contained in Table A.11. Characteristic ions for semivolatile surrogates and internal standards are contained in Table A.12. Characteristic ions for pesticides and Aroclors are contained in Table A.13.

Concentration for waters:

$$ug/L = \frac{A_x \times I_s \times V_t \times Df}{A_{is} \times RRF \times V_o \times V_i} \qquad (XI.6)$$

Concentration for soils/sediments:
(Dry weight basis)

$$ug/Kg = \frac{A_x \times I_s \times V_t \times Df}{A_{is} \times RRF \times V_i \times W_s \times D} \qquad (XI.7)$$

where:

- Ax = area of characteristic ion (EICP) for compound being measured
- A_{is} = area of characteristic ion (EICP) for the internal standard
- I_s = amount of internal standard added (ng)
- RRF = daily relative response factor for compound being measured
- V_o = volume of water extracted (mL)
- V_i = volume of extract injected (uL)
- V_t = volume of concentrated extract (uL)
- Df = dilution factor†
- D = (100 - % moisture)/100% - conversion to dry weight
- W_s = weight of sample (g)

† The dilution factor for analysis of water samples for semivolatiles by the method specified in SOW OLM01.0 is calculated using equation XI.8. If no dilution is performed, then the dilution factor equals 1.0.

$$Df = \frac{\text{uL of the most concentated extract used} - \text{uL of clean solvent}}{\text{uL of the most concentrated extract used}} \qquad (XI.8)$$

Table A.11 Characteristic Ions for Semivolatile Target Compounds

Analyte	Primary Ion	Secondary Ions
Phenol	94	65, 66
bis(2-Chloroethyl)ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 113
1,4-Dichlorobenzene	146	148, 113
1,2-Dichlorobenzene	146	148, 113
2-Methylphenol	108	107
2,2'-oxybis(1-Chloropropane)	45	77, 79
4-Methylphenol	108	107
N-Nitroso-di-propylamine	70	42, 101, 130
Hexachloroethane	117	201, 199
Nitrobenzene	77	123, 65
Isophorone	82	95, 138
2-Nitrophenol	139	65, 109
2,4-Dimethylphenol	107	121, 122
bis(2-Chloroethoxy)methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
4-Chloroaniline	127	129
Hexachlorobutadiene	225	223, 227
4-Chloro-3-methylphenol	107	144, 142
2-Methylnaphthalene	142	141
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 200
2-Chloronaphthalene	162	164, 127

Table A.11 Characteristic Ions for Semivolatile Target Compounds (Continued)

Parameter	Primary Ion	Secondary Ions
2-Nitroaniline	65	92, 138
Dimethyl phthalate	163	194, 164
Acenaphthylene	152	151, 153
3-Nitroaniline	138	108, 92
Acenaphthene	153	152, 154
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	109	139, 65
Dibenzofuran	168	139
2,4-Dinitrotoluene	165	63, 182
2,6-Dinitrotoluene	165	89, 121
Diethylphthalate	149	177, 150
4-Chlorophenyl-phenylether	204	206, 141
Fluorene	166	165, 167
4-Nitroaniline	138	92, 108
4,6-Dinitro-2-methylphenol	198	182, 77
N-Nitrosodiphenylamine	169	168, 167
4-Bromophenyl-phenylether	248	250, 141
Hexachlorobenzene	284	142, 249
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Anthracene	178	179, 176
Carbazole	167	166, 139
Di-n-butylphthalate	149	150, 104
Fluoranthene	202	101, 100
Pyrene	202	101, 100
Butylbenzylphthalate	149	91, 206
3,3'-Dichlorobenzidine	252	254, 126

Table A.11 Characteristic ions for Semivolatile Target Compounds (Continued)

Analyte	Primary Ion	Secondary Ions
Benz(a)anthracene	228	229, 226
bis(2-Ethylhexyl)phthalate	149	167, 279
Chrysene	228	226, 229
Di-n-Octyl phthalate	149	---
Benzo(b)fluoranthene	252	253, 125
Benzo(k)fluoranthene	252	253, 125
Benzo(a)pyrene	252	253, 125
Indeno(1,2,3-cd)pyrene	276	138, 227
Dibenz(a,h)anthracene	278	139, 279
Benzo(g,h,i)perylene	276	138, 277

Table A.12 Characteristic Ions for Semivolatile Surrogates and Internal Standards

Analyte	Primary Ion	Secondary Ions
SURROGATES		
Phenol-d_6	99	42, 71
2-Fluorophenol	112	64
2,4,6-Tribromophenol	330	332, 141
Nitrobenzene-d_5	82	128, 54
2-Fluorobiphenyl	172	171
Terphenyl	244	122, 212
2-Chlorophenol-d_4	132	68, 134
1,2-Dichlorobenzene-d_4	152	115, 150
INTERNAL STANDARDS		
1,4-Dichlorobenzene-d_4	152	115
Naphthalene-d_8	136	68
Acenapthene-d_{10}	164	162, 160
Phenanthrene-d_{10}	188	94, 80
Chrysene-d_{12}	240	120, 236
Perylene-d_{12}	264	260, 265

Table A.13 Characteristic Ions for Pesticides Aroclors

Analyte	Primary Ion	Secondary Ions
alpha-BHC	183	181, 109
beta-BHC	181	183, 109
delta-BHC	183	181, 109
gamma-BHC (Lindane)	183	181, 109
Heptachlor	100	272, 274
Aldrin	66	263, 220
Heptachlor epoxide	353	355, 351
Endosulfan I	195	339, 341
Dieldrin	79	263, 279
4,4'-DDE	246	248, 176
Endrin	263	82, 81
Endrin ketone	317	67, 319
Endrin aldehyde	67	250, 345
Endosulfan II	337	339, 341
4,4'-DDD	235	237, 165
Endosulfan sulfate	272	387, 422
4,4'-DDT	235	237, 165
Methoxychlor	227	228
Chlordane (alpha and/or gamma)	373	375, 377
Toxaphene	159	231, 233
Arochlor-1016	222	260, 292
Arochlor-1221	190	222, 260
Arochlor-1232	190	222, 260
Arochlor-1242	222	256, 292
Arochlor-1248	292	362, 326
Arochlor-1254	292	362, 326
Arochlor-1260	360	362, 394

APPENDIX B

CONTRACTUAL REQUIREMENTS AND EQUATIONS

LOW CONCENTRATION WATER - LCW
(O1.C01.0)

LOW CONCENTRATION WATER
CONTRACTUAL REQUIREMENTS AND EQUATIONS FOR VOLATILE DATA REVIEW

II. GC/MS Instrument Performance Check

Use equation II.1 to verify that the laboratory has not made errors the calculation of the percent relative abundance.

$$\%\ Relative\ Abundance = \frac{abundance\ of\ X}{abundance\ of\ Y} \times 100\% \qquad \text{(II.1)}$$

For example, the percent relative abundance of m/z 96 (X) relative to m/z 95 (Y) is calculated as follows:

$$\%\ Relative\ Abundance = \frac{abundance\ of\ m/z\ 96}{abundance\ of\ m/z\ 95} \times 100\%$$

III. Initial Calibration

<u>Data Review Criteria</u>: All volatile target compounds and system monitoring compounds must have a Relative Response Factor (RRF) of greater than or equal to 0.05 and a percent relative standard deviation (%RSD) of less than or equal to 30%.

<u>Contractual Criteria</u>: The maximum %RSD for most volatile compounds is 20.5% and the minimum RRF criteria vary as specified in the following table (The volatile compounds listed separately in Table 2 on page 13 are not contractually required to meet a maximum %RSD but do have to meet a contractual minimum RRF of 0.010). The contractual criteria for an acceptable initial calibration specifies that up to <u>any</u> 2 volatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%.

Initial calibration RRFs and $\overline{RRF}$ are calculated using equations III.1 and III.2.

$$RRF = \frac{A_x}{A_{is}} \times \frac{C_{is}}{C_x} \qquad \text{(III.1)}$$

$$\overline{RRF} = \frac{\sum_{i=1}^{5} RRF_i}{5} \qquad \text{(III.2)}$$

where:

RRF_i = "i"th Relative Response Factor
A = Area of the characteristic ion (EICP) measured
C = Concentration
is = Internal standard
x = Analyte of interest

Table B.1. Technical Acceptance Criteria for Initial and Continuing Calibration for Volatile Organic Compounds

Target Volatile Compound	Minimum RRF	Maximum %RSD	%D
Benzene	0.500	30.0	±30.0
Bromochloromethane	0.100	30.0	±30.0
Bromodichloromethane	0.200	30.0	±30.0
Bromoform	0.100	30.0	±30.0
Bromomethane	0.100	30.0	±30.0
Carbon tetrachloride	0.100	30.0	±30.0
Chlorobenzene	0.500	30.0	±30.0
Chloroform	0.200	30.0	±30.0
Dibromochloromethane	0.100	30.0	±30.0
1,2-Dibromoethane	0.100	30.0	±30.0
1,2-Dichlorobenzene	0.400	30.0	±30.0
1,3-Dichlorobenzene	0.600	30.0	±30.0
1,4-Dichlorobenzene	0.500	30.0	±30.0
1,1-Dichloroethane	0.200	30.0	±30.0
1,2-Dichloroethane	0.100	30.0	±30.0
1,1-Dichloroethene	0.100	30.0	±30.0
cis-1,3-Dichloropropene	0.200	30.0	±30.0
trans-1,3-Dichloropropene	0.100	30.0	±30.0
Ethylbenzene	0.100	30.0	±30.0
Styrene	0.300	30.0	±30.0
1,1,2,2-Tetrachloroethane	0.500	30.0	±30.0
Tetrachloroethene	0.200	30.0	±30.0
Toluene	0.400	30.0	±30.0
1,1,1-Trichloroethane	0.100	30.0	±30.0
1,1,2-Trichloroethane	0.100	30.0	±30.0
Trichloroethene	0.300	30.0	±30.0
Vinyl Chloride	0.100	30.0	±30.0
Xylenes (total)	0.300	30.0	±30.0
4-Bromofluorobenzene	0.200	30.0	±30.0

The %RSD is calculated using equation III.3 and III.4:

$$\sigma = \sqrt{\sum_{i=1}^{n} \frac{(x - \bar{x})^2}{(n-1)}} \qquad \text{(III.3)}$$

$$\%RSD = \frac{\sigma}{\bar{x}} \times 100 \qquad \text{(III.4)}$$

where:

σ = Standard deviation of 5 relative response factors

$\bar{x}$ = Mean of 5 relative response factors

IV. Continuing Calibration

Data Review Criteria: All volatile target compounds should meet a %D criterion of ± 30%.

Contractual Criteria: The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF is ± 30% for all compounds listed in Table B.1 (Page B-2). The contractual criteria for an acceptable continuing calibration specifies that up to any 2 volatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%.

Check the RRF calculations for volatile target compounds using equation III.1 (Page B-1). The %D between initial calibration $\overline{RRF}$ and continuing calibration RRF is calculated using equation IV.1.

$$\%D = \frac{\overline{RRF_i} - RRF_c}{\overline{RRF_i}} \times 100\% \qquad \text{(IV.1)}$$

where:

$\overline{RRF_i}$ = average relative response factor from initial calibration;

RRF_c = relative response factor from continuing calibration standard.

VI. Surrogate Spikes

The volatile surrogate compound and the contractual recovery limits are listed below.

Surrogate Spike	%Recovery Limits
BFB Bromofluorobenzene	80 - 120

Use equation VI.2 to check that the surrogate percent recovery was calculated correctly.

$$\% \ Recovery = \frac{Q_D}{Q_A} \cdot 100\% \qquad \text{VI.2}$$

where:

Q_D = Quantity determined by analysis.
Q_A = Quantity added to samples/blanks.

VII. Laboratory Control Samples (LCS)

Laboratory Control Sample compounds are listed in Table B.2. The contractual percent recovery limits are from 60 to 140 percent. However, these limits may eventually be expanded by the Agency during the period of performance if the limits are found to be too restrictive.

Table B.2 Volatile Laboratory Control Sample Compounds

Vinyl Chloride
1,2-Dichloroethane
Carbon Tetrachloride
1,2-Dichloropropane
Trichloroethene
1,1,2-Trichloroethane
Benzene
cis-1,3-Dichloropropene
Bromoform
Tetrachloroethene
1,2-Dibromoethane
1,4-Dichlorobenzene

Check that the LCS recovery was calculated correctly by using equation VI.2.

IX. Internal Standards

Table B.3 contains the volatile internal standards and their corresponding target compounds.

Table B.3 Volatile Internal Standards
and Their Corresponding Target Compounds

1,4-Difluorobenzene	Chlorobenzene-d_5	1,4-Dichlorobenzene-d_4
Chloromethane	1,1,1-Trichloroethane	Bromoform
Bromomethane	Carbon tetrachloride	1,2-Dibromo-3-chloropropane*
Vinyl Chloride	Bromodichloromethane	1,2-Dichlorobenzene*
Chloroethane	1,2-Dichloropropane	1,3-Dichlorobenzene*
Bromochloromethane*	cis-1,3-Dichloropropene	1,4-Dichlorobenzene*
Methylene Chloride	Trichloroethene	
Acetone	Dibromochloromethane	
Carbon disulfide	1,1,2-Trichloroethane	
1,1-Dichloroethene	Benzene	
1,1-Dichloroethane	trans-1,3-Dichloropropene	
cis-1,2-Dichloroethene**	4-Methyl-2-Pentanone	
trans-1,2-Dichloroethene**	2-Hexanone	
Chloroform	Tetrachloroethene	
1,2-Dichloroethane	1,1,2,2-Tetrachloroethane	
2-Butanone	1,2-Dibromoethane*	
4-Bromofluorobenzene (surr)	Toluene	
	Chlorobenzene	
	Ethylbenzene	
	Styrene	
	Total Xylenes	

* compounds not on Multi-media, Multi-concentration TCL
** on Multi-media, Multi-concentration TCL as total 1,2-Dichloroethene

XI. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

Check the reported positive sample results and quantitation limits with the quantitation lists and chromatograms using equation XI.1. Primary and secondary Quantitation ions are listed in Table B.4 (Page B-7).

$$ug/L = \frac{A_x \times I_s \times D_f}{A_{is} \times RRF \times V_o} \qquad \text{(XI.1)}$$

where:

A_x = area of characteristic ion (EICP) for compound being measured
A_{is} = area of characteristic ion for the internal standard
I_s = amount of internal standard added (ng)
RRF = relative response factor for compound being measured
V_o = volume of water purged (mL)
Df = dilution factor

The CRQL for a diluted sample should be calculated as follows:

Adjusted CRQL = Non-adjusted CRQL x Sample Dilution Factor

For example, the adjusted CRQL for a water sample with a 10U non-diluted CRQL and a 100 dilution (100.0 dilution factor) would be 1000U, according to the following calculation:

1000U = 10U x 100

TABLE B.4 Volatile Quantitation Ions

Volatile Target Compounds	Primary Quantitation Ion	Secondary Ions
Acetone	43	58
Benzene	78	--
Bromochloromethane	128	49, 130
Bromodichloromethane	83	85, 127
Bromoform	173	175, 254
Bromomethane	94	96
2-Butanone	43	72*
Carbon disulfide	76	78
Carbon tetrachloride	117	119
Chlorobenzene	112	77, 114
Chloroethane	64	66
Chloroform	83	85
Chloromethane	50	52
Dibromochloromethane	129	127
1,2-Dibromo-3-chloropropane	75	155, 157
1,2-Dibromoethane	107	109, 188
1,2-Dichlorobenzene	146	111, 148
1,3-Dichlorobenzene	146	111, 148
1,4-Dichlorobenzene	146	111, 148
1,1-Dichloroethane	63	65, 83
1,2-Dichloroethane	62	98
1,1-Dichloroethene	96	61, 63
cis-1,2-Dichloroethene	96	61, 98
trans-1,2-Dichloroethene	96	61, 98
1,2-Dichloropropane	63	112
cis-1,3-Dichloropropene	75	77

Quantitation of this analyte is based on m/z 43 but m/z 72 must be present in the spectrum.

TABLE B.4 Volatile Quantitation Ions (Continued)

Volatile Target Compounds	Primary Quantitation Ion	Secondary Ions
trans-1,3-Dichloropropene	75	--
Ethylbenzene	91	106
2-Hexanone	43	58, 57, 100
Methylene chloride	84	86, 49
4-Methyl-2-pentanone	43	58, 100
Styrene	104	78
1,1,2,2-Tetrachloroethane	83	131, 85
Tetrachloroethene	166	168, 129
Toluene	91	92
1,1,1-Trichloroethane	97	99, 61
1,1,2-Trichloroethane	97	83, 85, 99, 132, 134
Trichloroethene	95	130, 132
Vinyl chloride	62	64
Xylenes (total)	106	91
SURROGATE COMPOUND AND INTERNAL STANDARDS:		
4-Bromofluorobenzene	95	174, 176
Chlorobenzene-d_5	117	82, 119
1,4-Dichlorobenzene-d_4	150	115, 152
1,4-Difluorobenzene	114	63, 88

LOW CONCENTRATION WATER
CONTRACTUAL REQUIREMENTS AND EQUATIONS FOR SEMIVOLATILE DATA REVIEW

II. GC/MS Instrument Performance Check

Use equation II.1 (Page B-1) to verify that the laboratory has not made errors in the calculation of the percent relative abundance.

For example, the percent relative abundance of m/z 443 (X) relative to m/z 442 (Y) is calculated as follows:

$$\%\ Relative\ Abundance = \frac{abundance\ of\ m/z\ 443}{abundance\ of\ m/z\ 442} \times 100\%$$

III. Initial Calibration

Data Review Criteria: All semivolatile target compounds and surrogates must have a Relative Response Factor (RRF) of greater than or equal to 0.05 and a percent relative standard deviation (%RSD) of less than or equal to 30%.

Contractual Criteria: The maximum %RSD for most semivolatile compounds is 20.5% and the minimum RRF criteria vary as specified in the following table (The semivolatile compounds listed separately in table 4 on page 52 are not contractually required to meet a maximum %RSD but do have to meet a contractual minimum RRF of 0.010). The contractual criteria for an acceptable initial calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %RSD as long as they have RRFs that are greater than or equal to 0.010, and %RSD of less than or equal to 40.0%.

Initial calibration RRFs and $\overline{RRF}$ are calculated using equations III.1 and III.2 (Page B-1); %RSD is calculated using equations III.3 and III.4 (Page B-3).

IV. Continuing Calibration

Data Review Criteria: All semivolatile target compounds should meet a %D criterion of ± 25%.

Contractual Criteria: The percent difference (%D) between the initial calibration $\overline{RRF}$ and the continuing calibration RRF is ± 25.0% for the compounds listed in Table B.5. The contractual criteria for an acceptable continuing calibration specifies that up to any 4 semivolatile target compounds may fail to meet minimum RRF or maximum %D as long as they have RRFs that are greater than or equal to 0.010, and %D of less than or equal to 40.0%.

Check the RRF calculations for semivolatile target compounds using equation III.1 (Page B-1), and evaluate the %D between initial calibration $\overline{RRF}$ and continuing calibration RRF using equation IV.1 (Page B-3).

Table B.5. Acceptance Criteria for Initial and Continuing Calibration for Semivolatile Organic Compounds

Semivolatile Compounds	Minimum RRF	Maximum %RSD	%D
Phenol	0.800	20.5	±25.0
bis(-2-Chloroethyl)ether	0.700	20.5	±25.0
2-Chlorophenol	0.700	20.5	±25.0
2-Methylphenol	0.700	20.5	±25.0
4-Methylphenol	0.600	20.5	±25.0
N-Nitroso-di-n-propylamine	0.500	20.5	±25.0
Hexachloroethane	0.300	20.5	±25.0
Nitrobenzene	0.200	20.5	±25.0
Isophorone	0.400	20.5	±25.0
2-Nitrophenol	0.100	30.0	±30.0
2,4-Dimethylphenol	0.200	30.0	±30.0
bis(2-Chloroethoxy)methane	0.300	20.5	±25.0
2,4-Dichlorophenol	0.200	20.5	±25.0
1,2,4-Trichlorobenzene	0.200	20.5	±25.0
Naphthalene	0.700	20.5	±25.0
4-Chloro-3-methylphenol	0.200	20.5	±25.0
2-Methylnaphthalene	0.400	20.5	±25.0
2,4,6-Trichlorophenol	0.200	20.5	±25.0
2,4,5-Trichlorophenol	0.200	20.5	±25.0
2-Chloronaphthalene	0.800	20.5	±25.0
Acenaphthylene	1.300	20.5	±25.0
Acenaphthene	0.800	20.5	±25.0
Dibenzofuran	0.800	20.5	±25.0
2,4-Dinitrotoluene	0.200	30.0	±30.0
2,6-Dinitrotoluene	0.200	20.5	±25.0
4-Chlorophenyl-phenylether	0.400	20.5	±25.0
Fluorene	0.900	20.5	±25.0
4-Bromophenyl-phenylether	0.100	20.5	±25.0
Hexachlorobenzene	0.100	20.5	±25.0
Pentachlorophenol	0.050	20.5	±25.0
Phenanthrene	0.700	20.5	±25.0
Anthracene	0.700	20.5	±25.0
Fluoranthene	0.600	20.5	±25.0

Table B.5. Acceptance Criteria for Initial and Continuing Calibration for Semivolatile Organic Compounds (continued)

Semivolatile Compounds	Minimum RRF	Maximum %RSD	%D
Pyrene	0.600	20.5	±25.0
Benz(a)anthracene	0.800	20.5	±25.0
Chrysene	0.700	20.5	±25.0
Benzo(b)fluoranthene	0.700	20.5	±25.0
Benzo(k)fluoranthene	0.700	20.5	±25.0
Benzo(a)pyrene	0.700	20.5	±25.0
Indeno(1,2,3-cd)pyrene	0.500	20.5	±25.0
Dibenz(a,h)anthracene	0.400	20.5	±25.0
Benzo(g,h,i)perylene	0.500	20.5	±25.0
Phenol-d_5 (surr)	0.800	20.5	±25.0
2-Fluorophenol (surr)	0.600	20.5	±25.0
Terphenyl-d_{14} (surr)	0.500	20.5	±25.0
2-Fluorobiphenyl (surr)	0.700	20.5	±25.0

VI. Surrogate Spikes

Surrogate spike recoveries for semivolatile samples and blanks must be within the limits specified in Table B.6.

Table B.6 Semivolatile Surrogate Recovery Requirements

Surrogate Compound	% Recovery
Nitrobenzene-d_5	40 - 112
2-Fluorobiphenyl	42 - 110
p-Terphenyl-d_{14}	24 - 140
Phenol-d_5	17 - 113
2-Fluorophenol	16 - 110
2,4,6-Tribromophenol	18 - 126

Use equation VI.2 to verify that the surrogate recoveries were calculated correctly.

VII. Laboratory Control Samples (LCS)

The percent recovery for each of the compounds in the LCS spiking solution must be within the [illegible] limits listed in Table B.7. However, these limits may eventually be expanded by the Agency during the period of performance if the limits are found to be too restrictive.

Table B.7 Semivolatile Laboratory Control Sample Compounds and Recovery Limits

Compound	%Recovery
Phenol	44 - 120
2-Chlorophenol	58 - 110
4-Chloroaniline	35 - 98
2,4,6-Trichlorophenol	65 - 110
bis(2-Chloroethyl)ether	64 - 110
N-Nitroso-di-n-propylamine	34 - 102
Hexachloroethane	32 - 77
Isophorone	49 -110
1,2,4-Trichlorobenzene	44 - 96
Naphthalene	56 - 160
2,4-Dinitrotoluene	61 - 140
Diethylphthalate	76 - 104
N-Nitrosodiphenylamine	35 - 120
Hexachlorobenzene	30 - 95
Benzo(a)pyrene	55 - 92

Check that the recoveries were calculated correctly by using equation VI.2 (Page B-4).

IX. Internal Standards

Table B.8 (Page B-14) contains the semivolatile internal standards and their corresponding target compounds.

XI. Compound Quantitation and Reported Contract Required Quantitation Limits (CRQLs)

Check the reported positive sample results and quantitation limits with the quantitation lists and chromatograms using equation XI.6. Equation XI.4 (Page B-6) should be used to adjust the CRQL for a diluted sample. Table B.9 (Page B-15,16,17) contains the semivolatile primary and secondary Quantitation ions.

$$ug/L = \frac{A_x \times I_s \times V_t \times Df}{A_{is} \times RRF \times V_o \times V_i} \qquad (XI.6)$$

where:

A_x = area of characteristic ion (EICP) for compound being measured
A_{is} = area of characteristic ion (EICP) for the internal standard
I_s = amount of internal standard added (ng)
RRF = daily relative response factor for compound being measured
V_o = volume of water extracted (mL)
V_i = volume of extract injected (uL)
V_t = volume of concentrated extract (uL)
Df = dilution factor

Table B.8. Semivolatile Internal Standards and Their Corresponding Target Compounds

1,4-Dichlorobenzene-d_4	Naphthalene-d_8	Acenaphthene-d_{10}
Phenol	Nitrobenzene	Hexachlorocyclopentadiene
bis(2-Chloroethyl)ether	Isophorone	2,4,6-Trichlorophenol
2-Chlorophenol	2-Nitrophenol	2,4,5-Trichlorophenol
2-Methylphenol	2,4-Dimethylphenol	2-Chloronaphthalene
2,2'-oxybis-(1-Chloropropane)	bis(2-Chloroethoxy)methane	2-Nitroaniline
4-Methylphenol	2,4-Dichlorophenol	Dimethyl phthalate
N-Nitroso-di-n-propylamine	1,2,4-Trichlorobenzene	Acenaphthylene
2-Fluorophenol (surr)	Naphthalene	3-Nitroaniline
Phenol-d_5 (surr)	4-Chloroaniline	Acenaphthene
	Hexachlorobutadiene	2,4-Dinitrophenol
	4-Chloro-3-methylphenol	4-Nitrophenol
	2-Methylnaphthalene	Dibenzofuran
	Nitrobenzene-d_5 (surr)	2,4-Dinitrotoluene
		2,6-Dinitrotoluene
		Diethyl phthalate
		4-Chlorophenyl-phenyl ether
		Fluorene
		4-Nitroaniline
		2-Fluorobiphenyl (surr)
		2,4,6-Tribromophenol (surr)

surr = surrogate compound

Phenanthrene-d_{10}	Chrysene-d_{12}	Perylene-d_{12}
4,6-Dinitro-2-methylphenol	Pyrene	Di-n-octyl phthalate
N-Nitrosodiphenylamine	Butylbenzyl phthalate	Benzo(b)fluoranthene
4-Bromophenyl phenyl ether	3,3'-Dichlorobenzidine	Benzo(k)fluoranthene
Hexachlorobenzene	Benzo(a)anthracene	Benzo(a)pyrene
Pentachlorophenol	bis(2-Ethylhexyl)phthalate	Indeno(1,2,3-cd)pyrene
Phenanthrene	Chrysene	Dibenz(a,h)anthracene
Anthracene	Terphenyl-d_{14} (surr)	Benzo(g,h,i) perylene
Di-n-butyl phthalate		
Fluoranthene		

surr = surrogate compound

Table B.9 Semivolatile Quantitation Ions

Analyte	Primary Ion	Secondary Ion(s)
Phenol	94	65, 66
bis(2-Chloroethyl)ether	93	63, 95
2-Chlorophenol	128	64, 130
1,3-Dichlorobenzene	146	148, 113
1,4-Dichlorobenzene	146	148, 113
1,2-Dichlorobenzene	146	148, 113
2-Methylphenol	108	107
2,2'-oxybis(1-Chloropropane)	45	77, 79
4,-Methylphenol	108	107
N-nitroso-di-n-propylamine	70	42, 101, 130
Hexachloroethane	117	201, 199
Nitrobenzene	77	123, 65
Isophorone	82	95, 138
2-Nitrophenol	139	65, 109
2,4-Dimethylphenol	107	121, 122
bis(-2-Chloroethoxy)methane	93	95, 123
2,4-Dichlorophenol	162	164, 98
1,2,4-Trichlorobenzene	180	182, 145
Naphthalene	128	129, 127
4-Chloroaniline	127	129
Hexachlorobutadiene	225	223, 227
4-Chloro-3-methylphenol	107	144, 142
2-Methylnaphthalene	142	141
Hexachlorocyclopentadiene	237	235, 272
2,4,6-Trichlorophenol	196	198, 200
2,4,5-Trichlorophenol	196	198, 200
2-Chloronaphthalene	162	164, 127
2-Nitroaniline	65	92, 138

Table B.9 Semivolatile Quantitation Ions (Continued)

Analyte	Primary ion	Secondary ions
Dimethyl phthalate	163	194, 164
Acenaphthylene	152	151, 153
3-Nitroaniline	138	108, 92
Acenaphthene	153	152, 154
2,4-Dinitrophenol	184	63, 154
4-Nitrophenol	109	139, 65
Dibenzofuran	168	139
2,4-Dinitrotoluene	165	63, 182
2,6-Dinitrotoluene	165	89, 121
Diethylphthalate	149	177, 150
4-Chlorophenyl-phenylether	204	206, 141
Fluorene	166	165, 167
4-Nitroaniline	138	92, 108
4,6-Dinitro-2-methylphenol	198	182, 77
N-Nitrosodiphenylamine	169	168, 167
4-Bromophenyl-phenylether	248	250, 141
Hexachlorobenzene	284	142, 249
Pentachlorophenol	266	264, 268
Phenanthrene	178	179, 176
Anthracene	178	179, 176
Di-n-butylphthalate	149	150, 104
Fluoranthene	202	101, 100
Pyrene	202	101, 100
Butylbenzylphthalate	149	91, 206
3,3'Dichlorobenzidine	252	254, 126
Benzo(a)anthracene	228	229, 226
bis(2-Ethylhexyl)phthalate	149	167, 279
Chrysene	228	226, 229
Di-n-octyl phthalate	149	---

Table B.9 Semivolatile Quantitation Ions (Continued)

Analyte	Primary Ion	Secondary Ions
Benzo(b)fluoranthene	252	253, 125
Benzo(k)fluoranthene	252	253, 125
Benzo(a)pyrene	252	253, 125
Indeno(1,2,3-cd)pyrene	276	138, 227
Dibenz(a,h)anthracene	278	139, 279
Benzo(g,h,i)perylene	276	138, 277
Surrogates		
Phenol-d_5	99	42, 71
2-Fluorophenol	112	64
2,4,6-Tribromophenol	330	332, 141
d-5 Nitrobenzene	82	128, 54
2-Fluorobiphenyl	172	171
Terphenyl	244	122, 212
Internal Standards		
1,4-Dichlorobenzene-d_4	152	115
Naphthalene-d_8	136	68
Acenaphthene-d_{10}	164	162, 160
Phenanthrene-d_{10}	188	94, 80
Chrysene-d_{12}	240	120, 236
Perylene-d_{12}	264	260, 265

APPENDIX C

CONTRACTUAL REQUIREMENT COMPARISON TABLES

Table C.1. Comparison of Requirements for Volatile Data Review

REQUIREMENT	MULTI-MEDIA MULTI-CONCENTRATION	LOW CONCENTRATION WATERS
Target Compound List	33 Target Compounds	40 Target Compounds
Data Turnaround	35 days	14 days
Technical Holding Time	7 days if not preserved 14 days if preserved	7 days if not preserved 14 days if preserved
Initial Calibration	5 levels: 10 - 200 ug/L	5 levels: 1 - 25 ug/L (5 - 125 for Ketones)
Continuing Calibration	mid-level: 50 ug/L	mid-level: 5 ug/L (25 for Ketones)
Blanks	Method Blanks Instrument Blanks	Method Blanks Instrument Blanks Storage Blanks
SMC/Surrogates	SMC: 1,2-Dichloroethane-d_4 Bromofluorobenzene Toluene-d_8	Surrogate: Bromofluorobenzene
MS/MSD	Frequency: 1 per 20 samples, per matrix	N/A
LCS	N/A	1 per SDG
Regional QA/QC	PEs - variable	PEs - 1 per SDG
Internal Standards	IS Area: - 50% to + 100% IS RT Shift: ± 30 sec. 3 compounds: Chlorobenzene-d_5 1,4-Difluorobenzene Bromochloromethane	IS Area: ± 40% IS RT Shift: ± 20 sec. 3 compounds: Chlorobenzene-d_5 1,4-Difluorobenzene 1,4-Dichlorobenzene
CRQL	10 ppb (water/low soil) 1200 ppb (med soil)	1 - 5 ug/L
TICs	largest 10 ≥10% of nearest IS	largest 10 ≥40% of nearest IS

Table C.2. Comparison of Requirements for Semivolatile Data Review

REQUIREMENT	MULTI-MEDIA, MULTI-CONCENTRATION	LOW CONCENTRATION WATERS
Target Compound List	64 Target Compounds	60 Target Compounds
Data Turnaround	35 days	14 days
Technical Holding Time	Extraction - 5 days Analysis - 40 days after extraction	Extraction - 5 days Analysis - 40 days after extraction
Initial Calibration	5 levels: 20 - 160 ug/l	5 levels: varies
Continuing Calibration	mid-level: 50 ug/L	mid-level: varies
Blanks	Method Blanks Instrument Blanks	Method Blanks Instrument Blanks Storage Blanks
Surrogates	8 compounds	6 compounds
MS/MSD	Frequency: 1 per 20 samples, per matrix	N/A
LCS	N/A	1 per SDG
Regional QA/QC	PEs - variable	PEs - 1 per SDG
Internal Standards	IS Area: - 50% to + 100% IS RT Shift: ± 30 sec.	IS Area: - 50% to 100% IS RT Shift: ± 20 sec.
CRQLs	10 - 50 ppb (water) 330 - 1700 ppb (low soil) 10,000 - 50,000 (med soil)	5 - 20 ug/L
TICs	largest 20 ≥10% of nearest IS	largest 20 ≥50% of nearest IS

APPENDIX D

PROPOSED GUIDANCE FOR TENTATIVELY IDENTIFIED COMPOUNDS (VOA AND SV)

Proposed Guidance for Tentatively Identified Compounds (VOA)

A. **Review Items:** Form I VOA-TIC, chromatograms, library search printout and spectra for three TIC candidates, and GC retention time data.

B. Objective

Chromatographic peaks in volatile analyses that are not TCL compounds, system monitoring compounds, or internal standards are potential tentatively identified compounds (TICs) or library search compounds (LSCs). TICs must be qualitatively identified by a library search of the National Institute of Standards and Technology (NIST) mass spectral library, and the identifications assessed by the data reviewer.

C. **Criteria**

For each sample, the laboratory must conduct a library search of the NIST mass spectral library and report the possible identity for the 10 largest volatile fraction peaks which are not surrogates, internal standards, or TCL compounds, but which have a peak area greater than 40 percent of the peak area of the nearest internal standard. TIC results are reported for each sample on the Organic Analysis Data Sheet (Form I VOA-TIC).

Note: **Since the SOW revision of October 1986, the CLP does not allow the laboratory to report as tentatively identified compounds any TCL compound which is properly reported in another fraction. (For example, late eluting volatile TCL compounds must not be reported as semivolatile TICs.)**

D. **Evaluation**

1. Guidelines for Tentative Identification are as follows:

The interpretation of library search compounds (LSCs) is one of the aspects of data review which calls for the fullest exercise of professional judgement. The reviewer must be thoroughly familiar with the principles and practice of mass spectral interpretation and of gas chromatography. Because the interpretation process is labor-intensive, it is important to document the process involved in arriving at a tentative identification.

Worksheets for "Tentative Identification of Library Search Compounds" are provided in Appendix B for the volatile GC/MS fractions to assist in generating the information needed to make a reasonable tentative identification of the LSCs.

The process involved in tentatively identifying a library search compound may be summarized as follows:

a. Identify all samples in the related group (Case, SAS or SDG) in which the unknown compound occurs. Calculation of relative retention times (RRT) and comparison of RRT and mass spectral data across samples is extremely helpful in identifying unknowns that occur repeatedly in related samples. Use one worksheet per unknown for all samples in which it occurs.

b. Inspect the library search spectrum retrieved for each unknown, to determine if detailed mass spectral interpretation is necessary. Often, it is obvious that the

correct match is among the spectra retrieved for the unknown from the several samples in which it is found. It may only be necessary to check the unknown's RRT versus a reference list of VOA (generated under similar conditions and after accounting for bias in the samples) to arrive at a satisfactory tentative identification. Some references are provided. If a reference RRT is not available, then a comparison of the unknown's RRT or boiling point to the RRT or boiling point of a closely related compound may also provide a satisfactory tentative identification. Within a compound class, retention time increases with increasing boiling point.

c. In the event that serious ambiguity still exists after examining the library spectra and RRT data, a full mass spectral interpretation can narrow down the possibilities. While a full discussion of manual mass spectral interpretation is beyond the scope of this document, several key points may be mentioned as important objects:

- Determine a likely molecular weight. Depending on the unknown, the MW may or may not be apparent due to the extent of fragmentation. The MW of the retrieved library spectra, interpreted in light of the RRT, may be helpful if the molecular ion is not present.

- Determine the isotope ratios (M+1)/M, (M+2)/M, (M+4)/M, etc. (where M is the molecular ion) and determine a short list of possible molecular formulas. Isotope ratios will also reveal the presence of S, Cl, and Br.

- Calculate the total number of rings-plus-double-bonds in the unknown by applying the following equation to the likely molecular formulas, to determine the degree of unsaturation.

  Number of rings-plus-double bonds (r+db):

  $$(r+db) = C - \frac{H}{2} - \frac{X}{2} + \frac{N}{2} + 1$$

  where: C = no. of carbons
  H = no. of hydrogens
  X = no. of halogens
  N = no. of nitrogens

  Note: oxygen and sulfur do not need to be accounted for. An aromatic ring counts as four rings and double bonds.

- Calculate the mass losses represented by major peaks in the unknown spectrum, and relate these to the fragmentation of neutral moieties from the molecular ion or other daughter ions.

- Using the information gathered on molecular weight, molecular formula, degree of unsaturation, and mass losses in the unknown spectrum, combined with the RRT data, give as precise a description of the unknown as possible, including an exact identification if it is justified.

d. In the event that the unknown spectrum is not that of a pure compound, mass spectral interpretation may not be possible. However, in some instances, a mixed spectrum may be recognized as two compounds having very similar relative retention times. Target compounds, surrogates and internal standards may also be responsible for extra ions in an unknown spectrum.

2. Check the raw data to verify that the laboratory has generated a library search spectrum for all required peaks in the chromatograms for samples and blanks.

3. Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-TCL compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 40 percent of the internal standard peak area or height, but present in the blank chromatogram at similar relative retention time.

4. All mass spectra for every sample and blank must be examined.

5. The reviewer should be aware of common laboratory artifacts/contaminants and their sources (e.g., aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs.

Examples:

a. Common laboratory contaminants: CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluoro-trichloromethane), and phthalates at levels less than 100 ug/L or 4000 ug/Kg.

b. Solvent preservatives such as cyclohexene which is a methylene chloride preservative. Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol condensation reaction products of acetone include: 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

6. Occasionally, a TCL compound may be identified in the proper analytical fraction by non-target library search procedures, even though it was not found on the quantitation list. If the total area quantitation method was used, the reviewer should request that the laboratory recalculate the result using the proper quantitation ion. In addition, the reviewer should evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine whether the false negative result is an isolated occurrence or whether additional data may be affected.

7. TCL compounds may be identified in more than one fraction. Verify that quantitation is made from the proper fraction.

8. Library searches should not be performed on internal standards or surrogates.

9. TIC concentration should be estimated assuming a RRF of 1.0.

E. Action

1. All TIC results should be qualified as tentatively identified (N) with estimated concentrations (J) or (NJ).

2. General actions related to the review of TIC results are as follows:

   a. A non-TCL compound is not considered to be "tentatively identified" until the mass spectrum and retention time data have been reviewed according to the evaluation guidelines in XIII.D. The review should be documented on the Tentative Identification of Library Search Compound worksheet. The worksheet will be useful if a better library match for the unknown is retrieved in another Case, SAS, or SDG. It may also be used in writing a Special Analytical Service Statement of Work to identify the unknown, or if the sample is sent to an EPA research laborato[illegible] [illegible]SC identification by multiple spectral techniques.

   b. If all contractually required peaks were not library searched, the desig[illegible] representative could request these data from the laboratory.

3. TIC results which are not sufficiently above the level in the blank should not be reported. (Dilutions and sample size must be taken into account when comparing the amounts present in blanks and samples.)

4. When a compound is not found in any blanks, but is a suspected artifact or common laboratory contaminant, the result may be qualified as unusable (R).

5. The reviewer may elect to report all similar isomers as a total. (All alkanes may be summarized and reported as total hydrocarbons.)

6. The data reviewer should state the degree of confidence (high, medium, low) in the tentative identification after completing the review process.

7. The complete "Tentative Identification of Library Search Compound" worksheet should be attached to the final data review report.

APPENDIX

Equation 1:

$$RI = 100 \quad \frac{RTunk - RTz}{RTz+1 - RTz} + 100Z$$

where: RTunk is the retention time of the unknown
RTz is the retention time of the preceeding retention index standard
RTz+1 is the retention time of the following retention index standard
Z = number of rings in the retention index standard
RI = Lee Retention Index

Retention Index Standards

naphthalene	z=2	RI=200.00
phenanthrene	z=3	RI=300.00
chrysene	z=4	RI=400.00
Benzo(g,h,i) perylene	z=5	RI=500.00

Note: when these compounds are not dound in the sample of interest, RT data for the deuterated internal standards or most recent calibration may be used. Retention time shifts and bias must be accounted for.

Equation 2

Number of rings-plus-double bonds (r+db):

$$(r+db) = C - \frac{H}{2} - \frac{X}{2} + \frac{N}{2} + 1$$

where: C = no. of carbons
H = no. of hydrogens
X = no. of halogens
N = no. of nitrogens

Note: oxygen and sulfur do not need to be accounted for. An aromatic ring counts as four rings and double bonds.

REFERENCES

1. Lee, M.L., Vassilaros, D.L., White, C.M., and Novotny, M., "Retention Indices for Programmed-Temperature Capillary-Column Gas Chromatography of Polycyclic Aromatic Hydrocarbons" Analytical Chemistry, V. 51, no. 6, 1979, pp. 768-773.

2. Rostad, C.E., and Pereira, W.E., "Kovats and Lee Retention Indices Determined by Gas Chromatography/Mass Spectrometry to Organic Compounds of Environmental Interest." J. High Resolution Chrom. and Chrom. Commun., vol. 9, 1986, pp. 328-334.

3. Silverstein, R.M., Bassler, G.C., and Morrill, T.C., Spectrometric Identification of Organic Compounds 4th ed., Wiley, New York, 1981.

4. Vassilaros, D.M., Kong, R.C., Later, D.W. and Lee, M.L., "Linear Retention Index System for polycyclic Aromatic Compounds. Critical Evaluation and Additional Indices". J. of Chromatography, 252 (1982) pp. 1-20.

Proposed Guidance for Tentatively Identified Compounds (SV)

A. Review Items: Form I SV-TIC, chromatograms, library search printout and spectra for three TIC candidates, and GC retention time data.

B. Objective

Chromatographic peaks in semivolatile analyses that are not TCL compounds, surrogates, or internal standards are potential tentatively identified compounds (TICs) or library search compounds (LSCs). TICs must be qualitatively identified by a library search of the National Institute of Standards and Technology (NIST) mass spectral library, and the identifications assessed by the data reviewer.

C. Criteria

For each sample, the laboratory must conduct a library search of the NIST mass spectral library and report the possible identity for the 20 largest semivolatile fraction peaks which are not surrogates, internal standards, or TCL compounds, but which have a peak area greater than 50 percent of the peak area of the nearest internal standard. TIC results are reported for each sample on the Organic Analysis Data Sheet (Form I SV-TIC).

Note: Since the SOW revision of October 1986, the CLP does not allow the laboratory to report as tentatively identified compounds any TCL compound which is properly reported in another fraction. (For example, late eluting volatile TCL compounds must not be reported as semivolatile TICs.)

D. Evaluation

1. Guidelines for Tentative Identification are as follows:

The interpretation of library search compounds (LSCs) is one of the aspects of data review which calls for the fullest exercise of professional judgement. The reviewer must be thoroughly familiar with the principles and practice of mass spectral interpretation and of gas chromatography. Because the interpretation process is labor-intensive, it is important to document the process involved in arriving at a tentative identification.

Worksheets for "Tentative Identification of Library Search Compounds" are provided in Appendix B for the semivolatile GC/MS fractions to assist in generating the information needed to make a reasonable identification of the TICs.

The process involved in tentatively identifying a library search compound may be summarized as follows:

a) Identify all samples in the related group (Case, SAS or SDG) in which the unknown compound occurs. Calculation of retention indices (RI) and comparison of RI and mass spectra across samples is extremely helpful in identifying unknowns that occur repeatedly in related samples. Use one worksheet per unknown for all samples in which it occurs. Retention indices are calculated according to the following example

$$RI = 100 \quad \frac{RTunk - RTz}{RTz+1 - RTz} + 100Z$$

where: RTunk is the retention time of the unknown
RTz is the retention time of the preceeding retention index standard
RTz+1 is the retention time of the following retention index standard
Z = number of rings in the retention index standard
RI = Lee Retention Index

Retention Index Standards

naphthalene	z=2	RI=200.00
phenanthrene	z=3	RI=300.00
chrysene	z=4	RI=400.00
Benzo(g,h,i) perylene	z=5	RI=500.00

Note: when these compounds are not found in the sample of interest, RT data for the deuterated internal standards or most recent calibration may be used. Retention time shifts and bias must be accounted for.

b) Inspect the library search spectrum retrieved for each unknown, to determine if detailed mass spectral interpretation is necessary. Often, it is obvious that the correct match is among the spectra retrieved for the unknown from the several samples in which it is found. It may only be necessary to check the unknown's RI versus a reference list of SV (generated under similar conditions and after accounting for bias in the sample) to arrive at a satisfactory tentative identification. Some references are provided. If a reference RI is not available, then a comparison of the unknown's RI or boiling point to the RI or boiling point of a closely related compound may also provide a satisfactory tentative identification. Within a compound class, retention time increases with increasing boiling point.

c) In the event that serious ambiguity still exists after examining the library spectra and RI data, a full mass spectral interpretation can narrow down the possibilities. While a full discussion of manual mass spectral interpretation is beyond the scope of this document, several key points may be mentioned as important objects:

- Determine a likely molecular weight. Depending on the unknown, the MW may or may not be apparent due to the extent of fragmentation. The MW of the retrieved library spectra, interpreted in light of the RI, may be helpful if the molecular ion is not present.

- Determine the isotope ratios (M+1)/M, (M+2)/M, (M+4)/M, etc. (where M is the molecular ion) and determine a short list of possible molecular formulas. Isotope ratios will also reveal the presence of S, Cl, and Br.

Calculate the total number of rings-plus-double-bonds in the unknown applying the following equation to the likely molecular formula [illegible] the degree of unsaturation

Number of rings-plus-double-bonds [illegible]

$$[illegible] = [illegible]$$

where: C = no. of carbons
H = no. of hydrogens
X = no. of halogens
N = no. of nitrogens

Note: oxygen and sulfur do not need to be accounted for. An aromatic ring counts as four rings and double bonds.

- o Calculate the mass losses represented by major peaks in the unknown spectrum, and relate these to the fragmentation of neutral moieties from the molecular ion or other daughter ions.

- o Using the information gathered on molecular weight, molecular formula, degree of unsaturation, and mass losses in the unknown spectrum, combined with the RI data, give as precise a description of the unknown as possible, including an exact identification if it is justified.

d) In the event that the unknown spectrum is not that of a pure compound, mass spectral interpretation may not be possible. However, in some instances, a mixed spectrum may be recognized as two compounds having very similar retention indices (for example, ortho-terphenyl, RI=317.43 and nonadecane, RI=317.20). This particular coelution would result in an unknown spectrum having a polycyclic aromatic pattern at m/z 230, the MW of terphenyl, with an hydrocarbon type pattern at m/z 43,57,71, etc. Target compounds, surrogates and internal standards may also be responsible for extra ions in an unknown spectrum, and may be treated similarly.

2. Check the raw data to verify that the laboratory has generated a library search spectrum for all required peaks in the chromatograms for samples and blanks.

3. Blank chromatograms should be examined to verify that TIC peaks present in samples are not found in blanks. When a low-level non-TCL compound that is a common artifact or laboratory contaminant is detected in a sample, a thorough check of blank chromatograms may require looking for peaks which are less than 10 percent of the internal standard peak area or height, but present in the blank chromatogram at similar relative retention time.

4. All mass spectra for every sample and blank must be examined.

o Calculate the total number of rings-plus-double-bonds in the unknown by applying the following equation to the likely molecular formulas, to determine the degree of unsaturation.

Number of rings-plus-double bonds (r + db)

$$r + db = C - \frac{H}{2} - \frac{X}{2} + \frac{N}{2} + 1$$

where: C = no. of carbons
H = no. of hydrogens
X = no. of halogens
N = no. of nitrogens

Note: oxygen and sulfur do not need to be accounted for. An aromatic ring counts as four rings and double bonds.

o Calculate the mass losses represented by major peaks in the unknown spectrum, and relate these to the fragmentation of neutral moieties from the molecular ion or other daughter ions.

o Using the information gathered on molecular weight, molecular formula, degree of unsaturation, and mass losses in the unknown spectrum, combined with the RI data, give as precise a description of the unknown as possible, including an exact identification if it is justified.

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4. All mass spectra for every sample and blank must be examined.

5. The reviewer should be aware of common laboratory artifacts contaminants and their sources (e.g., aldol condensation products, solvent preservatives, and reagent contaminants). These may be present in blanks and not reported as sample TICs.

Examples:

a. Common laboratory contaminants: CO_2 (m/z 44), siloxanes (m/z 73), diethyl ether, hexane, certain freons (1,1,2-trichloro-1,2,2-trifluoroethane or fluoro-trichloromethane), and phthalates at levels less than 100 ug/L or 4000 ug/Kg

b. Solvent preservatives such as cyclohexene which is a methylene chloride preservative. Related by-products include cyclohexanone, cyclohexenone, cyclohexanol, cyclohexenol, chlorocyclohexene, and chlorocyclohexanol.

c. Aldol condensation reaction products of acetone include: 4-hydroxy-4-methyl-2-pentanone, 4-methyl-2-penten-2-one, and 5,5-dimethyl-2(5H)-furanone.

6. Occasionally, a TCL compound may be identified in the proper analytical fraction by non-target library search procedures, even though it was not found on the quantitation list. If the total area quantitation method was used, the reviewer should request that the laboratory recalculate the result using the proper quantitation ion. In addition, the reviewer should evaluate other sample chromatograms and check library reference retention times on quantitation lists to determine whether the false negative result is an isolated occurrence or whether additional data may be affected.

7. TCL compounds may be identified in more than one fraction. Verify that quantitation is made from the proper fraction.

8. Library searches should not be performed on internal standards or surrogates

9. TIC concentration should be estimated assuming a RRF of 1.0.

E. Action

1. All TIC results should be qualified as tentatively identified (N) with estimated concentrations (J) or (NJ).

2. General actions related to the review of TIC results are as follows:

a. A non-TCL compound is not considered to be "tentatively identified" until the mass spectrum and retention time data have been reviewed as per section XIII D. The review should be documented on the Tentative Identification of Library Search Compound worksheet. The worksheet will be useful if a better library match for the unknown is retrieved in another Case, SAS, or SDG. It may also be used in writing a Special Analytical Service Statement of Work to identify the unknown, or if the sample is sent to an EPA research laboratory for LSC identification by multiple spectral techniques.

b. If all contractually required peaks were not library searched, the designated representative could request these data from the laboratory.

3. TIC results which are not sufficiently above the level in the blank should not be reported. (Dilutions and sample size must be taken into account when comparing the amounts present in blanks and samples.)

4. When a compound is not found in any blanks, but is a suspected artifact or common laboratory contaminant, the result may be qualified as unusable (R).

5. The reviewer may elect to report all similar isomers as a total. (All alkanes may be summarized and reported as total hydrocarbons.)

6. The data reviewer should state the degree of confidence (high, medium, low) in the tentative identification after completing the review process.

7. The complete "Tentative Identification of Library Search Compound" worksheet should be attached to the final data review report.

GLOSSARY OF TERMS

APO	Administrative Project Officer
BFB	Bromofluorobenzene - volatile instrument performance check compound
BNA	Base Neutral/Acid Compounds - compounds analyzed by semivolatile technique
Case	A finite, usually predetermined number of samples collected over a given time period for a particular site. A Case consists of one or more Sample Delivery Group(s).
CCS	Contract Compliance Screening - process in which SMO inspects analytical data for contractual compliance and provides results to the Regions, laboratories and EMSLLV.
CF	Calibration Factor
CRQL	Contract Required Quantitation Limit
CSF	Complete SDG File
DFTPP	Decafluorotriphenylphosphine - semivolatile instrument performance check compound
DPO	Deputy Project Officer
EICP	Extracted Ion Current Profile
GC/EC	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
GPC	Gel Permeation Chromatography - A sample clean-up technique that separates compounds by size and molecular weight. Generally used to remove oily materials from sample extracts.
IS	Internal Standards - Compounds added to every VOA and BNA standard, blank, matrix spike duplicate, and sample extract at a known concentration, prior to instrumental analysis. Internal standards are used as the basis for quantitation of the target compounds.
LCS	Laboratory Control Sample
MS/MSD	Matrix Spike/Matrix Spike Duplicate
m/z	The ratio of mass (m) to charge (z) of ions measured by GC/MS
OADS	Organic Analysis Data Sheet (Form I)
ORDA	Organic Regional Data Assessment - from earlier version of the Functional Guidelines
NIST	National Institute of Standards and Technology

PCB	Polychlorinated biphenyls - A class of [illegible] pesticides
PE	Sample Performance Evaluation Sample
QA	Quality Assurance - Total program for assuring the reliability of data
QC	Quality Control - Routine application of procedures for controlling the [illegible]
RIC	Reconstructed Ion Chromatogram
RPD	Relative Percent Difference (between matrix spike and matrix spike duplicate)
RRF	Relative Response Factor
$\overline{RRF}$	Average Relative Response Factor
RRT	Relative Retention Time (with relation to internal standard)
RSD	Relative Standard Deviation
RT	Retention Time
SDG	Sample Delivery Group - Defined by one of the following, whichever occurs first: • Case of field samples • Each 20 field samples within a Case • Each 14-day calendar period during which field samples in a Case are received, beginning with receipt of the first sample in the SDG. (For VOA contracts, the calendar period is 7-day.)
SMC	System Monitoring Compound - formerly surrogates for volatile analysis.
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SV	Semivolatile analysis - Method based on analysis by GC/MS for BNA organic compounds
TCL	Target Compound List
TIC	Tentatively Identified Compound - A compound tentatively identified from search of the NIST mass spectral library that is not on the TCL.
TPO	Technical Project Officer

VOA — Volatile Organic Analysis - Meth[illegible] compound analysis

VTSR — Validated Time of Sample Receipt — time [illegible] the shipper's delivery receipt and Sample Traffic Report [illegible]

NM22306

No. 93-3380

U.S.C.A. - 7th Circuit
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IN THE UNITED STATES COURT OF APPEALS

FOR THE SEVENTH CIRCUIT

VILLAGE OF OCONOMOWOC LAKE,

Plaintiff-Appellant,

v.

DAYTON-HUDSON CORPORATION; GEORGE E. MEYER, Secretary; and the WISCONSIN DEPARTMENT OF NATURAL RESOURCES,

Defendants-Appellees.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF WISCONSIN
THE HONORABLE JOHN W. REYNOLDS, PRESIDING

BRIEF FOR THE UNITED STATES AS AMICUS CURIAE

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I N D E X

PAGE

Opinion Below ---------- 1
Subject Matter Jurisdiction and Appellate Jurisdiction - 1
Statutes Involved ---------- 2
Statement of Issues ---------- 2
Statement of the Case ---------- 2
Statement of Facts ---------- 4
Related Cases and Proceedings ---------- 4
Standard of Review ---------- 4
Argument --

I. Discharges Of A Pollutant To Groundwater Are Within CWA Jurisdiction In Specific Circumstances ---------- 4

A. The majority of cases recognize that discharges to groundwater may, in specified circumstances, come within Clean Water Act regulatory jurisdiction ---------- 5

B. EPA's view is in accord with the majority of caselaw and is entitled to Chevron deference ---------- 8

C. Discharges to groundwater come within CWA regulatory jurisdiction where there is a reasonably foreseeable direct hydrological connection between the groundwater in the proximity of the release, and a greater than de minimis quantity of pollutants reasonably is able to reach the surface water ---------- 13

II. Indirect Source Permit Requirements Approved Into State Implementation Plans To Satisfy Requirements Of Part D Of The Clean Air Act Are Enforceable By Citizens Under Section 304(A)(3) Of That Act ---------- 14

A. Caselaw supports the proposition that citizens may sue under CAA Section 304(a)(3) to enforce SIP indirect source provisions ---------- 17

B. The case should be remanded to the lower court for further determination regarding the Wisconsin SIP indirect source review provisions for emissions of NOx -- 19

Conclusion ---------- 20

C I T A T I O N S

CASES: **PAGE**

American Lung Association v. Kean, 871 F.2d 319 (3d Cir. 1989) ---------- 18
Arkansas v. Oklahoma 503 U.S. ____, 112 S. Ct. 1046 (1992) ---------- 10
Chevron U.S.A. v. Natural Resources Defense Council, 467 U.S. 837 (1984) ---------- 10
Citizens for a better Environment v. Deukmejian, 731 F. Supp. 1448 (N.D. Cal. 1990) ---------- 18
Coalition Against Columbus Center v. City of New York, 967 F.2d 764 (2d Cir. 1992) ---------- 18
Delaware Valley Citizens Council v. Davis, 932 F.2d 256 (3d Cir. 1991) ---------- 18
Exxon v. Train, 554 F.2d 1310 (5th Cir. 1977) ---------- 7,9
Inland Steel Co. v. EPA, 901 F.2d 1419 (7th Cir. 1990) - 5,6
Kelley v. United States, No. 79-10199 (E.D. Mich. Oct. 28, 1980) ---------- 7
Kelley v. United States, 618 F. Supp. 1103 (W.D. Mich. 1985) ---------- 8
McClellan Ecological Seepage Situation (MESS) v. Cheney, 763 F. Supp. 431 (E.D. Cal. 1989), appeals dockets, Nos. 91-16308, 91-16467 (9th Cir. Aug. 23, 1991) -- 5,7
McClellan Ecological Seepage Situation (MESS) v. Cheney, 707 F. Supp. 1182 (E.D. Cal. 1988) ---------- 7,8,9
Natural Resources Defense Council v. EPA, 966 F.2d 1292 (9th Cir. 1992) ---------- 11
New York v. United States, 620 F. Supp. 374 (E.D. N.Y. 1985) ---------- 7
Quivira Mining Co. v. United States EPA, 765 F.2d 126 (10th Cir. 1985), cert. denied, 474 U.S. 1055 (1986) ---------- 7
Sierra Club v. Colorado Refining Company (CRC), 383 F. Supp. 1428 (D. Colo. 1993) ---------- 6
Sierra Club v. Larson, 2 F.3d 462 (1st Cir. 1993) ------ 17,18
Town of Norfolk v. United States Army Corps of Engineers, 968 F.2d 1438 (1st Cir. 1992) ---------- 10
United States v. GAF Corporation, 389 F. Supp. 1379 (S.D. Tex. 1975) ---------- 8
United States v. Riverside Bayview Homes, Inc., 474 U.S. 121 (1985) ---------- 11
Village of Oconomowoc Lake et al. v. Dayton-Hudson et al. No. 93-C-0797 (E.D. Wisc. Sept. 21, 1993) --------- 3,15

STATUTES, RULES and REGULATIONS: **PAGE**

Clean Air Act,
42 U.S.C. 7401 *et seq.* ---------- 2
Section 110(a)(2)(A), 42 U.S.C. 7410(a)(2)(A) ----- 17
Section 113(a)(1), 42 U.S.C. 7613(a)(1) ---------- 18
Section 113(a)(5), 42 U.S.C. 7613(a)(5) ---------- 18
Section 304(a)(3), 42 U.S.C. 7604(a)(3) ---------- Passim
Section 304(a)(1), 42 U.S.C. 7604(a)(1) ---------- 18
Section 304(b)(1)(A), 42 U.S.C. 7604(b)(1)(A) ----- 19
Section 304(b) ---------- 19
42 U.S.C. 7604 ---------- 1
Clean Water Act,
33 U.S.C. 1251 *et seq.* ---------- 2
Section 301(a), 33 U.S.C. 1311(a) ---------- 4
Section 402, 33 U.S.C. 1342 ---------- 4
33 U.S.C. 1252(a) ---------- 8
33 U.S.C. 1254(a)(5) ---------- 8
33 U.S.C. 1256(e)(1) ---------- 8
33 U.S.C. 1362(7) ---------- 8
33 U.S.C. 1362(12) ---------- 8
33 U.S.C. 1365 ---------- 1
28 U.S.C. 1291 ---------- 1
28 U.S.C. 1331 ---------- 1
28 U.S.C. 1361 ---------- 1
28 U.S.C. 2201 ---------- 1
28 U.S.C. 2202 ---------- 1
40 C.F.R. 51.165(a)(1)(xiv) ---------- 16
Fed. R. App. P. 29 ---------- 2
55 Fed. Reg. 47,990, 47,997 (Nov. 16, 1990) ---------- 11
56 Fed. Reg. 64,876, 64,892 (Dec. 12, 1991) ---------- 12
58 Fed. Reg. 7,610, 7,631 (Feb. 8, 1993) ---------- 12

MISCELLANEOUS:

12 Harv. Envtl. L. Rev. 569, 613-614 (1988) ---------- 10
118 Cong. Rec. 10666 (1972) (remarks of Rep. Aspin) ---- 10
118 Cong. Rec. 10668 (1972) (remarks of Rep. Harsha) --- 9,10
Wis. Admin. Code § NR 408.02(21)(b)3 ---------- 19

IN THE UNITED STATES COURT OF APPEALS

FOR THE SEVENTH CIRCUIT

No. 93-3380

VILLAGE OF OCONOMOWOC LAKE,

Plaintiff-Appellant,

v.

DAYTON-HUDSON CORPORATION; GEORGE E. MEYER, Secretary; and the WISCONSIN DEPARTMENT OF NATURAL RESOURCES,

Defendants-Appellees.

ON APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF WISCONSIN

BRIEF FOR THE UNITED STATES AS AMICUS CURIAE

OPINION BELOW

The unreported decision of the district court (Honorable John W. Reynolds, District Judge) was issued September 24, 1993.

SUBJECT MATTER JURISDICTION AND APPELLATE JURISDICTION

The complaint predicated the subject matter jurisdiction of the district court on 28 U.S.C. §§ 1331, 1361, 2201, and 2202; 33 U.S.C. § 1365; and 42 U.S.C. § 7604. (App. 8) The judgment entered on September 24, 1993 was final as to all issues and parties. (App. 7) The notice of appeal was filed on September 24, 1993. (App. 7) This Court's jurisdiction rests on 28 U.S.C. § 1291.

STATUTES INVOLVED

This appeal involves the Clean Water Act, 33 U.S.C. § 1251 et seq., and the Clean Air Act, 42 U.S.C. § 7401 et seq.

STATEMENT OF ISSUES

Pursuant to Rule 29 of the Federal Rules of Appellate Procedure and Rule 29 of this Court, the United States of America submits this memorandum on the following issues:

> (1) Whether the discharge of pollutants to groundwater, in certain circumstances, may be subject to the CWA prohibition against unpermitted point source discharges of pollutants to waters of the United States.
>
> (2) Whether State Implementation Plan (SIP) provisions, approved by EPA pursuant to Part D of the CAA, that regulate "indirect sources" of air pollution, are enforceable by citizens under CAA section 304(a)(3).

The United States has a direct interest in the development of the law regarding citizen enforcement under the CWA and CAA because citizens play a major role in the integrated federal-state-citizen enforcement scheme under these statutes. Moreover, the United States is concerned that district court's erroneous reasoning, if not corrected on appeal, could undermine federal enforcement of these laws. Accordingly, the United States requests that the judgment of the district court be reversed and the case remanded to that court for further proceedings.

STATEMENT OF THE CASE

Plaintiffs, Village of Oconomowoc Lake and Town of Summit, Wisconsin, brought suit on July 30, 1993, against the Dayton-Hudson Corporation, the Wisconsin Department of Natural Resources

and its Secretary, George E. Meyer, and the United States Environmental Protection Agency (EPA) and its Administrator and Regional Administrator, alleging that defendants had failed to obtain or issue permits required under the CWA and the CAA in connection with Dayton-Hudson's proposed construction of a merchandise distribution center for its Target Department store chain. The federal defendants were dropped from the litigation by stipulation of the parties on August 26, 1993.

The district court dismissed plaintiffs' CWA claim in an opinion issued September 24, 1993. The district court held that since plaintiffs had alleged that Dayton-Hudson's proposed facility would discharge pollutants to waters of the United States via groundwater, rather than directly to surface water, no National Pollution Discharge Elimination System (NPDES) permit could be required under the CWA. Village of Oconomowoc Lake et al. v. Dayton-Hudson et al., No. 93-C-0797, slip opinion at 7 (E.D. Wisc. Sept. 21, 1993).

The district court also dismissed plaintiffs' CAA claim. Plaintiffs had claimed that Dayton-Hudson was required to obtain a "major source" CAA permit for its facility under portions of the Wisconsin SIP regulating "indirect sources" of air pollution such as parking lots and other attractors of mobile source pollution. Plaintiffs had filed suit under a portion of the citizen suit provision of the CAA, section 304(a)(3) of the CAA, 42 U.S.C. § 7604(a)(3), which provides that citizens may bring suit against any person who proposes to construct or constructs

any new or modified major emitting facility without a permit "required under" specific parts of the CAA. The district court found that plaintiffs could not invoke Section 304(a)(3) because permits for indirect sources are not "required under" the CAA.

On September 24, 1993, the Village of Oconomowoc Lake appealed the district court's judgment. The case has been fully briefed by the parties. Oral argument is set for February 16, 1994.

STATEMENT OF FACTS

The statement of the facts is provided in the briefs of the parties.

RELATED CASES AND PROCEEDINGS

These are provided in the briefs of the parties.

STANDARD OF REVIEW

The standard of review is stated in the brief of the Appellant.

ARGUMENT

I.

DISCHARGES OF A POLLUTANT TO GROUNDWATER ARE WITHIN CWA JURISDICTION IN SPECIFIC CIRCUMSTANCES

A discharge of a pollutant to groundwater comes within Clean Water Act (CWA) jurisdiction where the discharge is tantamount to a discharge to waters of the United States. In such circumstances, under Sections 301(a) and 402 of the Clean Water Act (CWA), 33 U.S.C. §§ 1311(a) and 1342, a point source discharge of a pollutant to ground or to groundwater is subject to CWA regulation. Whether these circumstances exist in any

particular case is a question of fact. The lower court, however, erroneously assumed that as a matter of law, point source discharges to groundwater may never be subject to CWA permitting jurisdiction; on that basis, it dismissed plaintiffs' CWA claim.

Citizen suit plaintiffs "should have the opportunity to demonstrate through expert testimony that any seepage of pollutants ... into groundwater" is effectively a discharge into surface waters. See McClellan Ecological Seepage Situation (MESS) v. Cheney, 763 F. Supp. 431, 437 (E.D.Cal. 1989), appeals docketed, Nos. 91-16308, 91-16467 (9th Cir. Aug. 23, 1991). This Court should reverse the judgment of the district court on the CWA claim and remand the claim to the lower court for further examination of the factual circumstances.

A. The majority of cases recognize that discharges to groundwater may, in specified circumstances, come within Clean Water Act regulatory jurisdiction.

This Court has expressly recognized the possibility that point source discharges to groundwater may be subject to regulation under the CWA where the groundwater is hydrologically connected to surface waters. In the Inland Steel case, this Court stated that "the legal concept of navigable waters might include ground waters connected to surface waters -- though whether it does or not is an unresolved question." Inland Steel Co. v. EPA, 901 F.2d 1419, 1422 (7th Cir. 1990) (emphasis added).

The majority of courts have refused to rule out the possibility that discharges of pollutants to groundwater can come within the regulatory compass of the CWA. Most recently, in

Sierra Club v. Colorado Refining Company (CRC), 838 F. Supp. 1428 (D. Colo. 1993), plaintiffs alleged that pollutants discharged from a point source were entering surface waters via groundwater. The court found these allegations sufficient to withstand a motion to dismiss:

> I therefore find that Sierra Club's allegations that CRC has and continues to discharge pollutants into the soils and groundwater beneath the refinery which then make their way to Sand Creek through the groundwater state a cause of action under the Clean Water Act. Accordingly, I deny CRC's Rule 12(b)(6) motion to dismiss the first cause of action.

Sierra Club v. CRC, slip op. at 17-18.

Although Sierra Club v. CRC is, to our knowledge, the only case other than the present one to confront the question squarely in the context of a motion to dismiss, all but one of the other courts that have considered the issue have specifically held out the possibility that NPDES permits may be required in specific circumstances for discharges to groundwater where the groundwater is connected to waters of the United States. In Inland Steel, supra, this Court suggested that "a well that ended in such connected ground waters might be within the scope of the [Clean Water] Act." Id., 901 F.2d at 1423 (7th Cir. 1990) (citations omitted). Although the Court of Appeals for the Fifth Circuit has indicated that an NPDES permit is not required for discharges of pollutants into isolated groundwaters because those groundwaters are not waters of the United States, it "express[ed] no opinion" on what the result would be under the CWA if the contaminated groundwater migrated to navigable waters. Exxon v.

Train, 554 F.2d 1310, 1312 n. 1 (5th Cir. 1977). And in Kelley v. United States, No. 79-10199 (E.D. Mich. Oct. 28, 1980) ("Kelley I"), the district court found that wastes migrating from groundwater under an air base into nearby surface waters could fall within CWA jurisdiction. See Sierra Club v. CRC, supra, slip op. at 12 (discussing Kelley I).

In McClellan Ecological Seepage Situation v. Weinberger, 707 F. Supp. 1182, 1193-96 (E.D.Cal. 1988) ("MESS I"), the district court concluded that some discharges to groundwater could fall within the regulatory purview of the CWA if the groundwater is "naturally connected to surface waters that constitute 'navigable waters' under the Clean Water Act." 707 F. Supp. at 1196. In a later phase of the MESS litigation, after defendant presented testimony showing the "naturally connected" standard was not met, the court elaborated a more detailed standard, holding that the CWA encompasses discharges to groundwater where it is "reasonably foreseeable and temporally imminent" that the discharges will percolate to surface waters. MESS II, supra, 763 F. Supp. at 437.[1/]

1/ In New York v. United States, 620 F. Supp. 374 (E.D.N.Y. 1985), the court "decline[d] to reach defendants' argument as to the scope of section 301 [of the CWA] as applied to groundwaters, since it is clear that plaintiff has alleged that the pollutants threaten to contaminate [various creeks], all of which are indisputably navigable waters." Id. at 381. And, Quivira Mining Co. v. United States EPA, 765 F.2d 126, 129-130 (10th Cir. 1985), cert. denied, 474 U.S. 1055 (1986), affirmed EPA's decision that a CWA permit was required for discharges of pollutants into surface arroyos which, during storms, channelled rainwater both directly to navigable-in-fact streams and into underground aquifers that connected with such streams.

Only in Kelley v. United States, 618 F. Supp. 1103, 1106-7 (W.D. Mich. 1985) ("Kelley II") did a district court hold that CWA jurisdiction did not extend to the alleged release of toxic chemicals into groundwater that allegedly was migrating into a bay. The other authorities cited are better-reasoned than Kelley II and the court below. Thus, this Court should hold, as a matter of law, that discharges of pollutants to groundwaters may fall within the regulatory jurisdiction of the CWA, depending on the factual circumstances.

B. EPA's view is in accord with the majority of caselaw and is entitled to Chevron deference.

Section 402 of the CWA authorizes states to administer permit systems for the discharge of pollutants. "Discharge of a pollutant" is defined as any addition of pollutants "to navigable waters from a point source." 33 U.S.C. § 1362(12). The statute defines "navigable waters" as "waters of the United States." 33 U.S.C. § 1362(7). The CWA distinguishes between and refers separately to navigable waters and ground waters. See 33 U.S.C. §§ 1252(a), 1254(a)(5), 1256(e)(1).[2/] Thus, isolated groundwaters are not "navigable waters", and discharges to groundwaters per se are not covered by the CWA permitting scheme. The statute does not explicitly address, however, whether the prohibition on unpermitted discharges includes the addition of

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2/ The legislative history of the CWA also demonstrates that "Congress did not intend groundwater and navigable waters to be synonymous." McClellan Ecological Seepage Situation v. Weinberger, 707 F. Supp. 1182, 1194 (E.D.Cal. 1988) ("MESS I"); see also United States v. GAF Corporation, 389 F. Supp. 1379, 1383 (S.D. Tex. 1975).

pollutants to navigable waters from a point source through groundwater.

The legislative history is similarly inconclusive on this point. Congress specifically considered - and rejected - extension of the NPDES program to all groundwater.[3/] There is no evidence, however, that rejecting this extension, Congress intended to create a groundwater loophole through which discharges of pollutants could flow, unregulated, to surface water. The legislative debated coalesced around an amendment introduced by Representative Aspin, that would have extended CWA regulatory jurisdiction to all discharges to groundwater. A review of the debate illustrates that Congress was primarily concerned with the Aspin amendment's extension of CWA jurisdiction to groundwater per se, including isolated groundwater. For example, Rep. McClory, arguing in favor of the Aspin amendment, stated, "to consider that we are providing for the protection of the surface waters...and omitting from the strong provisions of this measure vast groundwater supplies--is to my mind unthinkable". 118 Cong. Rec. 10668 (1972) (remarks of Rep. McClory). Rep. Sisk objected to the Aspin Amendment because, in his view, "what they are attempting to do here is

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3/ See Exxon Corp., supra, 554 F.2d at 1326-1329 (reviewing legislative history); MESS I, 707 F. Supp. at 1194.

bring groundwater under the control of the EPA." 118 Cong. Rec. 10669 (1972) (remarks of Rep. Sisk).[4/]

Congress ultimately rejected the Aspin amendment. But there is no evidence that Congress intended to throw jurisdiction over affected surface waters out with the groundwater.

Since the plain language and legislative history do not answer definitively the precise question presented here, a reviewing court should defer to the views of the EPA, the agency charged with administering the CWA. See Chevron U.S.A. v. Natural Resources Defense Council, 467 U.S. 837, 842-844 (1984). EPA's interpretation of the CWA, including the jurisdictional limits of the NPDES requirements, are entitled to deference. Arkansas v. Oklahoma, 503 U.S. ___, 112 S. Ct. 1046, 1056 (1992). As recognized in Town of Norfolk v. United States Army Corps of Engineers, 968 F.2d 1438 (1st Cir. 1992), the determination

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4/ See also 118 Cong. Rec. 10668 (1972) (remarks of Rep. Harsha) ("[T]his amendment purports to require water-quality standards for groundwater"). Rep. Aspin himself was concerned not only with pollution of isolated groundwater, but with hydrologically connected groundwater as well:

> If we do not stop pollution of ground waters through seepage and other means, ground water gets into navigable waters, and to control only the navigable water and not the ground water makes no sense at all.

118 Cong. Rec. 10666 (1972) (remarks of Rep. Aspin). The tenor of the debate indicates, however, that the representatives were most concerned with application of the NPDES program to the nation's vast and isolated groundwater reserves. See generally Exxon v. Train, supra, 554 F.2d at 1326-1329 (reviewing legislative history); and see Mary Christina Wood, "Regulating Discharges into Groundwater: The Crucial Link in Pollution Control under the Clean Water Act," 12 Harv. Envtl. L. Rev. 569, 613-614 (1988).

whether a discharge to "waters of the United States" includes discharges to hydrologically connected groundwaters should be left in the first instance to the discretion of the EPA, "since such a determination ultimately involves an ecological judgment about the relationship between surface waters and groundwaters." Id., 968 F.2d at 1451 (citing United States v. Riverside Bayview Homes, Inc., 474 U.S. 121, 134 (1985) (deference should be given to administering agency's ecological judgment about the relationship between wetlands and adjacent surface waters)).

EPA has repeatedly expressed its view that the CWA encompasses discharges to groundwaters that are hydrologically connected to waters of the United States. For example, EPA explained this interpretation when it promulgated regulations on storm water discharges. See Preamble, NPDES Permit Application Regulations for Storm Water Discharges, EPA Final Rule, 55 Fed. Reg. 47990, 47997 (Nov. 16, 1990) ("[T]his rulemaking only addresses discharges to waters of the United States, consequently discharges to ground waters are not covered by this rulemaking (unless there is a hydrological connection between the ground water and a nearby surface water body)").[5/]

EPA also interpreted the statute in this way when it promulgated regulations governing discharges from animal feedlots. See NPDES General Permit and Reporting Requirements for Discharges from Concentrated Animal Feeding Operations, EPA

5/ See Natural Resources Defense Council v. EPA, 966 F.2d 1292 (9th Cir. 1992) (upholding rule, remanding on other grounds).

Region 6 Public Notice of Final Permitting Decision, 58 Fed. Reg. 7610, 7631 (Feb. 8, 1993) (feedlots required to obtain NPDES permit for discharges to groundwater unless permittee can demonstrate lack of hydrologic connection to surface water).

EPA's statement of its position in connection with the promulgation of other recent regulations is particularly instructive:

> Notwithstanding the strong language in the legislative history of the Clean Water Act to the effect that the Act does not grant EPA authority to regulate pollution of groundwaters, EPA and most courts addressing the issue have recognized that...the Act requires NPDES permits for discharges to groundwater where there is a direct hydrological connection between groundwaters and surface waters. In these situations, the affected groundwaters are not considered "waters of the United States" but discharges to them are regulated <u>because such discharges are effectively discharges to the directly connected surface waters.</u>"

Amendments to the Water Quality Standards Regulations that Pertain to Standards on Indian Reservations, Final Rule, 56 Fed. Reg. 64,876, 64,892 (Dec. 12, 1991) (emphasis added).

This Court should defer to EPA's scientific judgment in the complex area of groundwater-surface water relationships and hold that the discharge of pollutants to groundwaters may come within CWA jurisdiction, depending on the circumstances.

C. Discharges to groundwater come within CWA regulatory jurisdiction where there is a reasonably foreseeable direct hydrological connection between the groundwater and the surface waters in the proximity of the release, and a greater than de minimis quantity of pollutants reasonably is able to reach the surface water.

As noted above, a discharge to groundwater comes within the CWA's regulatory compass when the discharge is tantamount to a discharge to waters of the United States. This occurs when there is a reasonably foreseeable direct hydrological connection to waters of the United States in the proximity of the release, and a greater than de minimis quantity of the pollutant reasonably is able to reach the waters of the United States (provided that no other Federal statute directly addresses the activity causing the release).

It bears emphasizing that EPA does not take the position that groundwaters themselves are "waters of the United States" within the meaning of the CWA. Rather, the mere fact that groundwaters are not waters of the United States does not mean that discharges of pollutants to groundwaters can never be regulated discharges within the meaning of the CWA. Such discharges are regulated by the CWA where the discharge to groundwater is effectively a discharge to waters of the United States. Thus, where there is a reasonably ascertainable direct hydrological connection to surface waters in the proximity of a release of pollutants, and it is reasonably foreseeable that pollutants discharged into groundwater will reach surface waters in greater than de minimis quantities, CWA jurisdiction attaches

(provided, of course, that no other Federal statute directly regulates the release or the activity causing the release).

The United States recognizes that expert analysis of hydrological conditions may be required in order to determine whether this standard has been met. Precisely because such factual determinations may be required, it is inappropriate to dismiss a CWA complaint simply because the plaintiff alleges that pollutants will flow to waters of the United States via groundwater. Accordingly, the judgment of the district court should be reversed. The case should be remanded to the lower court for further factual examination to determine whether, under this standard, CWA jurisdiction is properly invoked.[6/]

II.

INDIRECT SOURCE PERMIT REQUIREMENTS APPROVED INTO STATE IMPLEMENTATION PLANS TO SATISFY REQUIREMENTS OF PART D OF THE CLEAN AIR ACT ARE ENFORCEABLE BY CITIZENS UNDER SECTION 304(A)(3) OF THAT ACT

The district court concluded that because defendant Dayton-Hudson's distribution center will cause air pollution only indirectly, and because EPA may not require states to include indirect source review programs in SIPs, EPA could not have

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6/ In this case, appellant seeks prospectively to prevent discharges to groundwater. The record indicates that the distribution center is still under construction, and the citizens have not alleged that any discharges to groundwater in violation of the CWA have occurred. Appellants have argued that the CWA does not provide a basis for prospective enforcement jurisdiction. On remand, after conducting the factual inquiry described above, the district court may need to consider whether the CWA affords a basis for prospective jurisdiction.

required Wisconsin to include in its SIP a program requiring the distribution center to obtain a permit. Village of Oconomowoc Lake v. Dayton-Hudson, slip op. at 4-5. The court held that Section 304(a)(3) of the CAA, 42 U.S.C. § 7604(a)(3), does not provide jurisdiction over citizen suits alleging a failure to issue or obtain a permit required under a SIP if the permit requirement is not specifically mandated under the CAA itself. Slip op. at 5-6.

Section 304(a)(3) of the CAA provides:

> Except as provided in subsection (b) of this section, any person may commence a civil action on his own behalf--* * * *
>
> > (3) against any person who proposes to construct or constructs any new or modified major emitting facility without a permit required under part C of subchapter I of this chapter (relating to significant deterioration of air quality) or part D of subchapter I of this chapter (relating to nonattainment) ...

42 U.S.C. § 7604(a)(3) (emphasis added). The district court reasoned that Section 304(a)(3)'s phrase, "required under", limits jurisdiction to challenges alleging violation of requirements to obtain a permit stated in the CAA itself.

The district court's conclusion is overly broad. The correct reading of Section 304(a)(3) is that citizen suits will lie to enforce all permit requirements approved by EPA into a SIP under Part D of Title I of the CAA. The court should have construed the Section 304(a)(3) reference to permits "required under..part D of subchapter I" to include permits required under

the implementation plan of a state by virtue of EPA's approval (or promulgation) of the plan pursuant to Part D.[7]

This construction is the one adopted by EPA, the agency charged with administering the CAA, in its regulations governing approval of SIPs. There, EPA takes the position that all provisions of an applicable SIP are federally enforceable, regardless of their provenance:

> (xiv) *Federally enforceable* means all limitations and conditions which are enforceable by the Administrator, including those requirements developed pursuant to 40 CFR parts 60 and 61, requirements within any applicable State implementation plan, any permit requirements established pursuant to 40 CFR 52.21 or under regulations approved pursuant to 40 CFR part 51, subpart I, including operating permits issued under an EPA-approved program that is incorporated into the State implementation plan and expressly requires adherence to any permit issued under such program.

40 CFR § 51.165(a)(1)(xiv) (emphasis added). Thus, EPA has authority to enforce all SIP provisions - including indirect source review requirements - approved by it under Part D, even though such requirements are not mandated by the CAA.

Interpreting the Section 304(a)(3) citizen suit provision to omit coverage of such requirements would strain the balance of the integrated statutory scheme of the CAA. It would also fail to recognize that, beyond a relatively small number of federally mandated specific requirements, Congress gave states broad

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7/ The statute, and the analysis in this brief, apply as well to permits required under Part C of subchapter I of the CAA, but Part C is not at issue in this case.

discretion to fashion appropriate air pollution control measures to meet their SIP obligations. See CAA Section 110 (a)(2)(A), 42 U.S.C. § 7410(a)(2)(A).

Moreover, such an interpretation would leave a significant hole in citizen enforcement, and require a reviewing court in every Section 304(a)(3) citizen suit to trace the pedigree of each SIP provision back to the parent CAA in order to determine whether the provision was mandated by the Act and thus could be enforced in federal court. There is no evidence in the statute or the legislative history to indicate that Congress intended such a strained result.

A. Caselaw supports the proposition that citizens may sue under CAA Section 304(a)(3) to enforce SIP indirect source provisions.

While there is no direct precedent addressing the precise question whether citizen suits under Section 304(a)(3) will lie to enforce indirect source review requirements contained in state plans approved by EPA under Part D, the tenor of the caselaw indicates that such suits should be allowed as part of the integrated CAA statutory scheme. Only one court of appeals has addressed the question, and it specifically saw some ambit for citizen enforcement. In Sierra Club v. Larson, 2 F.3d 462, 469 (1st Cir. 1993), the Court of Appeals held that Massachusetts SIP provisions on indirect sources can, in certain cases, be enforceable by citizen suit under Section 304(a)(3):

> "Of course, not every state-law restriction on a project is a matter of federal concern, but a state restriction that is part of a federally approved state implementation plan under the Clean Air Act may at

> least in some circumstances be within the purview of a citizens suit under 42 U.S.C. § 7604."

Sierra Club v. Larson, 2 F.3d at 469 (emphasis added) (construing section 304(a)(3)). The court did not decide the question definitively in Larson because the relevant provision of the state SIP had not yet been approved by EPA. Id. at 469-470.

In a number of other cases, courts have held that indirect source review provisions can constitute an "emissions standard or limitation" within the meaning of section 304(a)(1) of the CAA.[8/] While these cases are not dispositive of the issue on appeal, they do support the proposition that the CAA's integrated enforcement scheme allows for citizen enforcement of indirect source requirements approved into a SIP under Part D.[9/]

8/ See, e.g., Coalition Against Columbus Center v. City of New York, 967 F.2d 764, 771 (2d Cir. 1992); Citizens for a Better Environment v. Deukmejian, 731 F. Supp. 1448, 1454 (N.D. Cal. 1990); Delaware Valley Citizens Council v. Davis, 932 F.2d 256, 264-67 (3d Cir. 1991); American Lung Association v. Kean, 871 F.2d 319, 321-324 (3d Cir. 1989). CAA Section 304(a)(1) provides that any person may commence a civil action against any person who is "alleged to have violated...or to be in violation of (A) an emission standard or limitation under this chapter or (B) an order issued by the Administrator or a State with respect to such a standard or limitation." 42 U.S.C. § 7604(a)(1) (emphasis added).

9/ The citizen suit provisions of Section 304 parallel the federal enforcement authorities of Section 113. EPA's general SIP enforcement authority is contained in Section 113(a)(1) of the CAA, 42 U.S.C. § 7413(a)(1), which requires 30 days notice to the person alleged to be in violation before a suit may be filed. However, in recognition of the exigencies surrounding violations of new source permitting requirements, Section 113(a)(5) of the CAA, 42 U.S.C. § 7413(a)(5), allows the Administrator to bring suit without issuing a 30 day notice whenever a state fails to comply with new source permitting requirements. Similarly, Section 304(a)(1), 42 U.S.C. § 7604(a)(1), allows citizens to file suit regarding SIP violations only after giving 60 days

(continued...)

These cases are particularly important in view of the district court's misinterpretation of the distinction between Sections 304(a)(1) and 304(a)(3). The district court interpreted Section 304(a)(3) as having a narrower scope than Section 304(a)(1). The proper distinction between these provisions, however, relates not to the question whether a particular SIP provision is mandated by federal law, but whether EPA approved the SIP provision under the authority of the new source permitting requirements of Part D of the CAA.

B. The case should be remanded to the lower court for further determination regarding the Wisconsin SIP indirect source review provisions for emissions of NOx.

Appellee State of Wisconsin has raised the argument that the specific Wisconsin SIP provisions invoked by appellant have not yet been approved by EPA. It is true that the recent proposed SIP revisions submitted by the State of Wisconsin to EPA, Wis. Admin. Code § NR 408.02(21)(b)3. (1992), have not been approved by EPA, and thus cannot be enforced in a citizen suit. However, any existing SIP requirements for indirect source review are enforceable by citizens under Section 304(a)(3) if the requirements were approved by EPA under Part D. The record in this case is not sufficient to determine whether Wisconsin's indirect source review requirements were approved into its SIP

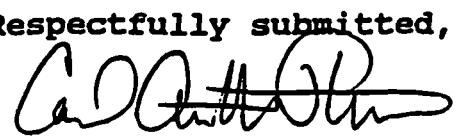
9/ (...continued)
advance notice to the Administrator, the affected state, and the alleged violator, see Section 304(b)(1)(A), 42 U.S.C. § 7604(b)(1)(A), while Section 304(b) in its entirety pointedly omits this advance notice requirement for suits brought under Section 304(a)(3). See 42 U.S.C. § 7604(b)(1)(A).

pursuant to Part D, and if so, whether they mandate permit distinctions between "major" and "minor" indirect sources of NOx. The United States therefore respectfully suggests that this Court remand the CAA claim to the lower court for it to make these determinations. While remand would entail some delay for review of an extensive administrative record that is nearly fifteen years old, the need for integrated enforcement of the CAA mandates that citizens be allowed under CAA Section 304(a)(3) to enforce all indirect source review requirements contained in a state's implementation plan. To hold otherwise would be to create an unwarranted gap in the CAA's comprehensive federal, state, and citizen enforcement scheme.

CONCLUSION

For the foregoing reasons, the judgment below should be reversed, and the case should be remanded to the district court.

Respectfully submitted,



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Hydrogeologic Evaluation of Tailings Ponds

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TABLE OF CONTENTS

	Page
1.0 INTRODUCTION	1
2.0 GEOLOGIC SETTING	3
2.1 Regional Geology	3
2.2 Site Geology	3
3.0 HYDROGEOLOGY	8
3.1 Hydrogeologic Units	8
3.2 Flow Directions and Hydraulic Gradients	12
3.3 Seepage Velocity and Unit Discharge	13
3.4 Dilution Effects	14
3.5 Chemistry	15
3.6 Summary of Hydrogeology	18
4.0 RECOMMENDATIONS	19
5.0 REFERENCES	21

APPENDICES

Appendix A - Borehole Logs
Appendix B - Results of Laboratory Analyses of Aquitard Samples
Appendix C - Results of Laboratory Analyses of Water Samples (August 17-18, 1993)
Appendix D - Constant Rate and Recovery Test Results
Appendix E - Drilling and Construction of Monitor Wells

LIST OF FIGURES

Figure 1. Location Map
Figure 2. Geologic Map: Tailings Pond Area
Figure 3. Borehole Stratigraphy: Tailings Pond Area
Figure 4. Geologic Cross-Section A-A'
Figure 5. Geologic Cross-Section B-B'
Figure 6. Ground-Water Flow Directions
Figure 7. Monitor Well Ground-Water Chemistry
Figure 8. Location of Proposed Extraction Systems

1.0 INTRODUCTION

This report presents an analysis of the hydrogeologic conditions in the vicinity of the Molycorp tailings ponds near Questa, New Mexico. The purpose of this work is to evaluate ground-water flow conditions and water-quality distributions in aquifers that connect impacted water beneath the ponds with discharge areas (such as private wells and the Red River south of the facility). The outcome of the analysis is 1) an explanation of the controlling hydrogeologic parameters; and 2) recommendations for additional work to clarify and extend the hydrogeologic data and for controlling, monitoring, and, if necessary, remediating impacted ground water.

The tailings ponds are located about 1 mile west of Questa, New Mexico (Taos County) and 0.5 mile north of the Red River (Figure 1). Since 1965, tailings slurry has been piped along the Red River from the mill near the Molycorp molybdenum mine, which is located approximately 8 miles east of the tailings disposal sites. The disposal sites currently cover about 550 acres and have been maintained since the mine ceased underground operations in 1992.

History of the Operation

The Questa open-pit mining and tailings disposal operations began in 1965 with the construction of an earth fill starter Dam No. 1 in a large arroyo at the southern end of Section 36. The upstream face of the dam was sealed with the slime faction of the tailings. The water clarification pond was at the dam face. Clarified water was piped via decant structures raised on the upstream dam face, through culvert tunnels under the dam, and then by ditch to the Red River.

Raises and operation of Dam No. 1 continued until 1969 when a second dam (Dam No. 2) was constructed at the north end of Section 36. The clarification pond was then shifted to the north, and the existing decant structures were abandoned for a new overflow weir structure constructed in the bank alongside the new Dam No. 2. Clarified water overflowed the weir and traveled down a decant ditch cut around the west side of Section 35 to a small holding pond called Pope Lake (located at the southern end of Section 35). From Pope Lake, the water flowed over a Parshall flume (later called Outfall 001) and to the Red River.

In 1969, the final 7520-foot and 7525-foot elevation raises on Dam No. 1 were shifted upstream (west) of the existing dam and were constructed on tailings. These lifts were of compacted earthfill.

In 1971, additional tailings storage was created by constructing starter Dam No. 4 in Section 35. This dam and all its subsequent lifts were constructed of earthfill and had internal drain systems. The upstream dam face was also covered with an asphalt or plastic membrane. A decant weir was built to the north of the dam so that the clarification pond could be kept away

from the dam face. Clarified water was released over the weir structure into the west ditch to Pope Lake and then to the Red River.

In 1974, east and west diversion ditches were constructed around both tailings storage areas in order to divert all natural drainage away from the impounded tailings. Diverted water re-entered the watershed below Dams 1 and 4.

In 1975, seepage barriers were constructed below Dam No. 1 and to the east of the ridge separating Dam No. 4 and Dam No. 1 areas. These barriers were excavated to clay, sealed on the downstream side, and filled with suitable drain material so that seepage from the tailings storage ponds could be collected and diverted around the dwellings situated downstream of the tailings storage area. This water was then piped to the Red River through Outfall 002.

In 1983, an ion exchange water treatment plant (I-X building) was constructed alongside Pope Lake. This plant processed all tailings decant water before it was discharged into the Red River.

2.0 GEOLOGIC SETTING

The tailings disposal site overlies a series of northeast-trending ridges and washes that have eroded into the sedimentary and volcanic rocks of the Santa Fe Formation. The Santa Fe Formation underlies a lowland bounded on the west by the Guadalupe Mountains and on the east by the Sangre de Cristo Mountains. The Guadalupe Mountains reach elevations just over 8,700 feet and the Sangre de Cristo Mountains just over 10,000 feet. Elevations in the lowland are on the order of 7,000 to 7,600 feet. The Red River, which lies south of the tailings ponds, is entrenched across the Tertiary sedimentary and volcanic rocks creating a gorge southwest of the site. Springs fed by perched or regional ground water occur in the volcanics along the walls of the gorge.

2.1 Regional Geology

Regionally, the site is located within the Rio Grande rift zone, a northeast-/southwest-trending fault-bound structural depression of Mid- to Late-Tertiary age, that extends across New Mexico into southern Colorado. The depression is composed of a number of structural subbasins including the San Luis Basin, which is located at the northern end of the rift. The San Luis Basin is bounded on the east by the Sangre de Cristo Range which was uplifted contemporaneously with the formation of the basin along high-angle normal faults extending parallel to the west front of the range. The basin filled with coarser alluvial sediments along the range front. Farther to the west, the basin fill consists of finer clays and silts deposited in lakes. At the tailings disposal site, the lacustrine (lake) sediments are interbedded with the alluvial sands and gravels. The San Luis Basin fill is assigned to the Santa Fe Formation (Miocene to Early-Pliocene in age) and is believed to be on the order of 15,000 feet thick.

Numerous volcanic fields developed as the result of the rifting and basin formation in Mid- to Late-Tertiary time. The volcanic units that underlie the Guadalupe Mountains along the west side of the site consist of lava flows and ash flow tuffs that range from rhyolite to basalt in composition and that are believed to be Oligocene to Early-Miocene in age (unpublished stratigraphic section, Molycorp files). These volcanics may intertongue with at least the lower Santa Fe Formation. Miocene basalts are intercalated with the Santa Fe Formation. Both the Santa Fe Formation and the older volcanic units are unconformably overlain by the Servilleta Basalt of Pliocene age.

2.2 Site Geology

Stratigraphy

The highly generalized lithologic logs for monitor wells (MW-1, -2, -3, and -4) drilled in 1979 suggested a simple stratigraphy for the site including an upper gravel unit, an underlying yellow clay, and, in one monitor well (MW-1), a volcanic unit beneath gravel (see Figures 2 and

3). Logs of five monitor wells drilled in 1993 show a more complex interlayering of gravel, sand, and clay in the Santa Fe Formation and a wider distribution of the volcanic rocks reported at MW-1. Recent alluvial sediments contain material reworked from the poorly consolidated Santa Fe Formation and appear to be largely confined to the washes. Field reconnaissance, combined with an earlier unpublished geologic map (Vail, 1987) and the borehole data, have demonstrated that two different volcanic units are in the area and that a thin sequence of volcanic sediments, distinct from other Santa Fe units, occurs in a small area south of the face of Dam 4.

Santa Fe Formation

Based on the borehole logs, the Santa Fe Formation in the area of the tailings ponds consists of:

- an Upper Aquifer Unit (UAU) composed of brown sandy gravels and gravelly sands with a subordinate component of pale red brown silty, sandy clay. (Recent sediment was not distinguished from the poorly consolidated UAU during logging);

- a Middle Aquitard Unit (MAU) in which pale red brown clay and gravelly clay are the dominant sediments; and

- a Lower Aquifer Unit (LAU) composed of sandy or clayey gravel. Thin beds of tightly cemented sandstone were noted in MW-7 and MW-10.

These three lithologic divisions are based on dominant textural characteristics, but each unit contains subordinate amounts of the other lithologies (for example: clay beds occur within the UAU and LAU). There are no marker beds to establish lateral equivalence between borehole sections, such that parts of the MAU may be temporally equivalent to the lower part of the UAU, or the upper part of the LAU. In general, the internal structure of a sequence of alluvial or alluvial/lacustrine (lake) sediments is expected to be lensoid in character and have sand and gravel lenses intertongueing and have clay-rich units (Galloway and Hobday, 1983). Borehole logs are presented in Appendix A.

Gravels range from very fine gravel (0.08 to 0.16 inch) to cobble sizes (2.4 to 10.24 inches), but most of the material appears to be below cobble size. Geotechnical drilling for Dam No. 1 (pre-dam cross-section along the proposed axis of Dam No. 1, Molycorp files) indicated boulder size material is present in the UAU. Clast composition in the gravels seems to largely reflect sources in the Sangre de Cristo Range to the east. A variety of volcanic rock types (flows, ash flow tuffs), intrusive igneous rocks (pegmatite, granite, quartz monzonite), and metamorphic rocks (gneisses) occur in the gravels.

A thin sequence of brown, silty highly burrowed sands, black coarsely grained volcanic sands, and gravelly clayey sands outcrop in the vicinity of MW-11. The gravels in this unit are entirely composed of volcanic clasts. Similar sediments were penetrated in the upper 29 feet of MW-11 and in several borings near the toe of Dam No. 4. This unit is shown separately (as T_{sva}) on the geologic map (Figure 2) and is here considered a unit in the Santa Fe Formation.

Volcanic Units

Lithologic information for the volcanic rocks penetrated by the monitor wells comes primarily from cuttings descriptions. The flow rock is a finely crystalline olivine basalt containing brown millimeter-size phenocrysts of altered olivine and of pyroxene (augite?). White phenocrysts of feldspar were also noted. A few cuttings showed glassy textures which probably indicate the tops or bases of individual flows. Both vesicular, and to a greater extent, non-vesicular basalt are present in the section. Flow banding was observed in some cuttings. White and pale blue quartz/chalcedony fills some vesicules and occurs along a few fractures. Thin volcanic breccias consisting of black to gray angular volcanic fragments in a red volcanic matrix are interlayered with the flows. Exposures of the basalt along the walls of Pope Wash, south of MW-11, show that the basalt is highly fractured with sets of vertical fractures coupled with units showing a distinct horizontal parting.

Volcanics observed along the east side of the Guadalupe Mountains were examined during a half-day reconnaissance of the area. These are dominantly medium gray ash flow tuffs characterized by flattened brown to tan pumice fragments and by the presence of black basal vitrophyres. Based on the Questa area volcanic stratigraphy (unpublished section in Molycorp files), and the presence of the basalt unit and the ash flow tuffs unconformably below Santa Fe Formation sediments, it would appear that the basalt is either a tongue within the Santa Fe Formation or belongs to a sequence of older ashflow tuffs and basalts that partly underlie and intertongue with lower Santa Fe. Without further stratigraphic information, such as a lower contact for the basalt (no monitor well penetrates the unit), petrographic data or radiometric age information the stratigraphic position of the basalt can not be completely resolved.

Geologic Structure

Reconnaissance mapping, combined with a description of subsurface geology based on borehole data, indicates the presence of four northeast-trending faults displacing Santa Fe Formation sediments relative to various volcanic units (Figures 4 and 5). The apparent movement along some of the faults is down to the east (a strike-slip component can not be ruled out).

Vail (unpublished geologic map, 1987) mapped a northeast-trending high-angle fault along the east flank of the Guadalupe Mountains. This fault appears to follow the west side of a linear, northeast-trending wash, now largely covered by the tailings behind Dam No. 4. The ash

flow tuffs along the east flank of the mountain are moderately tilted along the fault line and in places unconformably overlain by Santa Fe Formation on younger gravels. The Santa Fe volcanic sediments and the basalt unit south of Dam No. 4 lie east of the fault and appear to be truncated by the structure. The ash flow tuffs probably correlate with volcanics that are either equivalent to the lower Santa Fe or older than the Santa Fe and indicate that the fault block to the east has moved relatively downward.

In the Work Plan for the tailings pond facility study (GeoWest Group, 1993), the linear, northeast-trending pattern of the ridge between Dam No. 1 and Dam No. 4 and the wash to the east of the ridge was identified. The wash between MW-1 and MW-2 was postulated to follow a high-angle fault because of the apparent displacement of the volcanic unit in MW-1 relative to the sediments (at the same elevation) in MW-2 (Figures 4 and 5) and because of the linearity of the wash. Wells MW-8 and MW-7, drilled 1,500 feet to the north of MW-1 and MW-2, show a similar structural relationship confirming a linear structure extending northeast along the wash. The volcanics were not encountered in MW-9, drilled to elevations well below the level of the volcanics in MW-1 (Figure 4). However, the volcanic unit does appear at deeper levels farther east in the lower part of Private Well-4 and in MW-10 (Figure 5). The conclusion is that the volcanic unit is offset along a fault that aligns with the wash and that the displacement is down to the east. The eastern block may be slightly tilted to the west.

The cross-sections (Figures 4 and 5) suggest a northeast-trending fault may also extend beneath the ridge that divides Dam No. 1 and Dam No. 4. This structure is based on the difference in elevation between the basalt outcrop immediately east of the I-X building and the top of the volcanic unit in MW-1 (a difference of 157 feet) and the linearity of the ridge. However, at the I-X outcrop, Santa Fe gravels unconformably overlie the basalt, and the basalt ridge could be an erosional feature. The presence of documented faults in the area with the same trend and the linearity of the ridge when coupled with the Tertiary extensional history related to the Rio Grande Rift favors a fault interpretation.

The volcanic sediments outcropping below Dam No. 4 and noted in several boreholes appear to be truncated by the basalt unit unconformably overlain by the Santa Fe Formation immediately east of the I-X building. The volcanic sediments (T_{sva}) were not observed in the exposures of the Santa Fe Formation east of the I-X building. The apparent truncation of the stratigraphic units and the absence of the volcanic sediments are the basis for the fault shown east of the I-X building on the geologic map.

Both the borehole data and the field exposures are concentrated in a narrow band along the front of Dam No. 1 and Dam No. 4. We believe that the structure and the lithologic units, particularly the basalt unit, extend northward beneath the tailings pond facility and southward at least to the Red River. Of hydrogeologic significance is:

1) the extension of the basalt unit in an east-west direction entirely beneath the tailings pond facility at fairly shallow depths; and

2) the northeast-trending structures juxtaposed lithologic units with significantly different hydrogeological properties (for example: clay in fault contact with fractured basalt).

3.0 HYDROGEOLOGY

3.1 Hydrogeologic Units

Part of the Santa Fe Formation can be divided into three sedimentary divisions of hydrogeological significance: the UAU, MAU, and LAU (discussed earlier in Section 2.2 - Stratigraphy; see also borehole logs in Appendix A and Figure 3). Each of these units, plus the volcanic unit, are discussed below. Well construction data is given in Appendix E.

Laboratory measurements of vertical hydraulic conductivity are given in centimeters per second (cm/sec). When these values are converted to gallons per day per square foot (g/d/ft^2), cm/sec is multiplied by a constant of 21220. Horizontal hydraulic conductivity was calculated by dividing transmissivity (derived from pump or recovery test data) by the saturated thickness of the aquifer. The monitor wells do not fully penetrate the aquifers, which results in greater amounts of drawdown and lower calculated transmissivity. Saturated thickness was estimated as the distance between static water level and the bottom of the screen (volcanic aquifer) or the thickness of the confined beds in the case of the LAU at MW-10. The calculations for seepage velocity are in feet/day which, when divided by 86,400 seconds (number of seconds in a day), becomes feet/second. Discharge equals velocity (feet/second) times the cross-sectional area (feet^2) resulting in a flow reported in cubic feet per second (cfs).

Upper Aquifer Unit (UAU)

The UAU is characterized by sandy gravels and gravelly sands, but lenses of clay occur. Wells MW-A, -B, -C, and -9A are screened in the UAU. MW-A (total depth 38 feet) and MW-C (total depth 14.5 feet) commonly have measurable water levels (water-level elevations of 7,282.7 feet and 7,312 feet, respectively). MW-B (total depth 18 feet) was dry in May 1993 but contained measurable water in August 1993 with a water-level elevation of 7,302.77 feet. These three wells are within 100 to 150 feet of each other. Yet the difference in water level-elevations are significant (for example: 20.07 feet between MW-A and MW-B, and 29.3 feet between MW-A and MW-C). Logs of these borings are not available, but the most likely explanation is that these piezometers have intercepted perched zones within the UAU. Evidence of possible perched zones in the UAU include:

- In MW-9A screened from 32 to 42 feet, sandy gravel at 35 feet is underlain by gravelly clays that might have caused perched conditions.
- Air rather than water was used to drill some of the monitor wells in parts of the UAU; field notes commonly reference moist and dry zones at multiple levels in the UAU suggesting possible perched zones.

- Field observations in the area of seepage barrier No. 2 revealed lines of willows or other plants at clay/gravel-sand contacts which are also indicative of perched water.

Although the UAU may be a zone of numerous perched water bodies above a static level in the underlying MAU, at this point, the UAU is not completely characterized. An irregularly shaped water table could occur in the lower UAU, with highs related to preferential discharge areas caused by variations in the alluvial stratigraphy (the elevation of gravelly units underlain by clay) and the distribution of heads beneath the tailings pond. [The term ***head*** refers to elevations of the water-level surface.] Differences in elevation, or head, cause ground water to flow from points of higher total head to lower total head.

Heads throughout the UAU are higher than those in the MAU, LAU, and volcanic unit such that, in all cases, a downward gradient exists. Perched water bodies, developed over lenses of clay in the UAU, contribute to the vertical infiltration of tailings pond water to the MAU. Water infiltrates the clayey sediments (gravelly clays, sandy clays) and also moves beyond the lateral edges of the clay lenses to infiltrate to lower levels. The ephemeral nature of perched zones is probably illustrated by MW-B, which is normally dry but contained measurable water in August. Seasonal or other longer term changes in heads beneath the tailings ponds may cause some zones to be ephemeral.

Middle Aquitard Unit (MAU)

The Middle Aquitard Unit (MAU) consists of interbedded tan to pale red brown sandy/silty clay and gravelly clay with minor lenses of sandy gravels and sands. MW-7A and MW-7B are screened entirely in the MAU. MW-2, MW-3, and MW-4 are screened in the upper MAU, but the upper part of the screened interval may include some UAU sediments. At MW-9, a series of split-tube drive samples (2-inch diameter, 6-inch brass tubes) were collected in the 55- to 56-foot and 85- to 86-foot intervals within the aquitard. The results of the laboratory analyses for vertical hydraulic conductivity, moisture content at saturation (porosity), and grain size distribution are given in Appendix B and are summarized below. The ASTM D 2434-68 fixed wall method was used to find the hydraulic conductivity.

Summary of Laboratory Analyses

Depth (in feet bgs)	Sample Description	Average Vertical Hydraulic Conductivity (cm/sec)	Moisture at Full Saturation (Porosity) (percent)
55.0 to 55.5	Sandy, Clayey, Gravelly Silt	2.25 E-04	18.5
55.5 to 56.0	----	8.26 E-05	22.4
56.0 to 56.5	Sandy, Clayey, Gravelly Silt	3.46 E-02	20.8
85.0 to 85.5	Gravelly, sandy Clayey Silt	2.32 E-03	21.4
85.5 to 86.0	----	4.98 E-07	20.3
Average:		7.4 E-03	20.68

The vertical hydraulic conductivity ranges from 4.98E-07 to 3.46E-02 cm/sec. These values could be lower than the corresponding horizontal hydraulic conductivity by up to at least a factor of 10 (Freeze and Cherry, 1979). If the set of values listed in Table 1 are raised by a factor of 10, the lowest measured value would correspond to a silty clay (Walton, 1988); however, grain size distribution was not determined for this sample. The highest measured value was for a gravelly silt. The hydraulic conductivity value, if raised to E-01, would correspond to a hydraulic conductivity for a silty sand (Walton, 1988). The lower vertical hydraulic conductivities (E-05 to E-07 cm/sec) would be typical of clayey sediment and are the reason the MAU is described as an aquitard. The lense-like character of the MAU and the wide range of vertical hydraulic conductivities indicate that ground water can, given the appropriate head conditions, move down to lower units and that the MAU is a leaky aquitard. These conductivities are sufficient for ground water to move laterally in the MAU.

Lower Aquifer Unit (LAU)

The Lower Aquifer Unit (LAU) consists of interbedded gravelly sand, sandy gravel, and clayey gravel with a lesser component of silt and clay. Three monitor wells are screened in the LAU: MW-7C, MW-9B, and MW-10. The LAU produced very little water during drilling which probably is the result of a significant clay component occurring as matrix and as thin beds in the unit.

An aquifer test (described in Appendix D) was conducted at MW-10 for an estimate of transmissivity. The LAU is a confined aquifer, since the top of the unit is at 86 feet bgs and the water level was at 39 feet. Step tests at 15 and 5 gpm were attempted, but the well pumped dry almost immediately. The test was conducted at a constant rate of 2 gpm for a period of 100 minutes at which time drawdown began to level off at 79 feet bgs. The test had to be stopped before drawdown dropped below pump level.

The constant rate test extended across three log cycles. Applying the Cooper/Jacob Straight Line Method for transmissivity (T) and dividing the T value (9.01 g/d/ft) by saturated thickness (50 feet), the resulting horizontal hydraulic conductivity (Kh) is 0.1802 g/d/ft^2 (8.5E-06 cm/sec). This value would correspond to a clayey fine sand or silt (Walton, 1988). Because the drawdown at MW-10 did not stabilize during the test period, the results from the Cooper-Jacob Straight Line Method cannot be considered accurate.

Another approach to estimating hydraulic conductivity (Kh) is to use the empirical relationship between specific capacity and transmissivity for a confined aquifer (Driscoll, 1986). Specific capacity (Q/S) would equal 0.025 (2/79) and T would equal 50.63 g/d/ft (2,025 x 0.025). The T value divided by saturated thickness (50 feet) results in a Kh value of 1.01 g/d/ft^2 (4.8E-5 cm/sec). This value also corresponds to a clayey fine sand or silt. Again, since maximum drawdown was not reached, the results may not accurately reflect the conductivity of the unit at MW-10. However, the log for MW-10 indicates that clayey gravels and sandy clays make up more than 50 percent of the saturated LAU and, consequently, a low Kh value might be anticipated.

Volcanic Unit

Based on the borehole log for MW-11 and nearby outcrops, the volcanic unit is composed of highly fractured vesicular and non-vesicular basalt. Volcanic breccias and volcanic sediments (at the top of the unit) are a very minor component of the section penetrated by MW-11. During drilling, after static water level was intercepted, the return water was estimated to be in excess of 200 gpm. Medium-grained sand used as a filter pack was carried into the fractures by the strong ground-water flow and ⅜-inch gravel was used instead.

Step, constant rate, and recovery tests were conducted at MW-11 (August 18, 1993). Test results are in Appendix D. Because the 8-inch schedule 80 PVC casing used at MW-11 has an inside diameter of 7.62 inches, the largest pump that could be used had a maximum rate of 660 gpm. A step test of 43 minutes duration at 530 gpm produced 2.21 feet of drawdown. The constant rate test was conducted at 660 gpm for a period of 140 minutes after which drawdown had stabilized. Water level oscillated several feet during the first 15 seconds (well storage effects) before a uniform drawdown curve could be generated. Using the Cooper-Jacobs Straight Line Method and the saturated thickness of the well, a hydraulic conductivity (Kh) of 34,472.9

g/d/ft^2 was calculated. This value is very high, corresponding with the higher Kh values published for permeable basalt flows (E04 to E05 g/d/ft^2) in Freeze and Cherry (1979). The recovery curve using the straight line equation resulted in a calculated Kh of 14,102.56 g/d/ft^2. Recovery tests are generally considered to give better estimates for Kh than pump tests since minor fluctuations in the pump discharge during pumping do not allow a constant rate to be achieved. Specific capacity can also be used to estimate transmissivity and hydraulic conductivity. From the drawdown curve, the maximum drawdown was 2.58 feet. The specific capacity (Q/S) was calculated to be 660/2.58, which is 255.81 g/ft. Using the empirical equation Q/S = T/1500 for an unconfined aquifer, T = 383,715.0 g/d/ft and Kh = T/b (b is the saturated thickness, 56.16 feet), which results in a Kh of 6,832.53 g/d/ft^2. The results from the specific capacity and recovery test gave horizontal hydraulic conductivities that range from 6,833 to 14,102 g/d/ft^2, which is well within published values for permeable basalts.

3.2 Flow Directions and Hydraulic Gradients

Because the Upper Aquifer Unit is likely characterized by several perched water zones, a distinct static water-level surface could not be recognized. Water levels for all of the wells screened only in the UAU were higher than water levels in the MAU, LAU, and volcanic units, thus indicating a downward gradient.

Flow direction and lateral hydraulic gradient for the MAU was based on solving a three-point problem based on water-level elevations in MW-7A, MW-2, and MW-3. Water levels for MW-2 and MW-3 may not be entirely representative of MAU levels because the 1979 logs show the screens extending across a gravel/clay contact. From comparison with the more detailed log of MW-9 (close to both wells), it appears that the top of the screens may include the lower 5 feet of the UAU at best. The flow direction for the MAU is S47°W with a hydraulic gradient of 0.02 foot/foot. The vertical hydraulic gradient within the MAU is downward and fairly steep at 0.97 foot/foot between MW-7A and MW-7B (head is 25.8 feet and the mid-screen to mid-screen length is 26.6 feet). The vertical gradient between the upper part of the MAU (MW-7A) and the LAU (MW-7C) is downward at 0.33 foot/foot. With respect to the lower MAU (MW-7B) and the LAU (MW-7C), the vertical gradient is upward -- indicating the LAU is either confined or within a regional ground-water discharge zone.

In the case of the Lower Aquifer Unit, using water-level elevations for MW-7, MW-9, and MW-10, the flow direction is S6°W at a hydraulic gradient of 0.026 foot/foot. Water-level elevations at MW-7B, MW-7C, and at MW-10 with respect to the adjacent MW-4 show upward gradients -- indicating the LAU is a confined aquifer or is in a ground-water discharge area. MW-9B is screened in the LAU and the water level is near the bottom of the screen at 142 feet bgs. Prior to well construction, the water level was slightly higher (130 feet bgs) and the well water was described as very muddy. It is possible that because of the presence of clay in the LAU, the lower screen has been partially plugged by clay/silt forced into the well bore during

development causing the low water level. The pre-construction water level at MW-9B was used to evaluate flow direction and gradient for the LAU.

Water-level elevations at MW-1, MW-8 and MW-11 were used to calculate a flow direction of S55°W and a hydraulic gradient of 0.029 foot/foot for the basalt aquifer. The southwesterly flow direction is similar to the regional flow directions reported by Dames and Moore, 1986. The water level used for MW-8 was measured at the completion of well construction and has not been confirmed by later measurements (due to partial collapse of the casing at a depth of 40 feet; the drilling contractor is scheduled to repair the well in September). The calculated gradient here is an order of magnitude higher than those reported from the Guadalupe Mountain study, but is probably caused by proximity to discharge along the Red River.

3.3 Seepage Velocity and Unit Discharge

Seepage velocity can be calculated from the equation

$$Vs = \frac{KI}{7.48\ ne}$$

where K = hydraulic conductivity,
I = hydraulic gradient,
ne = effective porosity,
7.48 = a constant that converts the result to feet/day when K is in $g/d/ft^2$

For the Lower Aquifer Unit, the hydraulic conductivity ranges from 0.1802 to 1.01 $g/d/ft^2$, the hydraulic gradient is 0.026 foot/foot, and the porosity was estimated at 20 percent. The seepage velocity as a function of the range in hydraulic conductivity ranges from 0.003 foot/day (3.5E-08 feet/second) to 0.018 foot/day (2.08E-07 feet/second).

The rate of flow through a LAU cross-section 50 feet thick and 100 feet in length (5,000 ft^2) can be calculated from the equation Q = VA, where V is the seepage velocity, A is the cross-sectional area, and Q is the discharge. Discharge ranges from 1.74E-04 to 1.04E-03 cfs for this LAU cross-section. Because of the high clay content in the upper LAU, it is likely that similar discharges could be calculated for parts of the MAU.

In the case of the basalt aquifer in the vicinity of MW-11, the seepage velocity ranges from 0.001 to 0.003 feet/second based on the hydraulic conductivities (6,832.53 and 14,102 $g/d/ft^2$), an hydraulic gradient of 0.029 foot/foot, and an effective porosity of 25 percent.

Effective porosity for permeable basalts range from 10 percent to over 50 percent. The 25 percent value is sufficiently conservative given the highly fractured state of the unit. Discharge through a 50-foot thick by 100-foot long cross-section of basalt ranges from 5 cfs at the lower seepage velocity to 15 cfs at the higher one.

3.4 Dilution Effects

An estimate of the effect of the high rate of underflow in the basalt unit with respect to downward moving ground water in the LAU impacted by tailings pond leachate can be calculated using seepage velocities and a mixing equation. Vertical seepage in the LAU will be largely controlled by the scattered clay units. Using the lowest and the average vertical hydraulic conductivity (0.011 and 1.569E+02 g/d/ft^2) from the laboratory results for the MAU (which contains similar lithologies) and a downward vertical gradient between MW-7A (MAU) and MW-7C (LAU) of 0.33 foot/foot, a range of vertical seepage velocity can be calculated. Porosity was estimated to be 20 percent.

$$Vs = \frac{KI}{7.48\ ne}$$

Seepage velocity ranges from 2.8 E-08 to 4.006 E-04 feet/second.

Vertical discharge from the LAU along a 10,000 ft^2 surface at the top of the basalt ranges from 2.71E-04 cfs to 4.006 cfs (Q = VA).

The dilution effect of the underflow in the basalt on ground water discharging from the LAU can be calculated from a mixing formula using the following equation:

$$Cm = \frac{(Cb\ Qb) + (C_{LA}\ Q_{LA})}{Qb + Q_{LA}}$$

where Cm = concentration in underflow due to mixing.

Cb = sulfate (SO_4) concentration in ground water from the basalt (MW-11 = 78 mg/L).

Qb = discharge through a 50-foot thick by 100-foot long cross-section of basalt.

C_{LA} = sulfate concentration (MW-7C = 613 mg/L) in the LAU.

Q_{LA} = vertical discharge over a 10,000 ft^2 surface (100 feet by 100 feet).

Using the range of discharges calculated for the LAU (Q_{LA}), the resulting sulfate concentration in the underflow through the basalt would range from 43.32 mg/L to 315.98 mg/L. These results suggest that underflow in the volcanic unit can dilute LAU seepage to concentrations well below State standards.

Since the Red River cuts through the Santa Fe Formation east of Questa Springs, the mixing equation was used to estimate the dilution effect of the Red River flow on a discharge from the LAU. Unpublished results from a 1993 study of the Red River by Vail Engineering gave a flow rate for the Red River above Questa Springs of 31.4 cfs and a sulfate concentration of 141 mg/L. Using the higher discharge from the LAU calculations (1.04E-03 cfs) and a sulphate concentration of 613 mg/L (MW-7C), the resulting mixing concentration would be 141.00 mg/L. Ground water discharging from the LAU into the Red River at the elevated sulfate concentration would have no effect on the water quality of the river. Discharge from the MAU would be in the same range as the upper LAU and similar dilution effects would be anticipated.

3.5 Chemistry

This discussion of the ground water chemistry is based on the analytic results of monitor well water samples collected as split samples with the New Mexico Environmental Department on August 17 and 18, 1993. The results of the chemical analyses are presented in Appendix C, Plate C-1. Additional chemistry data from documents in Molycorp files or from other consultants' reports are also presented in this discussion.

Plate C-2 shows a series of STIFF diagrams comparing the ground-water chemistry of the monitoring wells. MW-10, MW-11, and MW-CH belong to a different set of water quality measurements than the rest of the monitoring wells. Wells MW-10 and MW-11, which are located down-gradient from the tailings ponds, produce high quality water and are characterized by low Total Dissolved Solids (TDS) and low sulphate content. Water from these wells is of higher quality than a recently (April 1993) collected water sample form the Red River upstream of Questa Springs which showed a TDS at 268 mg/L and sulphate at 141 mg/L. The third well of this group is the change house well (MW-CH) which appears to be screened in the MAU and LAU (based on depth of the perforated intervals; no lithologic log is available). This well has a slightly higher TDS, a lower sulphate, and a higher sodium, potassium, and bicarbonate content compared to all of the other wells. MW-CH is located east of the tailings pond behind Dam No. 1 and, based on flow directions for the MAU and LAU, may be indicative of some of the upgradient water chemistry. The water chemistry at the remaining monitoring wells can be characterized as a high TDS, calcium-sulphate water.

The principal components of the tailings pond leachate that exceed New Mexico State Standards are Total Dissolved Solids (TDS) and sulphate (Appendix C, Plates C-1 and C-2). The higher concentrations of TDS and sulphate occur in wells located east of Dam No. 4 and south

and east of Dam No. 1 (see Figure 7). TDS and sulphate concentrations are high in the UAU and MAU units over the same area. Significantly, concentrations are lower in the LAU (MW-7C and MW-10) where the LAU (based on head relationships) appears to be a confined aquifer or part of a regional ground-water discharge zone. A conductivity measurement at MW-9B (LAU) gave a reading of 230 micromhos (08/18/93) similar to the measurement at MW-10 (240 micromhos) where the TDS and sulphate values are quite low. Although the head relationship between the MAU and the LAU are unknown at MW-9, the hydraulic gradient may be upward here as well (based on the low conductivity reading). The water sample at MW-9B was described as very muddy, so the reliability of the conductivity measurement is questionable.

The water-level surface within the tailings pond material (Molycorp data) slopes southward toward the Dam No. 1 at a hydraulic gradient of 0.22 foot/foot, significantly steeper than gradients within the Santa Fe units. MW-7C (LAU) has elevated concentrations of TDS and sulfate, compared to other LAU wells to the south of Dam No. 1. This condition suggests that heads in the UAU and MAU beneath the tailings ponds are higher than those in the underlying LAU and that some leachate-impacted ground water moves down into the LAU. Below the ponds, the bulk of the downward-moving leachate may be concentrated in perched zones within the UAU and may migrate south and west in the MAU. From the toe of the Dam No. 1 southward, the heads are such that the vertical gradient is upward between the LAU and the higher units and the TDS and sulfate remain concentrated in the UAU/MAU. With southward flow, TDS and sulfate are attenuated in the confined LAU, and monitor wells intercepting this unit have low concentrations of TDS and sulfate. The elevated concentrations of TDS and sulfate southeast of Dam No. 1 in MW-4 (UAU/MAU well) are likely caused by the head build up behind the east-trending ridge between the pond and MW-4.

Plate C-3 illustrates a series of histograms showing changes in TDS and sulfate for the period 1988 to 1993, for MW-1 through -4 and for MW-A, -B, and -C. Except for a decline in these components at MW-1, the changes at MW-2, -3, and -4 seem to fluctuate. This fluctuation may be a function of head changes in the pond area possibly related to year-to-year variations in natural recharge from melting snow. In contrast, MW-A and MW-C show a trend of increasing concentration with time. These increases occur in the shallow UAU, in wells constructed near the toe of Dam No. 1. The rising concentration may also result from changes in head. If the head within the pond material declines with time because no new tailings are accumulating, then residence time for the water within the pond sediment increases and concentrations may rise. Shallow wells near the toe of the dam would be particularly responsive to such changes.

South of Dam No. 4, the basalt aquifer, which has a high rate of underflow (see Section 3.4), lies at a shallow level beneath the tailings pond. The water sample from this well shows very low concentrations of TDS (267 mg/L) and sulfate (78 mg/L). This sulphate concentration is lower than that in the Red River north of Questa Springs (141 mg/L) according to unpublished data from Vail Engineering (1993). If tailings leachate is moving down into the basalt aquifer, it

is rapidly diluted by the southwesterly underflow in the basalt and the monitor well near the toe of the dam produces high quality water (for example, see STIFF diagram, Plate C-2).

Southeast of Dam No. 4, MW-1 is screened in the volcanic unit. This well has slightly elevated TDS (1,051 mg/L) and sulfate (540 mg/L) with respect to State standards. Head relationships between the volcanic unit and the overlying sediments are unknown here and it is possible that water from the overlying units has moved down into the aquifer. However the heads in the sedimentary section above the basalt at MW-8 was lower (132 feet bgs) than the head in the screened basalt (105 feet bgs) at the time of well construction. The water-level elevation for the basalt can not be confirmed until after MW-8 is repaired. If these head relationships are correct, this would indicate the basalt is confined east of Dam No. 4 and leachate-impacted water would be derived from upgradient sources where higher heads in the sediments might cause a downward gradient. It is also possible that, since flow in the MAU is to the southwest, some ground water having high TDS/sulfate concentrations might move across the fault zone into the basalt. Farther to the west, the normal underflow in the basalt is able to dilute tailings pond concentrations. Once MW-8 is repaired, water level and water quality can be measured and further clarification of the ground-water movement in this area may be possible.

There is some evidence that the fault east of MW-1 may exert some control on the movement of ground water toward the Red River. If this fault is projected to the river, it would approximately correspond to the Questa Springs area and the springs may be directly related to the structure. Water from Questa Springs is piped to the fish hatchery (approximately 4.5 downstream from the springs). This water has a TDS of 173 mg/L and a sulphate concentration of 80 mg/L (Vail Engineering data, 1993). These concentrations are comparable with LAU or volcanic aquifer water. It is possible that, with the southerly flow direction in the LAU, there is a component of flow parallel to the structure. The temperature of this water (8.3°C) is perhaps more compatible with shallow ground water than the temperature (16°C) of the deeper flow system in the volcanics (Vail Engineering data, 1993).

The deeper private wells (P-4 and P-5) south of the tailings ponds have good quality water in terms of TDS and sulfate. Although the P-4 data are fairly old (1988), TDS was 270 mg/L and sulfate was 88 mg/L. Well P-4 is a deep well (175 bgs), is partly screened in the volcanic unit, and is partly in the overlying sedimentary material. Well P-5 is 131 feet deep, which is enough to be into the LAU (perforated interval unknown). The TDS concentration for P-5 is 270 mg/L and sulphate is 112 mg/L (09/15/93). The high concentrations of TDS and sulfate in the shallower wells (67 to 90 feet bgs) may result from these wells being largely screened in the UAU and MAU. Existing logs for these wells are too generalized to be certain of the stratigraphy south of the monitor wells.

3.6 Summary of Hydrogeology

The major points derived from the analyses of the hydrogeological conditions in the area of the tailings ponds are:

- Underflow of high quality water in the regional volcanic aquifer that extends beneath the site appears, through dilution, to reduce the highest concentrations of pond-related TDS and sulfate in ground water from the LAU to levels well below State standards.

- Ground water that flows to the Red River from the MAU or LAU moves with sufficiently low seepage velocity and resulting low discharges that dilution is accomplished by the large flows that move through the channel of the river.

- Ground water from the LAU may be diverted toward the river along a hydrogeological boundary created by the fault east of MW-1 and appears to reach the surface at Questa Springs. Questa Springs water is a cold, low TDS/low sulphate water that is closer in chemistry to the LAU or possibly the deeper volcanic aquifer water (if there is an upward gradient along the fault) than to the MAU or LAU ground water.

- The bulk of the pond-related ground water is concentrated in the UAU and MAU. Concentrations of TDS and sulphate are affected by proximity to the tailings ponds, particularly Dam No. 1, and to heads developed within the tailings pond material and the underlying hydrogeological units.

- The LAU contains high quality water except near the toe of Dam No. 1. From the dam northward, heads may build up in the overlying units such that leachate may move down into the LAU. South of the dam, decreasing heads in the UAU and MAU and upward hydraulic gradient conditions in the LAU (higher heads relative to the overlying units) may result in no downward movement of pond-related water to the LAU.

- The deeper private wells (P4 and P5) are screened partly in the LAU and the volcanic unit and produce good quality water. The shallower private wells (less than 100 feet bgs) appeared to be screened mainly in the MAU or UAU. These wells have the high concentrations of TDS and sulfate.

4.0 RECOMMENDATIONS

Several responses may be implemented for further investigation and remediation of ground water containing TDS and sulfate concentrations associated with leachate from the tailings ponds. These responses fall into two categories: 1) intercepting and extracting seepage and ground water containing high levels of TDS and sulfate; and 2) monitoring the water quality to ascertain any changes in input as well as extraction processes. Although the water quality issues addressed in this report have focused on TDS and sulfate, the extraction of ground water having high levels of TDS and sulfate will also lead to reduction in other components that exceed State standards (for example: Molybdenum at MW-2 and MW-C; manganese at MW-2, MW-C, and MW-10; and fluoride at MW-C). Recommended responses to the issues addressed in the report are:

- Extract seepage waters in the UAU by expanding seepage barrier No. 2 system west of MW-1.

- Construct a line of wellpoints by auger drilling to a depth of 15 feet along an east-west line south of MW-2 to extract seepage from the UAU. The volume of seepage extracted will be used to evaluate feasibility of a seepage barrier or grout curtain.

- Site and construct four extraction wells (Figure 8) to remove impacted ground water primarily from the MAU. These wells would be sited within the current Molycorp property boundary. Extraction Well No. 1 would be constructed northwest of MW-1 and downgradient from the seepage barrier No. 2. Extraction Well No. 2 would be located northeast of MW-7. Extraction Well No. 3 would be located northeast of MW-2. Extraction Well No. 4 would be located just up slope from MW-4. Extractions Wells 2 and 3 might be more effective if they were located southwest of their plotted position. This relocation would depend on access or availability of the parcel of private land between MW-1 and MW-2. Extraction wells in this private parcel of land would require a downgradient monitor well with piezometers in the UAU, MAU, and LAU to monitor water quality changes.

- Prior to the construction of any of the proposed extraction wells, a pump would be placed in MW-4 to test the response of the MAU to pumping at different rates. Discharge from MW-4 will be transported in a tanker truck and disposed of through Outfall 002.

- Because the MAU is dominated by clay-rich units and contains only minor sandy gravel beds, constructing an effective extraction well will

require drilling an initial test well at Site 2 or 3 (see Figure 8). The test hole would be used to evaluate whether a well screened in water-bearing zones within the MAU would create a capture zone or cone of depression that effectively extracted MAU ground water. It may be necessary to consider screens in the LAU, which might more effectively dewater the MAU and extract high TDS/sulfate ground water. Because there is an upward gradient from the LAU to the MAU, pumping in the LAU should not cause degradation of the LAU, particularly if the extent of the dewatered zone is maintained within the MAU by controlling the pumping rate. If the LAU is used in this manner, it should be drilled to a depth greater than the existing monitor wells in order to get beyond the clay-bearing zone at the top of the unit.

- Water recovered from the extraction wells would either be added to the 002 Outfall system (if it did not exceed NPDES requirements), or it would be pumped to Dam 5A along the west side of the Dam No. 4 complex.

- A deep (approximately 400 feet bgs) test hole should be drilled along the ridge between Dam No. 1 and MW-4. The purpose of the borehole would be to:

  1) evaluate heads or water-level surface elevations for the three hydrogeologic units versus heads in the pond area and heads down-gradient of the test hole;

  2) define high TDS/sulfate producing zones using geophysical logging (for example, resistivity logs); and

  3) evaluate the stratigraphic section through both lithologic and geophysical logging.

- Continue to monitor water levels and water quality on a semi-annual basis. The purpose of the monitoring is to evaluate any changes in water chemistry related to head changes in the tailings pond area and to evaluate the effectiveness of the extraction system. Key sites along the Red River, in particular Questa Springs, should be part of this monitoring program. The results of the monitoring program should be reviewed on a semi-annual basis to evaluate the need for additional monitoring or extraction wells.

5.0 REFERENCES

Dames and Moore, 1986. Hydrogeologic and Chemical Analysis for the Proposed Guadalupe Mountain Disposal Site. Submitted to Molycorp/Questa Division, April 11, 1986.

Driscoll, F.G., 1986. Groundwater and Wells. 2nd Ed., published by Johnson Filtration System, Inc., St. Paul, Minnesota; 1089 p.

Freeze, R.A. and J.A. Cherry, 1979. Groundwater. Prentice-Hall, New Jersey, 604 p.

Galloway, W.E., and D.K. Hobday, 1983. Terrigenous Clastic Depositional Systems. Springer-Verlag, New York, 426 p.

GeoWest Group, 1993. Hydrogeologic Studies for Molycorp/Questa. Submitted to Molycorp Questa Division, May 4, 1993.

Vail, S.C., 1987. Geologic Map of the Guadalupe Mountain Area, Taos County, New Mexico. Unpublished map.

Walton, W.C., 1988. Principles of Groundwater Engineering. Lewis Publishers, Florida, 407 p.

SOUTH PASS RESOURCES, Inc.

REPORT DISTRIBUTION

Report Title: Hydrogeologic Evaluation of Tailings Ponds

Date: September 23, 1993

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FIGURES

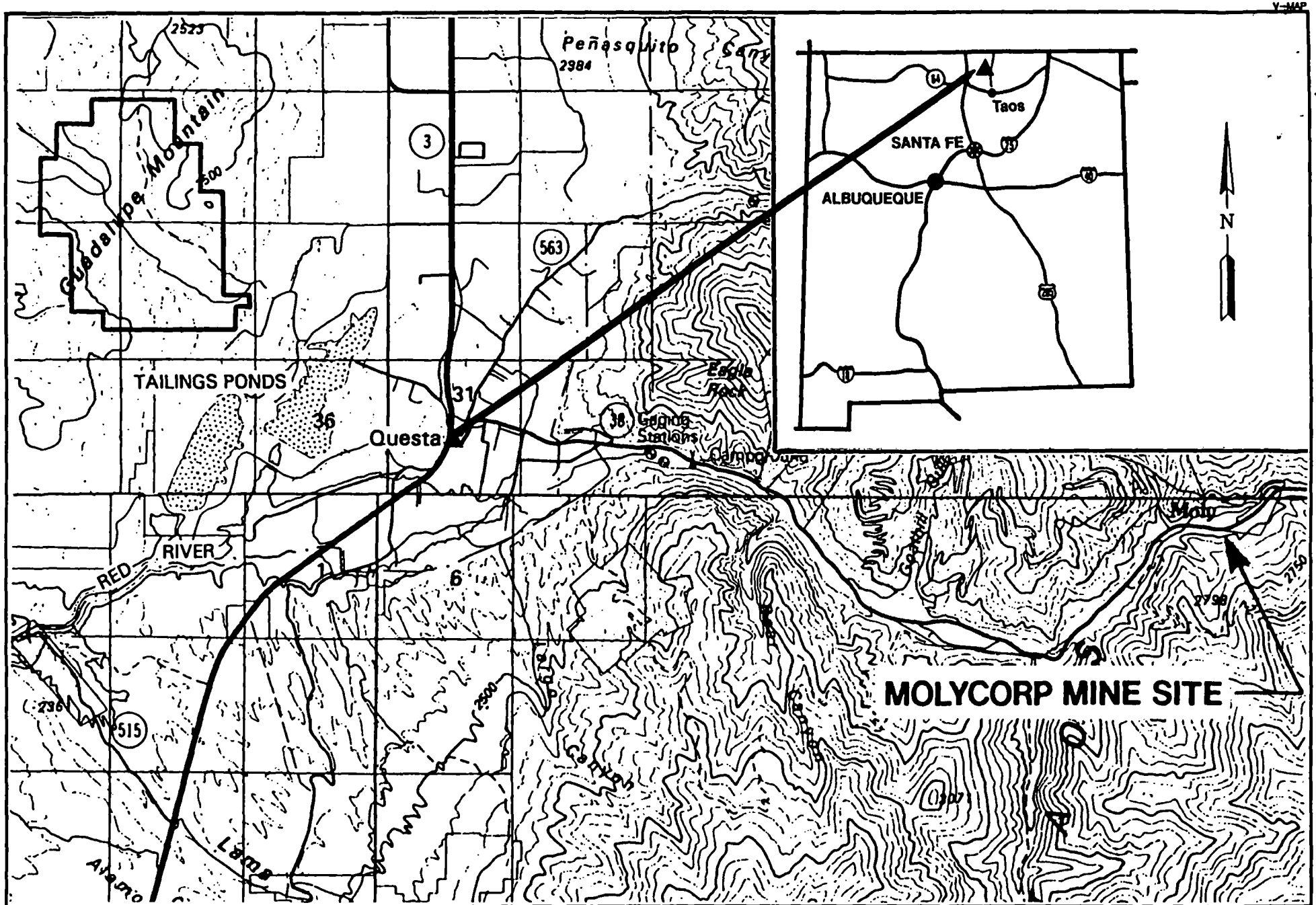


FIGURE: 1	The GeoWest Group Inc.				LOCATION MAP Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 5-25-93	AUTHOR: JCK	DRAWN BY: M.O'M.	

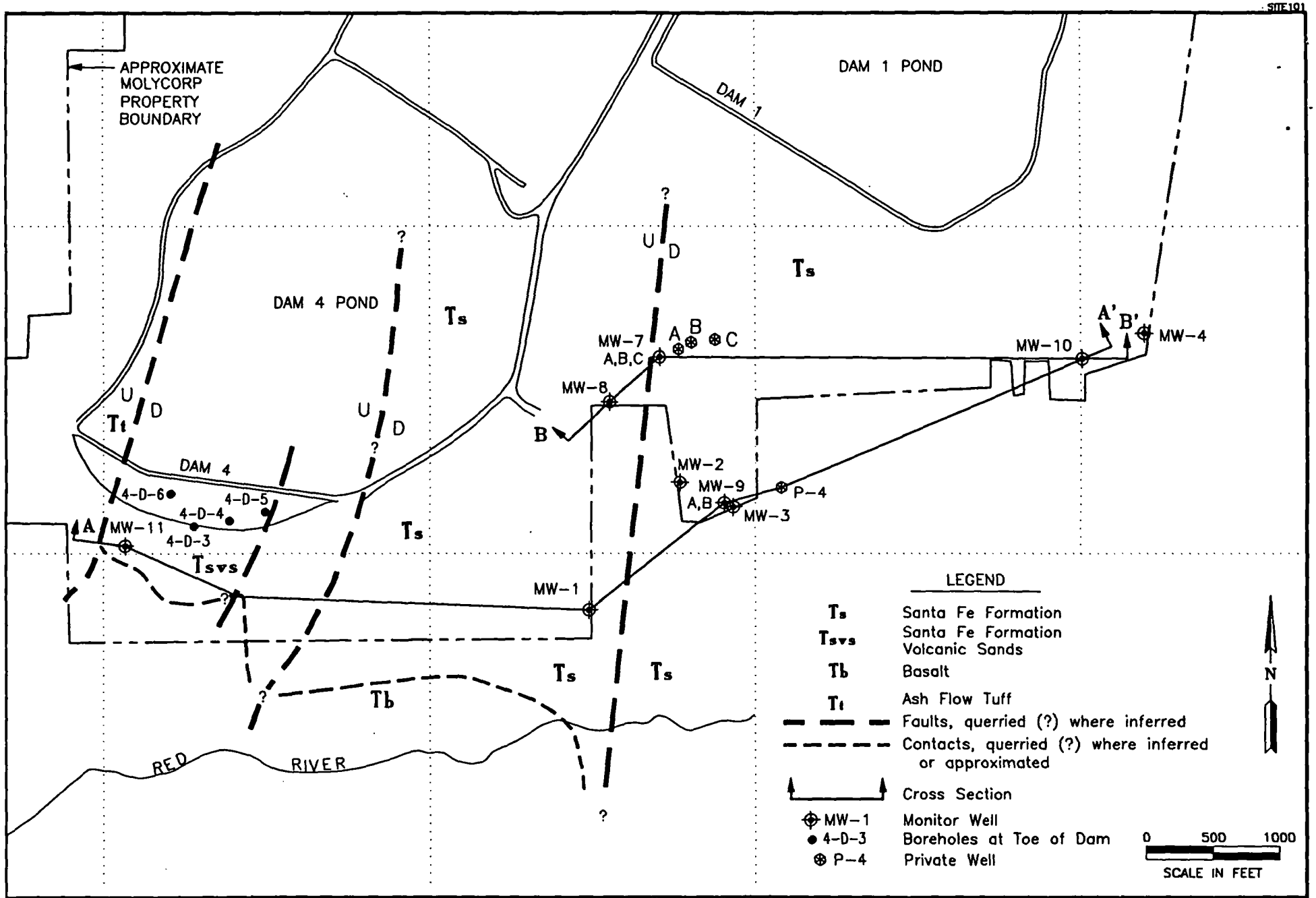
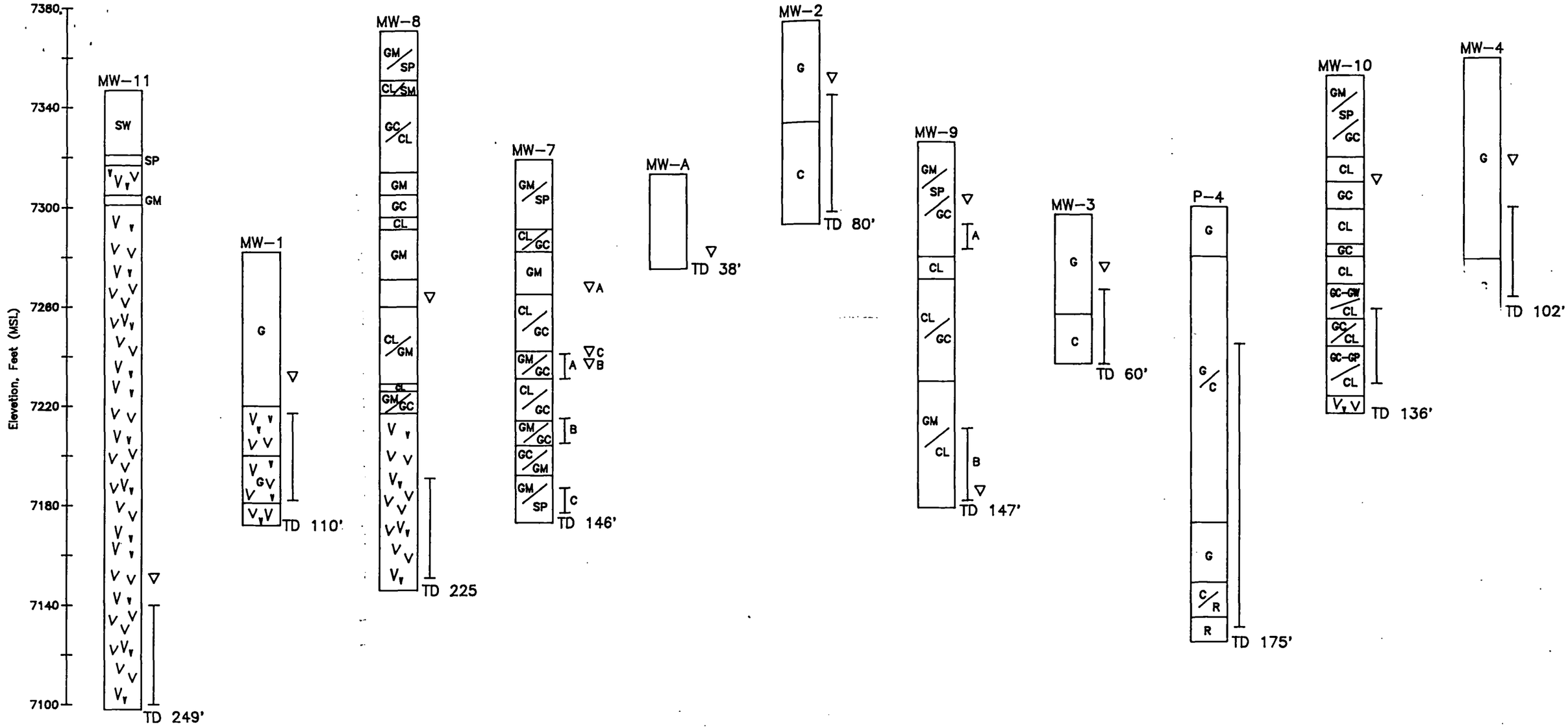


FIGURE: 2	SOUTH PASS RESOURCES, Inc.				GEOLOGIC MAP – TAILINGS PONDS AREA Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 9-20-93	AUTHOR:	DRAWN BY: M.O'M.	



LEGEND

CL	Silty Clays, Sandy Clays Gravelly Clays	SM	Silty Sand				
GC	Clayey Gravel	SP	Gravelly Sand to Poorly Graded Sand	C	Clay (1979 well)	▽	Water Level
GM	Sandy Gravel	SW	Well Graded Sand	G	Gravel (1979 well)		
GP	Poorly Graded Gravels (narrow size range) less than 5% Fines	GM/CL	Unit with Interbedded Sandy Gravel and Gravelly Clay and/or Clay (top unit more abundant)	R	Rock, possible Volcanic Unit	I	Position of Well Screen Letter refers to a Piezometer in a Multiple Completion Well
GW	Well Graded Gravels (wide range if sizes) less than 5% Fines			MW-11	Monitor Well		
				P-4	Private Well, 1964 no current water level		

0 20 40
VERTICAL SCALE IN FEET

BOREHOLE STATIGRAPHY
TAILINGS PONDS AREA
Molycorp, Inc.
Questa, New Mexico

SOUTH PASS RESOURCES, Inc.

PROJECT NO.:	DATE:	AUTHOR:	DRAWN BY:	FIGURE:
001-02	9-20-93	JLK	M.O'M.	3

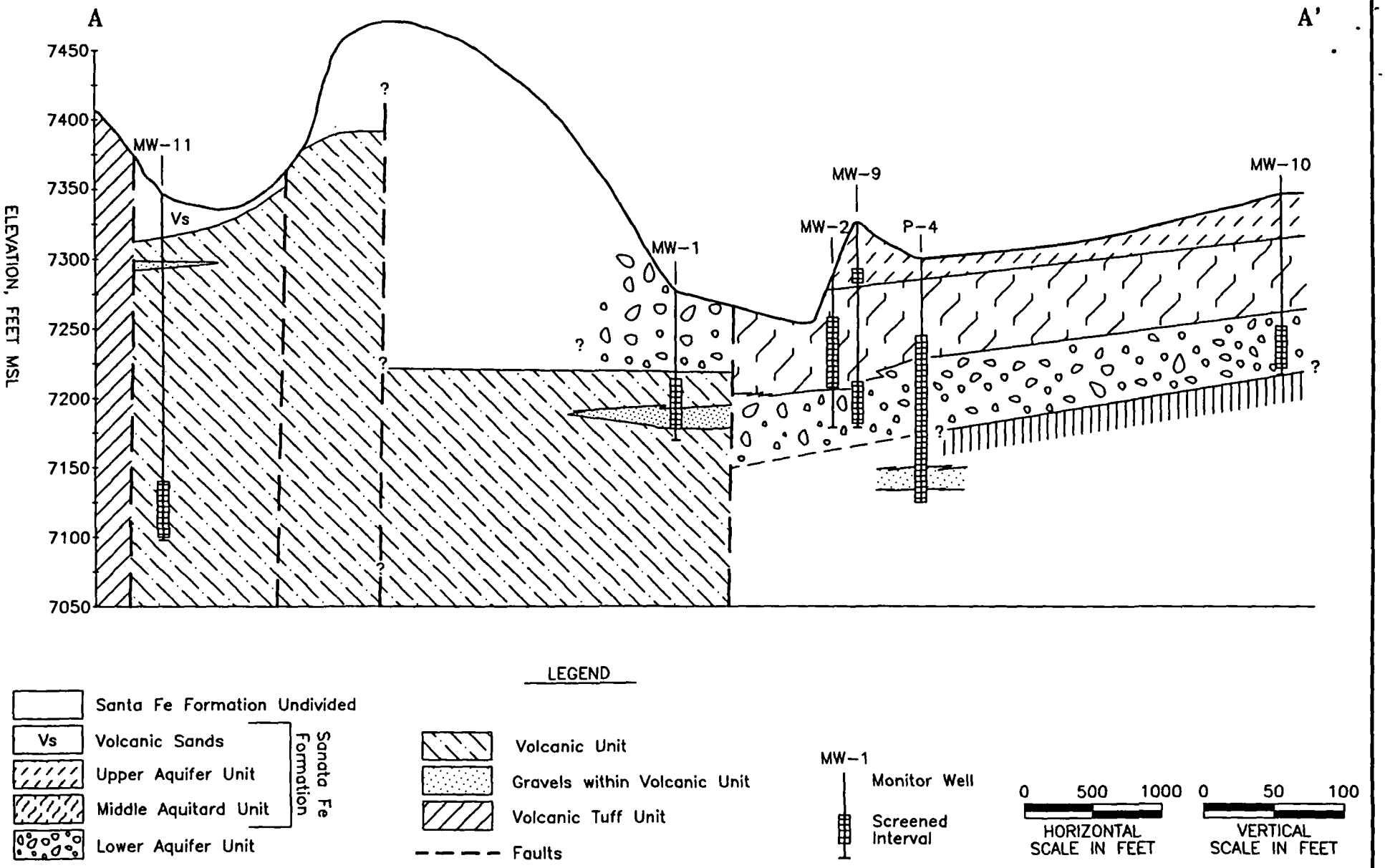
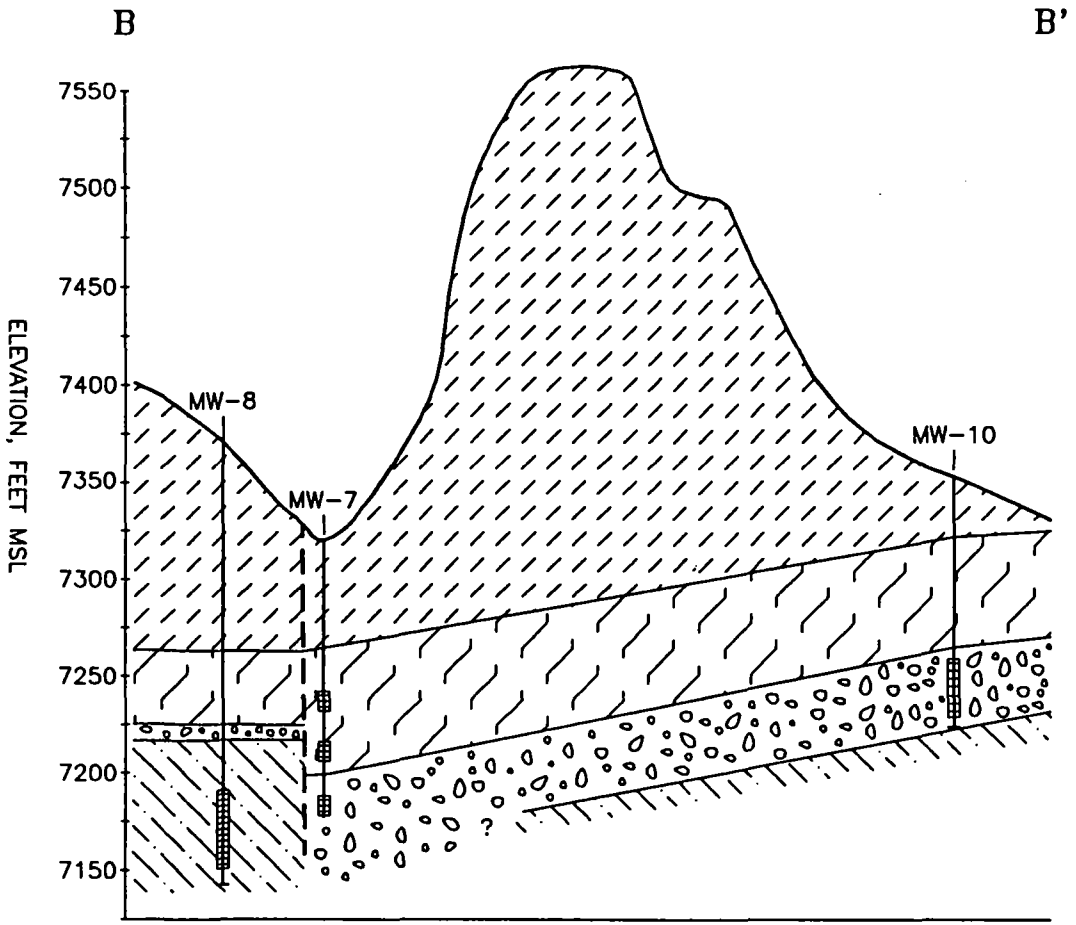


FIGURE: 4	SOUTH PASS RESOURCES, Inc.				GEOLOGIC CROSS-SECTION A – A'
	PROJECT No.: 001-02	DATE: 9-15-93	AUTHOR:	DRAWN BY: M.O'M.	Molycorp, Inc. Questa, New Mexico

XSEC-7



LEGEND

- Upper Aquifer Unit
- Middle Aquitard Unit
- Lower Aquifer Unit
- Volcanic Unit
- Faults
- MW-8 Monitor Well
- Screened interval
- 0 500 1000 HORIZONTAL SCALE IN FEET
- 0 50 100 VERTICAL SCALE IN FEET

FIGURE: 5

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-02	9-15-93		M.O'M.

GEOLOGIC CROSS-SECTION B - B'

Molycorp, Inc.
Questa, New Mexico

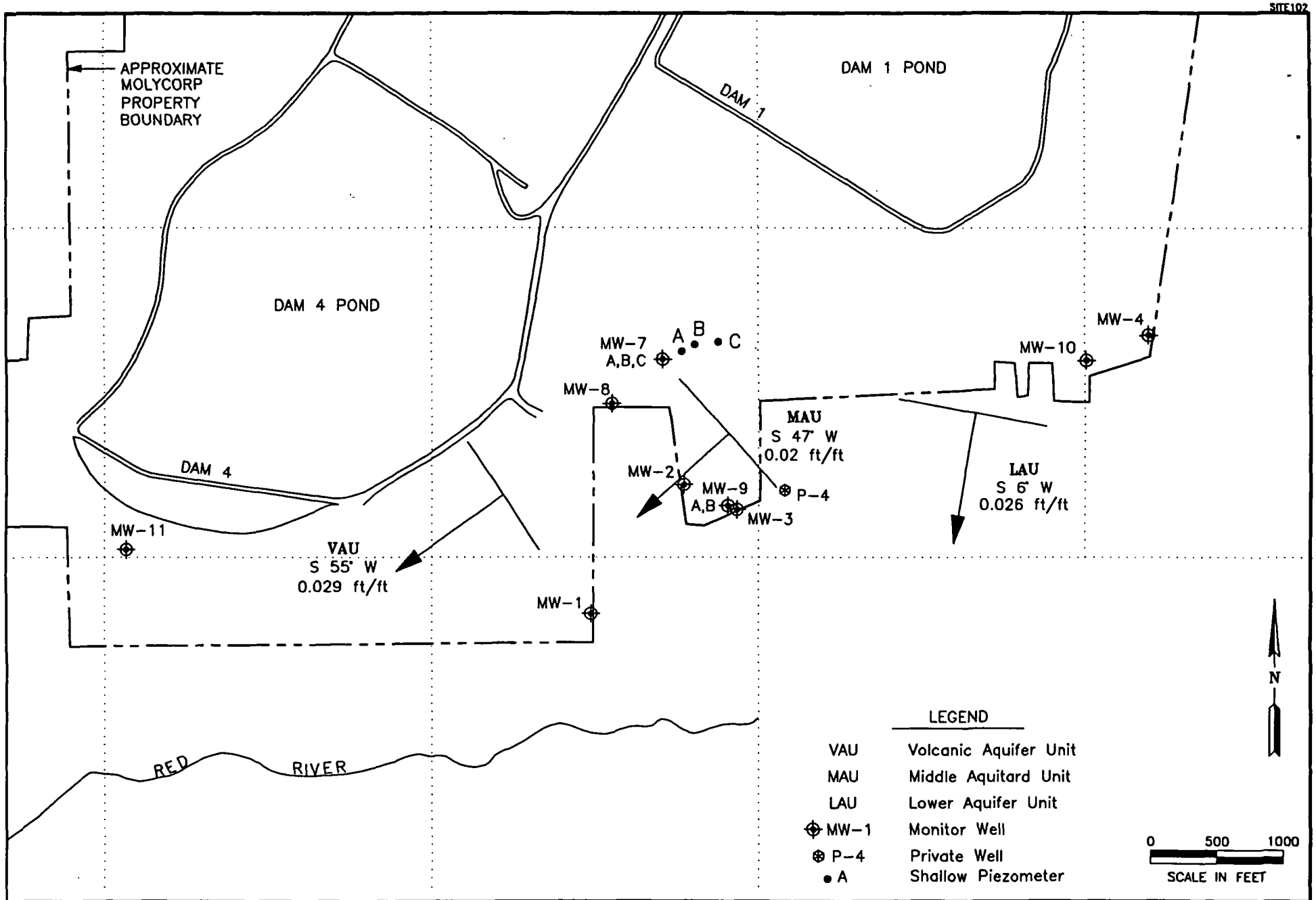


FIGURE: 6

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-02	9-15-93	JCL	M.O'M.

GROUND-WATER FLOW DIRECTIONS & GRADIENTS
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Questa, New Mexico

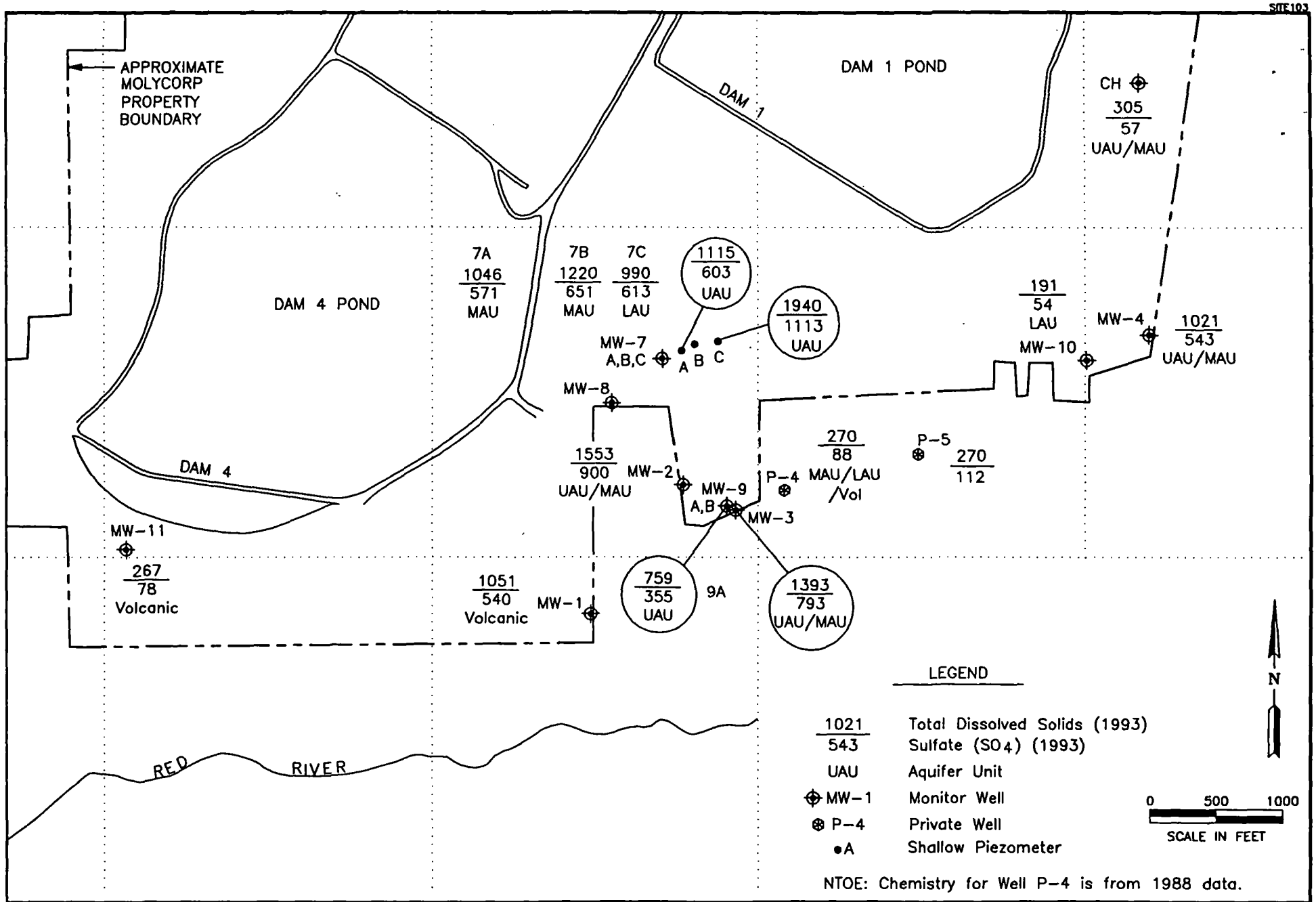

FIGURE: 7

SOUTH PASS RESOURCES, Inc.

PROJECT No.:	DATE:	AUTHOR:	DRAWN BY:
001-02	9-15-93		M.O'M.

MONITOR WELL GROUND-WATER CHEMISTRY

Molycorp, Inc.
Questa, New Mexico

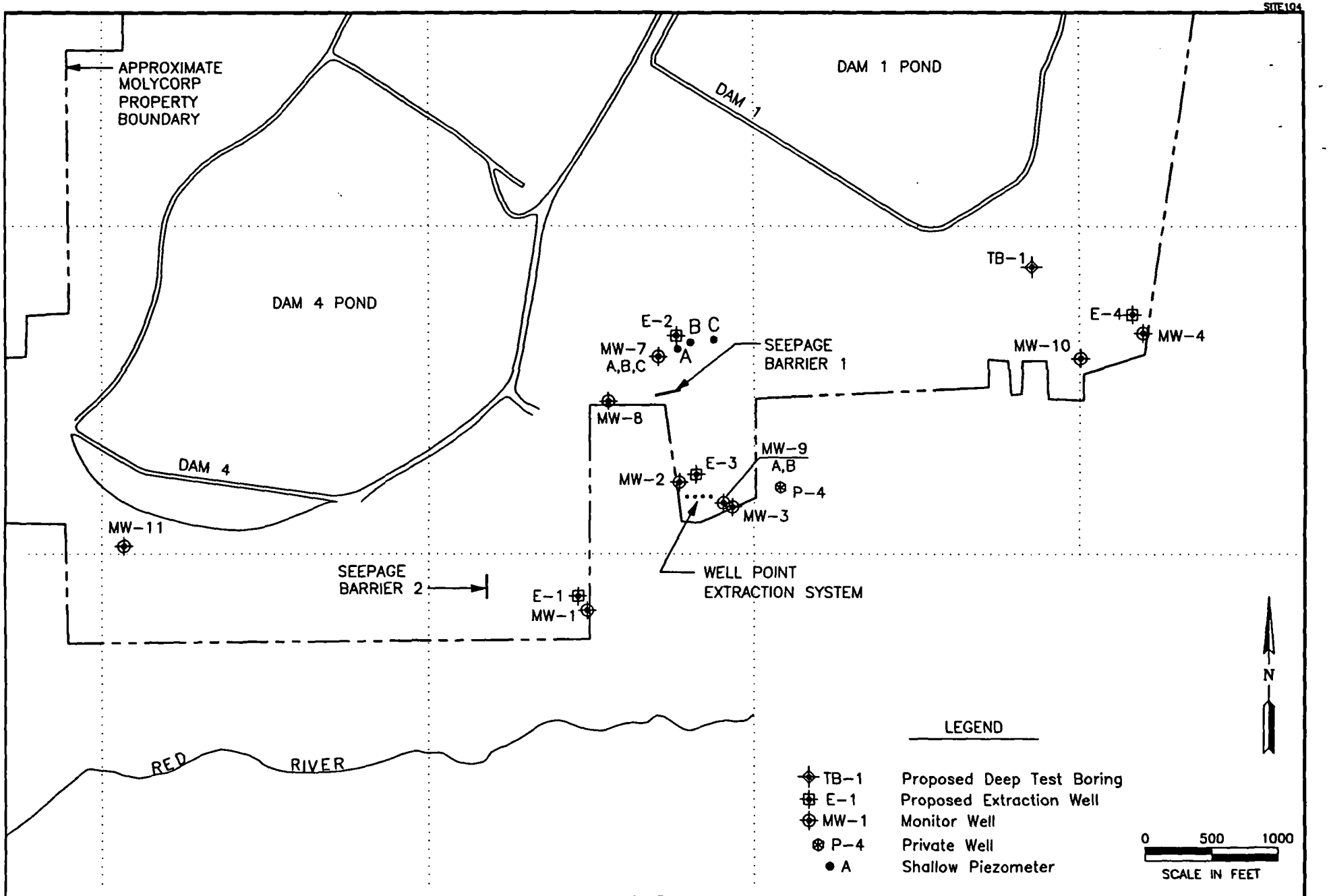

FIGURE: 8	SOUTH PASS RESOURCES, Inc.				EXTRACTION SYSTEM – TAILINGS PONDS AREA Molycorp, Inc. Questa, New Mexico
	PROJECT No.: 001-02	DATE: 9-20-93	AUTHOR:	DRAWN BY: M.O'M.	

APPENDIX A

APPENDIX A

BOREHOLE LOGS

Boring Log No. MW-7

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7320.10

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
TAN SILTY SANDY GRAVEL	GP		0, 5			Final groundwater depths: 7A = 56.5' 7B = 82.3' 7C = 74.3'
TAN SILTY GRAVELLY SAND with tan silty sandy gravel (80%), 1 to 2 inches. No observable moisture.	SP		10, 15	☒		
SILTY SANDY GRAVEL & SILTY GRAVELLY SAND layers alternate, with possible clay layers. Gravels appear to be fine-grained volcanics with a trace of plutonic sand from 25' to 26'; sand is brown, clayey and coarse-grained. Well-rounded brown to tan clay balls appear to be silty gravelly clay.	GM		20, 25	☒		
SILTY GRAVELLY SAND & SILTY CLAY moist, with trace gravel.	GM CL					
REDDISH BROWN SILTY SANDY CLAY	CL					
BROWN CLAYEY SANDY GRAVEL moist, poorly sorted angular (volcanics), with interbedded clay.	GC		30, 35	☒		
BROWN SANDY GRAVEL & WHITE QUARTZ no clay, volcanic fragments.	GP		40			

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TAILINGS PONDS AREA
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Questa, New Mexico

Figure No.
A1

Boring Log No. MW-7

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7320.10

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
			40			
gravelly/clayey mudballs at surface	GP		45, 50, 55			Losing water to formation above 55 feet
BROWN GRAVELLY CLAY fine-grained silicates (volcanic) up to 1 1/2", clay is silty.	CL					
BROWN CLAYEY GRAVEL light to dark fine-grained volcanics, small to large, up to 1 1/2".	GC		60			
REDDISH BROWN GRAVELLY CLAY fine-grained, 1/4" to 1/2".	CL		65, 70, 75			
coarse gravel at 77' to 78'			80			

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Questa, New Mexico

Figure No.
A1a

Boring Log No. MW-7

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7320.10

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
	CL		80	☒		
SANDY GRAVEL coarse-grained, mixed volcanics (80%) and plutonic (20%).	GM		85			Yielding water at 20 gpm
REDDISH BROWN GRAVELLY CLAY interbedded coarse sandy gravel.	CL GM		90	☒		
			95			
			100	☒		
coarse gravel yielding water			105			Yielding water at 3 gpm at 107-108'
RED-BROWN GRAVELLY CLAY some green clay lenses, reddish brown clay is dense, dry and hard.	CL		110	☒		
coarse gravel with large 2" chips of clay, with red and green volcanic pieces 115' to 118'			115			
			120			

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Figure No.
A1b

Boring Log No. MW-7

PROJECT NUMBER: 001-02
DATE: 9-20-93
LOGGED BY: W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer
HOLE DIA.: 12" in.
SAMPLER: Grab
INITIAL GW DEPTH: ft.
FINAL GW: ft.
HOLE ELEV.: 7320.10

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
gravel is red, green brown and black, volcanic fragments, clay is dense and dry	CL		120	☒		
CLAYEY GRAVEL gravel up to 70-80%.	GC		125			Yielding water 5 to 8 gpm
TAN COARSE SANDSTONE with volcanic and granitic fragments, sandstone chips from 1/4" to 2", 35% quartz, 35% sandstone, 30% volcanics.	SS		130	☒		
SANDY GRAVEL/GRAVELLY SANDS no indication of cementation; 35% granitic, 35% sandstone, 30% red and black volcanic fragments - 132' to 133'. 30% sandstone, 30% red and black volcanics - 133' to 138'. Volcanic gravel below 138'.	GP		135 140	☒		
			145			
Boring terminated at 146.0 feet. See Monitor Well Completion Detail.			150 155 160			

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TAILINGS PONDS AREA
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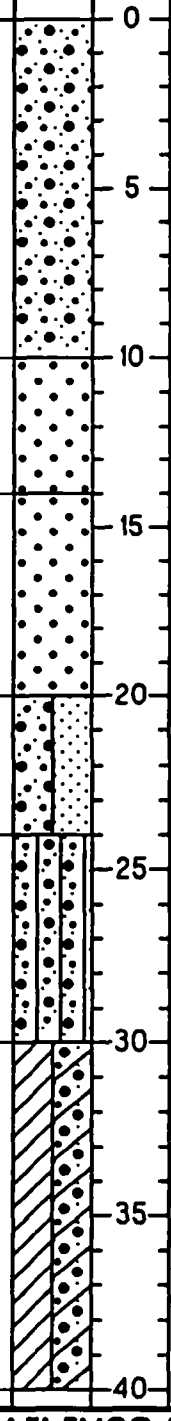
Figure No.
A1c

Boring Log No. MW-8

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 105 ft. **HOLE ELEV.:** 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
BROWN GRAVEL well sorted rounded gravel, very coarse-grained sand, cobble fragments with volcanics, gneisses, and quartz fragments.	GW		0 5			
COBBLES tightly packed, mostly chips.	GP		10			
DARK BROWN SANDY GRAVEL damp, pebble and cobble chips with medium to very coarse-grained sand.	GP		15			
BROWN SANDY GRAVEL TO GRAVELLY SAND very moist, with clay stringers.	GW SP		20			
BROWN SANDY GRAVEL very coarse gravel (1 1/2" to 2 1/2") with medium- to very coarse- grained sand and clay stringers.	GM		25			
BROWN GRAVELLY CLAY & CLAYEY GRAVEL moist, interbedded clay and gravel with very fine- to fine-grained sand and silt; chips indicate very coarse gravel or cobbles in some layers.	CL GC		30 35 40			



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TAILINGS PONDS AREA
MOLYCORP, Inc.
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Figure No.
A2

Boring Log No. MW-8

PROJECT NUMBER: 001-02
DATE: 9-20-93
LOGGED BY: J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer
HOLE DIA.: 12" in.
SAMPLER: Grab
INITIAL GW DEPTH: ft.
FINAL GW: 105 ft.
HOLE ELEV.: 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
SANDY CLAY moist, with layers of gravelly clay, very fine- to medium-grained sand , 20%-30% gravel up to 1 1/2".	CL		40 45			
PALE TO RED-BROWN-SANDY CLAY with stringers of clayey gravel and pebbles up to 1 1/2", 20%-30% sand in clay and silt.	CL		50 55			
BROWN SANDY GRAVEL coarse, 1 to 1 1/2" rounded to subrounded chips or larger clasts, sand is medium- to very coarse-grained, subrounded, some stringers of gravelly sand, gravel 60%, sand 40%.	GW		60 65			
BROWN GRAVELLY SANDY CLAY layers of sandy clayey gravel.	CL		70 75 80			

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TAILINGS PONDS AREA
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Questa, New Mexico

Figure No.
A2a

Boring Log No. MW-8

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 105 ft. **HOLE ELEV.:** 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
SANDY CLAY	SC		80			
BROWN SANDY GRAVEL very fine gravel with interbedded gravelly sand layers. Sand is very fine- to coarse-grained.	GW		85 90			
BROWN SANDY CLAYEY GRAVEL medium grained gravel, very fine- to medium-grained sand, 20% clay- silt matrix.	GC		95			
BROWN GRAVELLY SANDY CLAY pale red-brown clay from 104' to 108'.	CL		100 105			
BROWN SANDY GRAVEL very coarse-grained sand and <3/4" gravel.	GW					
BROWN CLAYEY GRAVEL very fine gravel (subrounded).	GC		110			
PALE RED-BROWN SILTY SANDY CLAY 75 % very fine- to fine-grained sand, with less than 10% gravel.	CL		115 120			

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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A2b

Boring Log No. MW-8

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 105 ft. **HOLE ELEV.:** 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
with thin gravel layers	CL		120			
BROWN SANDY GRAVEL 60%-70% rounded to subrounded gravel, some chips 1 1/2". Sand is medium- to very coarse-grained.	GP		125			
BROWN SANDY GRAVEL TO GRAVELLY SAND gravel up to 2", fine- to very coarse-grained sand.	GP SW		130 135			
PALE BROWN CLAY with silt, sand and less than 10% gravel.	CL					
BROWN SANDY GRAVEL	GW		140			
PALE RED-BROWN SANDY SILTY CLAY interbedded layers of clayey gravel and gravelly clay, sand is very fine- to fine-grained.	CL		145 150			
BASALT chips of vesicular and nonvesicular basalt, 155' to 165'			155 160			

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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A2c

Boring Log No. MW-8

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 105 ft. **HOLE ELEV.:** 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
brown clay chips, vesicular basalt, red and white quartz chips 165' to 175'			160, 165			
BASALT WITH WHITE FELDSPAR PHENOCRYSTS white quartz chips.			170, 175, 180			
VOLCANIC CONGLOMERATE with minor fragments of quartz and pegmatitic material.			185, 190, 195, 200			

SOUTH PASS RESOURCES, Inc.
Environmental Consultants
Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A2d

Boring Log No. MW-8

PROJECT NUMBER: 001-02
DATE: 9-20-93
LOGGED BY: J.C. Kepper & W.J. Opfel
DRILL RIG: Air Rotary Casing Hammer
HOLE DIA.: 12" in.
SAMPLER: Grab
INITIAL GW DEPTH: ft.
FINAL GW: 105 ft.
HOLE ELEV.: 7371.46

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
BLACK BASALT			200, 205, 210, 215, 220, 225			
Boring terminated at 225 feet. See Monitor Well Completion Detail.			230, 235, 240			

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Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A2e

Boring Log No. MW-9

PROJECT NUMBER: 001-02
DRILL RIG: Air Rotary Casing Hammer
INITIAL GW DEPTH: ft.

DATE: 9-20-93
HOLE DIA.: 12" in.
FINAL GW: ft.

LOGGED BY: W. J. Opfel
SAMPLER: Grab
HOLE ELEV.: 7326.00

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
TAN SILTY SANDY GRAVEL	GM		0			
TAN SILTY SANDY CLAY	CL		5			
			10	☒		
GRAVEL	GP					
TAN SILTY SANDY CLAY	CL					
TAN SANDY GRAVEL/GRAVELLY SAND moist, 80% volcanic gravels, 20% granitic gravels.	GP/SP		15			
			20	☒		
CLAYEY SANDY GRAVEL moist, clay content increase with depth.	GC		25			
			30	☒		
BROWN CLAYEY GRAVEL/GRAVELLY CLAY moist.	GC/CL		35			
			40			

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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A3

Boring Log No. MW-9

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7326.00

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
			40			
BROWN GRAVELLY CLAY moist.	GC CL CL		45			
BROWN CLAY moist, thin gravelly clay layers.	CL		50			
BROWN CLAYEY GRAVEL moist. coarse sand and trace of gravel/gravelly clay, 62' to 65 feet	GC		55 60			
BROWN GRAVELLY CLAY moist, thin layers of clayey gravel.	CL GC		65 70			
BROWN CLAYEY GRAVEL moist.	GC		75			
BROWN GRAVELLY CLAY moist.	CL		80			

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Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A3a

Boring Log No. MW-9

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7326.00

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
	CL		80	☒		
BROWN CLAY moist, with trace gravel.	CL					
BROWN GRAVELLY CLAY	CL		85			
			90	☒		
GRAVEL with trace clay.	GW		95			
			100	☒		Losing return water at 10 gpm - 103' to 14'
CLAYEY GRAVEL/GRAVELLY CLAY gravel contains volcanic and granitic fragments.	GC CL		105			
			110	☒		
BROWN CLAYEY GRAVEL with trace clay.	GC GW		115			making water, 1 to 2 gpm - 115' to 125'
			120			

SOUTH PASS RESOURCES, Inc.	TAILINGS PONDS AREA MOLYCORP, Inc. Questa, New Mexico	Figure No.
Environmental Consultants Phoenix, Arizona		A3b

Boring Log No. MW-9

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** W. J. Opfel
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** ft. **HOLE ELEV.:** 7328.00

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
BROWN GRAVELLY CLAY	GC GW CL		120, 125, 130	☒ ☒		
BROWN CLAYEY GRAVEL volcanic and white granitic fragments.	GC		135, 140, 145	☒		
Boring terminated at 147 feet. See Well Completion Detail.			150, 155, 160			

SOUTH PASS RESOURCES, Inc.
Environmental Consultants
Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A3c

Boring Log No. MW-10

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** K. Zappetello
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 39 ft. **HOLE ELEV.:** 7353.20

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
BROWN TO TAN SANDY SILTY CLAYEY GRAVEL sand is subrounded to angular, consists of quartz weathered basalt and granitic fragments.	GM		0 5			
BROWN TO TAN GRAVELLY SAND with silt and clay, gravels are well rounded.	SP SC		10	☒		
BROWN TO TAN GRAVELLY SANDY CLAY larger clasts of granitic fragments. gravels are rounded to angular	CL		15 20	☒		
BROWN TO TAN SANDY SILTY CLAYEY GRAVELS gravels are rounded to angular and consist of basalt and granitic fragments.	GC		25 30	☒		
SANDY CLAY moist, with well sorted subrounded gravels.	CL		35 40			

SOUTH PASS RESOURCES, Inc.
Environmental Consultants
Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A4

Boring Log No. MW-10

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** K. Zappetello
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 39 ft. **HOLE ELEV.:** 7353.20

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
	CL		40	☒		
BROWN SANDY GRAVELS with minor clay, gravels are rounded to angular.	GC		45 50	☒		
BROWN GRAVELLY SANDY CLAY alternating gravels and clay, gravels are 1" to 2" diameter; clay balls are present.	CL		55 60 65	☒		
BROWN TO TAN CLAYEY SILTY SANDY GRAVEL gravels are rounded to angular.	GC		70	☒		
BROWN GRAVELLY SANDY CLAY alternating gravel and clays, gravels are well rounded 1/4" to 1/2".	CL		75 80			

SOUTH PASS RESOURCES, Inc.
Environmental Consultants
Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A4a

Boring Log No. MW-10

PROJECT NUMBER: 001-02
DRILL RIG: Air Rotary Casing Hammer
INITIAL GW DEPTH: ft.

DATE: 9-20-93
HOLE DIA.: 12" in.
FINAL GW: 39 ft.

LOGGED BY: K. Zappetello
SAMPLER: Grab
HOLE ELEV.: 7353.20

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
	CL		80	☒		
			85			
BROWN TO TAN CLAYEY GRAVEL	GC					
BROWN TO TAN GRAVEL rounded to subangular clasts.	GW		90	☒		
BROWN TO TAN GRAVELLY SANDY CLAY	CL		95			
BROWN SANDY GRAVEL gravels 1/2" to 1".	GP		100	☒		
BROWN SANDY CLAYEY GRAVEL/GRAVELLY SANDY CLAY	GC CL		105			
BROWN TO TAN GRAVEL subrounded to angular.	GP					
BROWN SANDY CLAYEY GRAVEL/GRAVELLY SANDY CLAY	GC CL		110	☒		
			115			
BROWN GRAVELLY SANDY CLAY gravels rounded, 1/2" to 1".	CL		120			

SOUTH PASS RESOURCES, Inc.
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Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A4b

Boring Log No. MW-10

PROJECT NUMBER: 001-02
DATE: 9-20-93
LOGGED BY: K. Zappetello
DRILL RIG: Air Rotary Casing Hammer
HOLE DIA.: 12" in.
SAMPLER: Grab
INITIAL GW DEPTH: ft.
FINAL GW: 39 ft.
HOLE ELEV.: 7353.20

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
	CL		120	☒		
			125			
BASALT						
Boring terminated at 129.0 feet. See Monitor Well Completion Detail.			130			
			135			
			140			
			145			
			150			
			155			
			160			

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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A4c

Boring Log No. MW-11

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper
DRILL RIG: Air Rotary Cassing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 191 ft. **HOLE ELEV.:** 7347.12

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
BROWN CLAYEY SAND well sorted sand, coarse gravel, gray volcanic rock. Volcanic rock clasts show varying amounts of weathering.	SC		0 10 20			
BLACK BASALT andesitic sand, minor quartz grains, rounded very coarse-grained sand, poorly sorted.	SP					
OLIVINE/AUGITE BEARING BASALT chips up to 2".			30 40			
BROWN VOLCANIC CONGLOMERATE rounded 1 inch pebbles of basalt in quartz and volcanic sand matrix; fine- to coarse-grained sand.	GW					
BLACK TO GRAY OLIVINE AUGITE BASALT pale blue silica coating on fracture surfaces; chips 1/2" or less. Thin gray volcanic sandstone within the interval.			50 60			
BLACK TO GRAY OLIVINE AUGITE BASALT highly vesicular rock; chips 1" or less.			70 80			

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Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A5

Boring Log No. MW-11

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 191 ft. **HOLE ELEV.:** 7347.12

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
			80			
			90			
MEDIUM GRAY VOLCANIC finely crystalline with pink to light brown vuggy bands, flow bands; chips 1 1/2" or less.			100			
			110			
MEDIUM GRAY OLIVINE AUGITE BASALT minor 2" chips of red volcanic breccia gray volcanic fine scoraceous texture; chips up to 2".			120			
			130			
MEDIUM TO DARK GRAY VOLCANIC BASALT trace olivine/augite, scoraceous to dense; chips 1" or less (1/4" common).			140			
some fine white feldspar crystals in basalt; red fracture coatings; chips 1" or less (1/4" common).			150			
			160			

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Phoenix, Arizona

TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A5a

Boring Log No. MW-11

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper
DRILL RIG: Air Rotary Cassing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 191 ft. **HOLE ELEV.:** 7347.12

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
chips 1" or less (1/2" common).			160			
MEDIUM GRAY-PINK TO BROWN VOLCANIC ROCK vuggy bands, flow bands, large 3/4" chip common.			170			
			180			
DARK GRAY TO BLACK BASALT trace augite/olivine; trace brown to pink vuggy bands; large 3/4" chips common.			190			
			200			
strong flow water at joint change at 212 feet chips up to 1"			210			
			220			
			230			
			240			

SOUTH PASS RESOURCES, Inc.
Environmental Consultants
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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A5b

Boring Log No. MW-11

PROJECT NUMBER: 001-02 **DATE:** 9-20-93 **LOGGED BY:** J.C. Kepper
DRILL RIG: Air Rotary Casing Hammer **HOLE DIA.:** 12" in. **SAMPLER:** Grab
INITIAL GW DEPTH: ft. **FINAL GW:** 191 ft. **HOLE ELEV.:** 7347.12

DESCRIPTION	USCS CLASS	GRAPHIC LOG	DEPTH	SAMPLE	BLOWS/FT.	REMARKS
			240			
some chips look glossy; chips 1" to 1 1/2" common making 200 to 300 gpm, hole caving badly.			250			
Boring terminated at 256.0 feet. See Monitor Well Completion Detail.			260			
			270			
			280			
			290			
			300			
			310			
			320			

SOUTH PASS RESOURCES, Inc.
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TAILINGS PONDS AREA
MOLYCORP, Inc.
Questa, New Mexico

Figure No.
A5c

APPENDIX B

APPENDIX B

RESULTS OF LABORATORY ANALYSES OF AQUITARD SAMPLES

SHB AGRA INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT: SOUTHPASS RESOURCES

LOCATION: MW-9 @ 55'-55.5'

PROJECT NO: LT93-3971
W O NO: 2
LAB NO: 9
DATE: 8/17/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	94
1/2 IN	75
3/8 IN	70
1/4 IN	68
#4	67
#8	67
#10	66
#16	66
#30	65
#40	64
#50	62
#100	58
#200	51.4

MOISTURE CONTENT = 2.5%

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT	SOUTHPASS RESOURCES	JOB No	LT93-3971
SAMPLE	MW-9 @ 55'-55.5'	W. O. No	2
		LAB NO.	9
		DATE	8/9/93

HYDROMETER TEST REPORT (ASTM D-422)

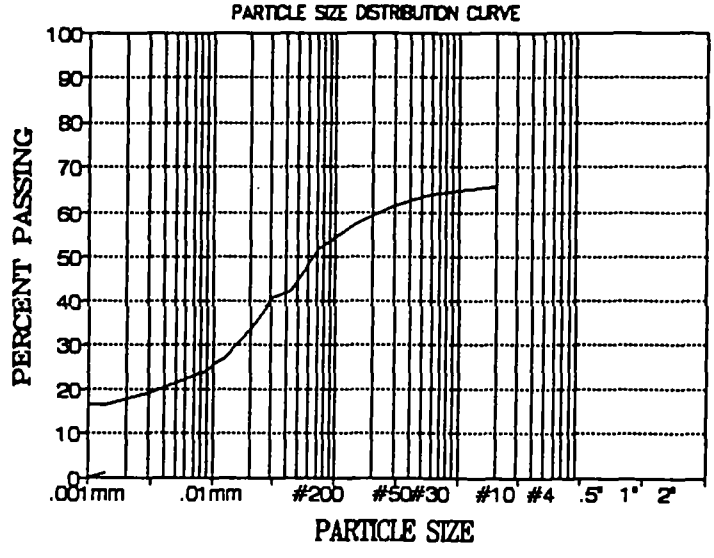
WEIGHT OF SAMPLE DISPERSED	48.70	SPECIFIC GRAVITY OF SOLIDS	2.541
PERCENT PASSING #10 SIEVE	66.00		

CALCULATED RESULTS

PARTICAL SIZE (DIA. mm)	0.0440	0.0314	0.0205	0.0122	0.0088	0.0063	0.0032	0.0014
PERCENT SAMPLE TESTED	63.8	61.7	51.3	40.8	36.4	34.2	29.5	25.2
PERCENT TOTAL SAMPLE	42.1	40.8	33.8	26.9	24.0	22.6	19.5	16.6

SIEVE ANALYSIS AFTER HYDROMETER ACCUMULATED % PASSING

#200	#100	#50	#40	#30	#16	#10
52	57	62	63	64	65	66



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SHB AGRA, INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SOURCE:	MW-9 @ 55'-55.5'	**W.O. NO.**	2
		LAB NO.	9
		DATE	8/8/93

SPECIFIC GRAVITY OF SOIL (ASTM D854)

O.D. WT. OF SOIL	49.85
WT OF FLASK + H2O	363.38
WT FLASK+H20+SSD	393.61
SPECIFIC GRAVITY	2.541

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SAMPLE:	MW-9 @ 55'-55.5'	**W.O. NO.**	2
		LAB NO.	9
		DATE	8/1/93

PERMEABILITY TEST (ASTM D2434-68) FIXED WALL

WET DENSITY	123.3	pcf
DRY DENSITY	104.0	pcf
VOLUME	271.840	cc
INITAL MOISTURE	9.2%	
MOISTURE @ SATURATION	18.5%	

HEAD inches	PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
16.06	0	107	5880	3.44E-04	3.55E+02
13.00	0	21	2100	2.32E-04	2.40E+02
12.13	0	16	2520	1.55E-04	1.61E+02
11.13	0	26	4260	1.67E-04	1.73E+02

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PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SAMPLE:	MW-9 @ 55.5'-56'	**W.O. NO.**	2
		LAB NO.	10
		DATE	8/1/93

PERMEABILITY TEST (ASTM D2434-68) FIXED WALL

WET DENSITY	125.5	pcf
DRY DENSITY	102.5	pcf
VOLUME	204.658	cc
INITAL MOISTURE	13.1%	
MOISTURE @ SATURATION	22.4%	

HEAD inches	HEAD PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
9.65	0	22	5700	9.40E-05	9.73E+01
20.00	0	16	2400	7.70E-05	7.96E+01
19.06	0	24	3120	9.32E-05	9.64E+01
18.00	0	21	4140	6.61E-05	6.84E+01

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT: SOUTHPASS RESOURCES

LOCATION: MW-9 @ 56'-56.5'

PROJECT NO: LT93-3971
W O NO: 2
LAB NO: 11
DATE: 8/17/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	100
1/2 IN	87
3/8 IN	79
1/4 IN	77
#4	76
#8	75
#10	75
#16	74
#30	73
#40	72
#50	70
#100	66
#200	58.2

MOISTURE CONTENT = 2.2%

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT	SOUTHPASS RESOURCES	**JOB No**	LT93-3971
SAMPLE	MW-9 @ 56'-56.5'	**W. O. No**	2
		LAB NO.	11
		DATE	8/9/93

HYDROMETER TEST REPORT (ASTM D-422)

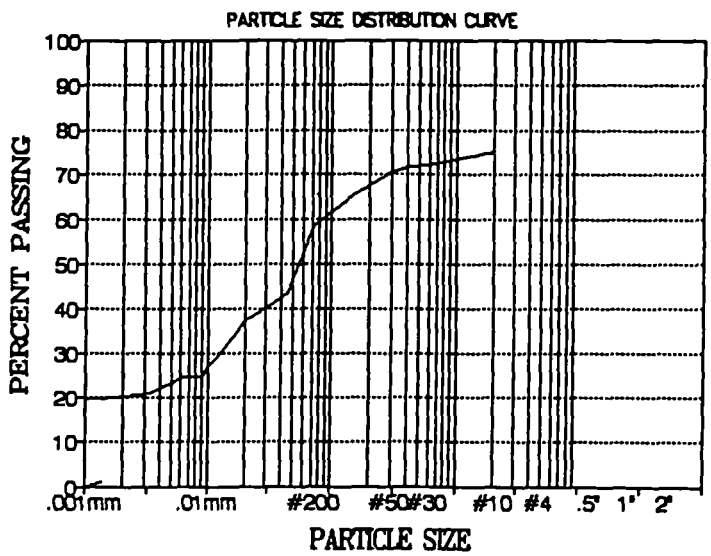
WEIGHT OF SAMPLE DISPERSED	50.27	**SPECIFIC GRAVITY OF SOLIDS**	2.531
PERCENT PASSING #10 SIEVE	75.00		

CALCULATED RESULTS

PARTICAL SIZE (DIA. mm)	0.0448	0.0319	0.0205	0.0123	0.0090	0.0063	0.0032	0.0014
PERCENT SAMPLE TESTED	57.9	54.0	49.9	39.6	33.2	33.2	27.6	26.5
PERCENT TOTAL SAMPLE	43.4	40.5	37.4	29.7	24.9	24.9	20.7	19.9

SIEVE ANALYSIS AFTER HYDROMETER ACCUMULATED % PASSING

#200	#100	#50	#40	#30	#16	#10
59	65	70	72	72	74	75



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SHB AGRA, INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SOURCE:	MW-9 @ 56'-56.5'	**W.O. NO.**	2
		LAB NO.	11
		DATE	8/8/93

SPECIFIC GRAVITY OF SOIL (ASTM D854)

O.D. WT. OF SOIL	52.09
WT OF FLASK + H2O	366.4
WT FLASK+H20+SSD	397.91
SPECIFIC GRAVITY	2.531

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SHB AGRA INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SAMPLE:	MW-9 @ 56'-56.5'	**W.O. NO.**	2
		LAB NO.	11
		DATE	8/1/93

PERMEABILITY TEST (ASTM D2434-68) FIXED WALL

WET DENSITY	115.9	pcf
DRY DENSITY	95.9	pcf
VOLUME	228.729	cc
INITAL MOISTURE	13.3%	
MOISTURE @ SATURATION	20.8%	

HEAD inches	PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
10.50	0	63	40.02	3.76E-02	3.89E+04
7.50	0	63	55.98	3.76E-02	3.89E+04
11.00	0	42	25.02	3.82E-02	3.96E+04
7.00	0	42	60	2.51E-02	2.59E+04

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SHB AGRA INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT: SOUTHPASS RESOURCES

LOCATION: MW-9 @ 85'-85.5'

PROJECT NO: LT93-3971
W O NO: 2
LAB NO: 12
DATE: 8/17/93

MECHANICAL SIEVE ANALYSIS (ASTM C136)

SIEVE SIZE	% PASSING
2 IN	100
1 1/2 IN	100
1 IN	100
3/4 IN	100
1/2 IN	96
3/8 IN	90
1/4 IN	84
#4	83
#8	81
#10	81
#16	80
#30	78
#40	77
#50	75
#100	70
#200	63.5

MOISTURE CONTENT = 8.7%

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT	SOUTHPASS RESOURCES	JOB No	LT93-3971
SAMPLE	MW-9 @ 85'-85.5'	W. O. No	2
		LAB NO.	12
		DATE	8/9/93

HYDROMETER TEST REPORT (ASTM D-422)

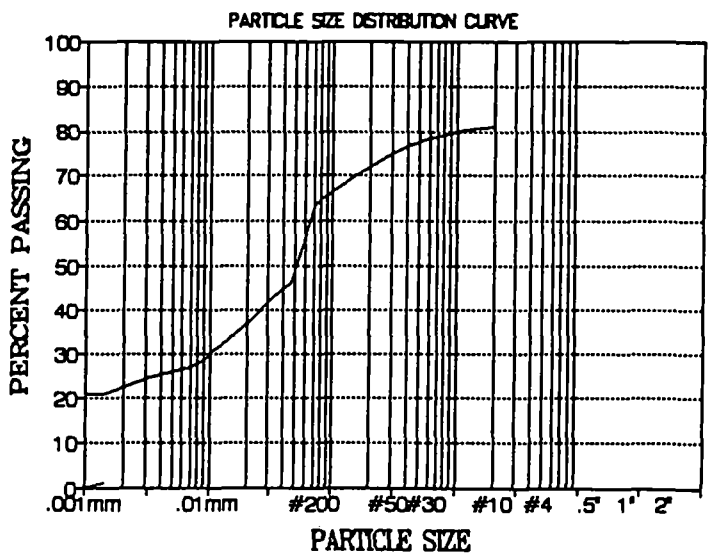
WEIGHT OF SAMPLE DISPERSED	47.77	SPECIFIC GRAVITY OF SOLIDS	2.498
PERCENT PASSING #10 SIEVE	81.00		

CALCULATED RESULTS

PARTICAL SIZE (DIA. mm)	0.0460	0.0329	0.0212	0.0126	0.0090	0.0065	0.0032	0.0014
PERCENT SAMPLE TESTED	57.0	52.7	46.2	39.6	35.3	33.0	30.4	25.9
PERCENT TOTAL SAMPLE	46.2	42.7	37.4	32.1	28.6	26.7	24.6	21.0

SIEVE ANALYSIS AFTER HYDROMETER ACCUMULATED % PASSING

#200	#100	#50	#40	#30	#16	#10
64	70	75	77	78	80	81



AGRA
Earth & Environmental Group

SHB AGRA, INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SOURCE:	MW-9 @ 85'-85.5'	**W.O. NO.**	2
		LAB NO.	12
		DATE	8/8/93

SPECIFIC GRAVITY OF SOIL (ASTM D854)

O.D. WT. OF SOIL	40.11
WT OF FLASK + H2O	353
WT FLASK+H20+SSD	377.05
SPECIFIC GRAVITY	2.498

AGRA
Earth & Environmental Group

SHB AGRA INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SAMPLE:	MW-9 @ 85'-85.5'	**W.O. NO.**	2
		LAB NO.	12
		DATE	8/1/93

PERMEABILITY TEST (ASTM D2434-68) FIXED WALL

WET DENSITY	123.4	pcf
DRY DENSITY	101.7	pcf
VOLUME	225.828	cc
INITAL MOISTURE	13.4%	
MOISTURE @ SATURATION	21.4%	

HEAD inches	PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
15.00	0	42	255	2.75E-03	2.85E+03
13.50	0	21	181.8	2.14E-03	2.22E+03
12.50	0	21	172.2	2.44E-03	2.53E+03
11.31	0	29	331.02	1.93E-03	2.00E+03

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ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	SOUTHPASS RESOURCES	**JOB NO.**	LT93-3971
SAMPLE:	MW-9 @ 85.5'-86'	**W.O. NO.**	2
		LAB NO.	13
		DATE	8/1/93

PERMEABILITY TEST (ASTM D2434-68) FIXED WALL

WET DENSITY	133.0	pcf
DRY DENSITY	110.6	pcf
VOLUME	265.282	cc
INITAL MOISTURE	14.9%	
MOISTURE @ SATURATION	20.3%	

HEAD inches	PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
13.13	23	26	25560	5.03E-07	5.21E-01
18.22	28	33	28500	4.62E-07	4.78E-01
16.25	28	50	50700	3.96E-07	4.09E-01
19.50	28	21	13380	6.29E-07	6.51E-01

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APPENDIX C

APPENDIX C

RESULTS OF LABORATORY

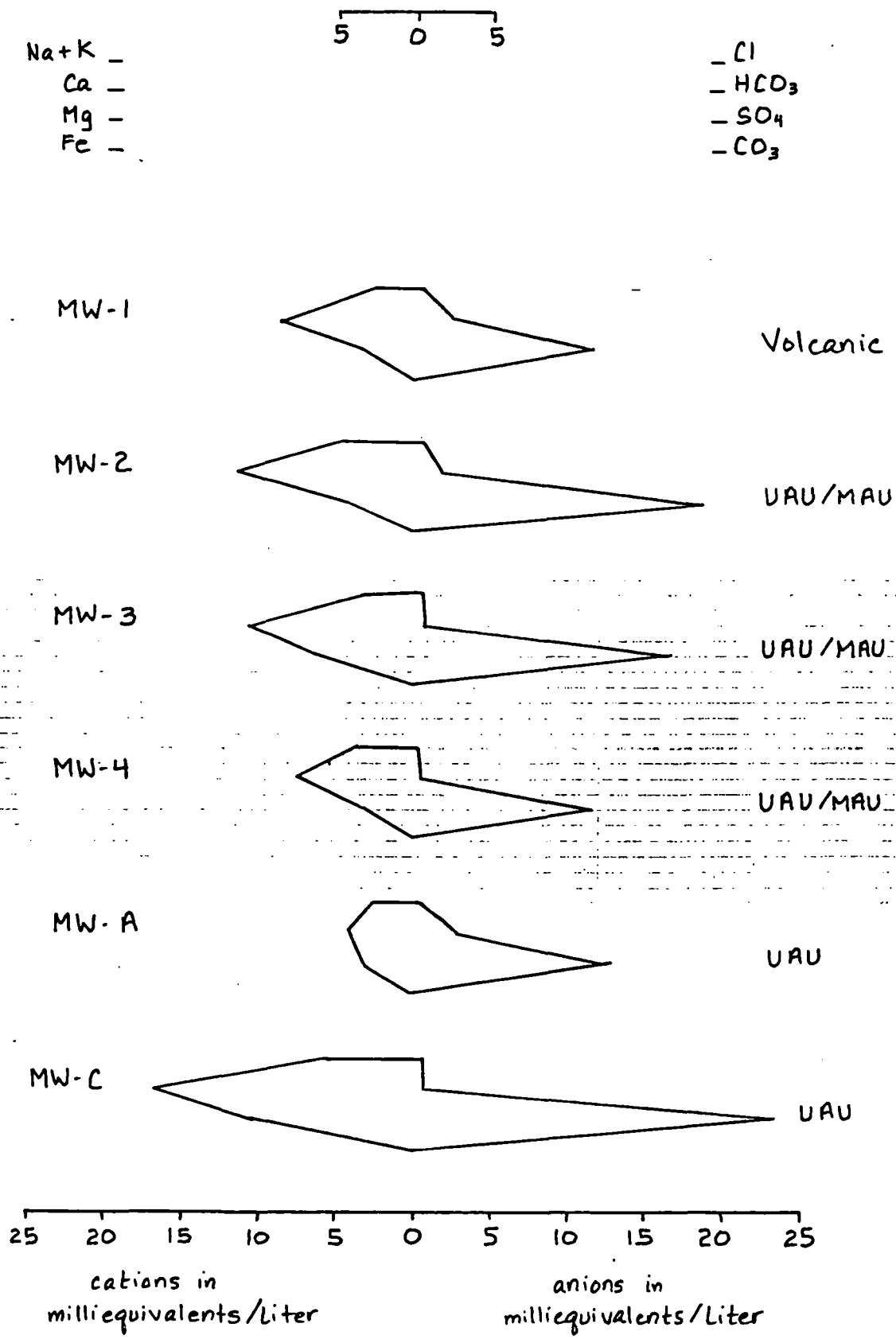
ANALYSES OF WATER SAMPLES

(AUGUST 17-18, 1993)

TABLE C-1
MONITOR WELL CHEMISTRY

Boring or Monitor Well #	MW-1	MW-2	MW-3	MW-4	MW-A	MW-C	MW-7A	MW-7B	MW-7C	MW-9A	MW-10	MW-11	CH
pH	7.9	7.7	7.4	7.3	7.4	7.2	7.1	8.9	10.6	7.6	8.1	8.1	7.7
TDS	1051	1553	1393	1021	1115	1940	1046	1220	990	759	191	267	305
Sulfate	540	900	793	543	603	1113	571	651	613	355	54	78	57
Sodium	56	102	72	86	58	117	41	80	81	47	36	32	98
Potassium	3.5	4.7	3.5	1.4	2.4	6.5	1.9	<1.0	157	1.3	1.8	3.1	117
Calcium	169	231	219	155	189	339	185	163	119	130	18	34	30
Magnesium	39	52	48	38	38	61	36	3.1	<1	26	3.3	11	6
Arsenic	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005
Aluminum	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Cadmium	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005
Chromium	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	0.034	<.001	0.002	0.001	0.003
Lead	<.002	<.002	<.002	<.002	<.002	<.002	<.002	<.002	0.006	<.002	<.002	<.002	<.002
Molybdenum	0.08	1.8	<.005	0.21	0.50	2.8	0.04	<.005	<.005	0.02	0.02	0.09	<.005
Iron	0.06	0.06	0.03	0.05	0.20	0.05	<.02	<.02	0.03	<.02	0.03	<.02	<.02
Manganese	0.03	0.58	<.01	<.01	0.05	2.6	<.01	<.01	<.01	1.2	<.01	0.01	<.01
Copper	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01
Zinc	0.014	0.00	0.00	0.00	0.00	0.00	0.03	0.20	0.008	0.12	0.038	0.014	0.007
Carbonate Alkalinity	<1	<1	<1	<1	<1	<1	<1	10	24	<1	<1	<1	<1
Bicarbonate Alkalinity	148	116	17	18	156	18	134	<1	<1	169	66	81	187
Hydroxide Alkalinity	<1	<1	<1	<1	<1	<1	<1	3	300	<1	<1	<1	<1
Fluoride	0.34	0.92	0.45	0.71	0.37	2.8	0.25	0.19	0.78	0.16	0.65	0.66	1.20

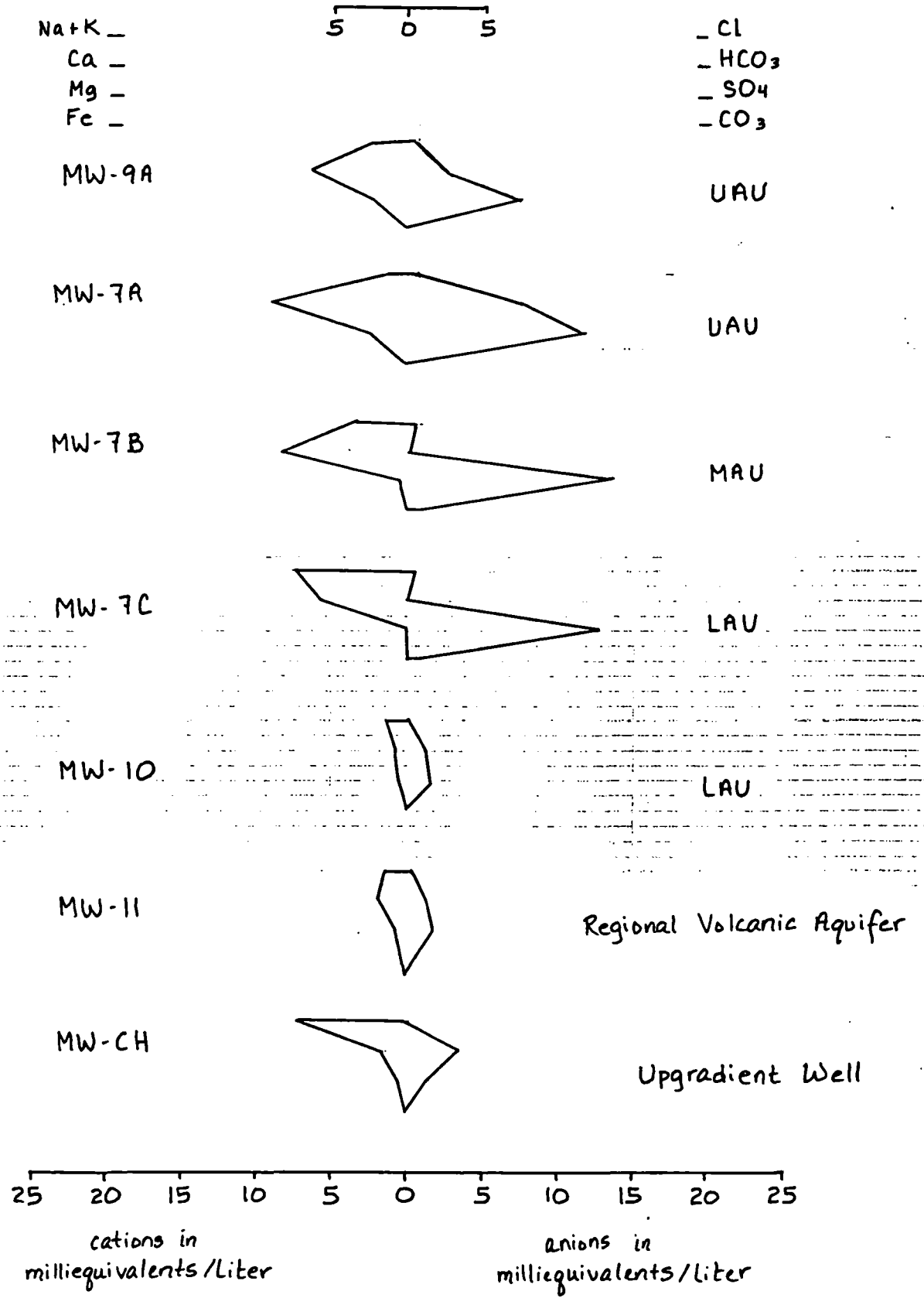
South Pass Resources **PROJECT RECORD**	Client: Molycorp Inc., Questa	Job No. 001-02
	Project: Tailings Pond	Date: 9-20-93
	Subject: Stiff Diagrams	Page 1 of 2



Record By: JCK	Date:	Cked By:	Appr. By:
Revised By:	Date:	Cked By:	Appr. By:

C2

South Pass Resources PROJECT RECORD	Client: Molycorp Inc, Questa	Job No. 001-02
	Project: Tailings Pond	Date: 9-20-93
	Subject: Stiff Diagrams	Page 2 of 2



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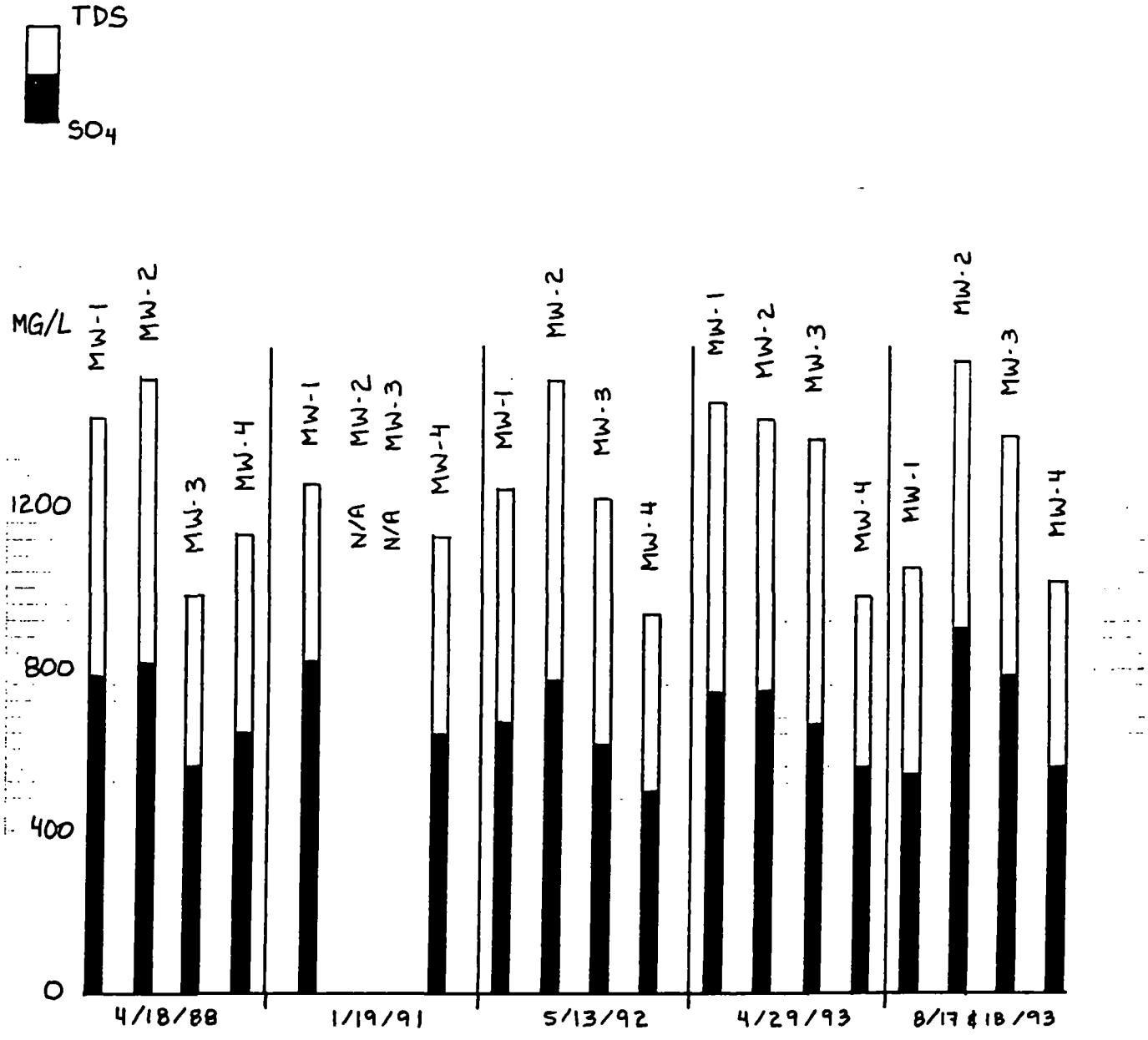
Revised By:	Date:	Cked By:	Appr. By:

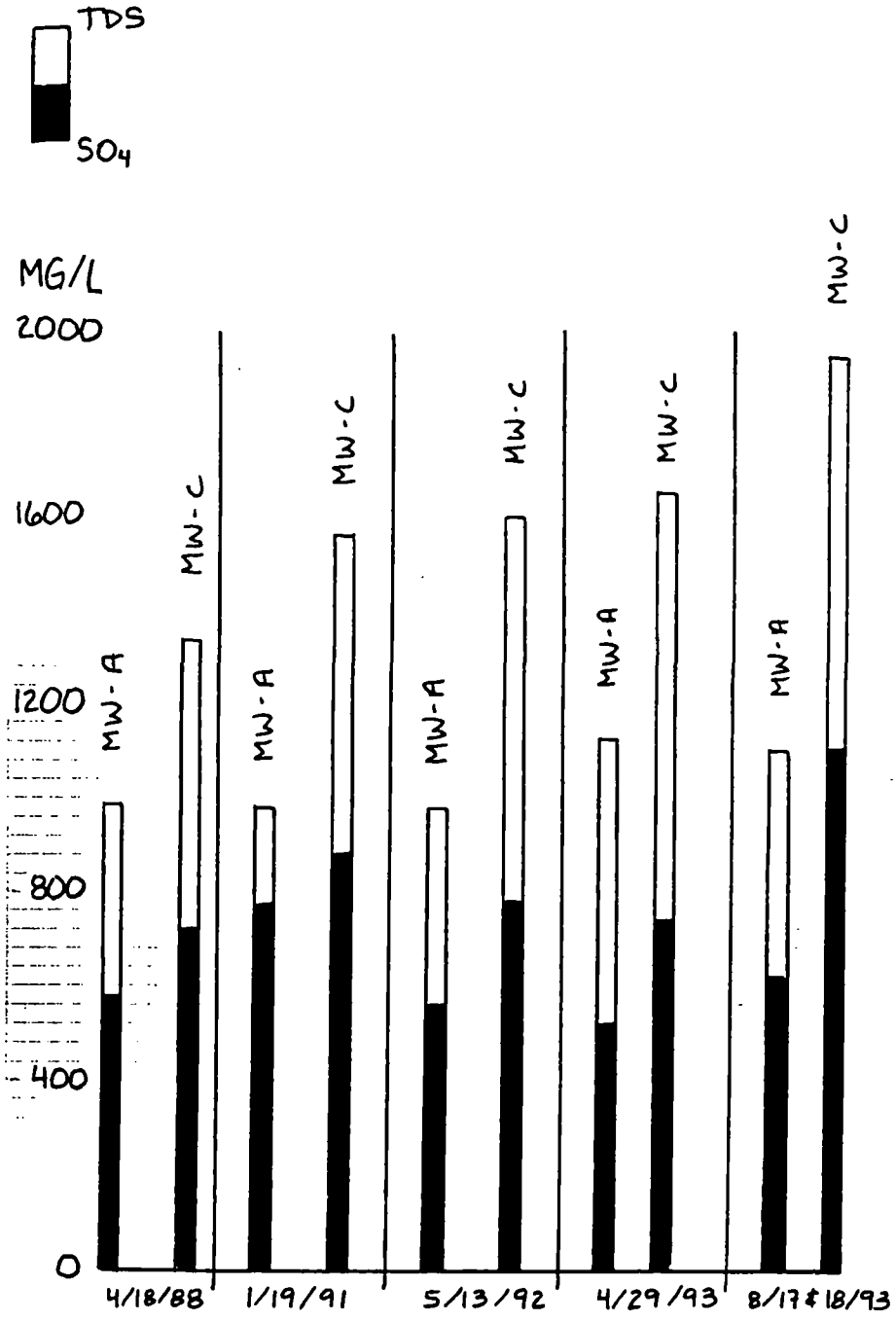
South Pass Resources PROJECT RECORD	Client: Molycorp Inc., Questa	Job No. 001-02
	Project: Tailings Pond	Date: 9-20-93
	Subject: Histograms-MW Chemistry	Page 1 of 2



Record By: JCK	Date:	Cked By:	Appr. By:
Revised By:	Date:	Cked By:	Appr. By:

C3

South Pass Resources **PROJECT RECORD**	Client: Molycorp Inc., Questa	Job No. 001-02
	Project: Tailings Pond	Date: 9-20-93
	Subject: Histograms - MW Chemistry	Page 2 of 2



Record By: JCK	Date:	Cked By:	Appr. By:
Revised By:	Date:	Cked By:	Appr. By:

APPENDIX D

APPENDIX D

CONSTANT RATE AND

RECOVERY TEST RESULTS

APPENDIX D

CONSTANT RATE AND RECOVERY TEST RESULTS

A pump test was designed to stress the aquifers screened in the volcanic unit and in the Lower Alluvial Unit for an appropriate period of time to estimate transmissivity. The pump test was preceded by a step test to evaluate the maximum pumping rate for each well.

Monitor well MW-11, located south of Dam No. 4 in the bottom of a small canyon near Pope Lake, was used to test the volcanic unit. Monitor well MW-10, which is located just north of the county road near the southeastern corner of the Molycorp property, was used to test the Lower Aquifer Unit.

PUMP TEST PROCEDURES

Pumping Equipment

MW-11 was pumped using a 60-horsepower submersible pump capable of pumping 660 gpm. The flow rate was controlled by a gate valve and a flow meter located at the top of the discharge pipe. A diesel generator powered the pump. The intake for the pump was set at 235 feet.

MW-10 was pumped using a 4-inch submersible pump capable of pumping 15 gpm. The flow rate was controlled by a gate valve and a flow meter located at the top of the discharge pipe. A gas generator powered the pump. The intake for the pump was set at 117 feet.

Discharge and Water-Level Measurements

Discharge during the pump test was measured using a totalizing flow meter and a stopwatch. Water-level measurements were made with a transducer and a Hermit 1000C datalogger that were programmed to take measurements on a logarithmic time scale and that were installed at the same time as the pumps. Hand measurements with an electric sounder were not possible after the pump and transducers were installed because well diameters were not large enough to accommodate the additional probe.

Pump Test Procedures: MW-11

Static water levels were measured prior to the test using an electric sounder. After the transducer was installed at 221.15 feet below the top of the casing, static water levels were measured with the datalogger.

A step-drawdown test was performed at 11:27 on August 17, 1993 for 45 minutes. The purpose of the step test was to evaluate the drawdown response of the well at a pumping rate(s) below maximum rate. The pumping rate was set at approximately 530 gpm. Water-level measurements were recorded by a datalogger at the following intervals:

Elapsed Time:	Measurement Interval
0-1 minute	0.2 second
1-10 minutes	0.2 minute
10-100 minutes	2 minutes
100-1,000 minutes	20 minutes

After pumping was shut off, the datalogger was stepped so that recovery could be recorded at the same intervals as described above. Less than 1.0 foot of drawdown was recorded at 530 gpm, and the rate was increased to the maximum of 660 gpm for the constant rate test.

The pump test was not started until the aquifer had fully recovered. Due to the high flow velocity in the aquifer, over 99 percent of the recovery took place within the hour.

The pump test was performed at 16:07 and was conducted for 230 minutes. The pump rate was set at a maximum of 660 gpm. Water-level measurements were recorded at the same intervals described above. Recovery was quite rapid, again within an hour, though the datalogger was allowed to record recovery data until the following morning.

Pump Test Procedures: MW-10

Depth to static water level for this well was based on a measurement made immediately after well construction (91 feet bgs). The transducer was set at 117 feet below the top of the casing. A step test was run at 15 gpm, but after 10 minutes the well was pumped dry. The rate was then lowered to 5 gpm, but the water started becoming cloudy and the pump was shutdown. The information was not recorded correctly by the datalogger. The higher water level at the time of the pump test (39.0 feet) was likely the result of post-construction development.

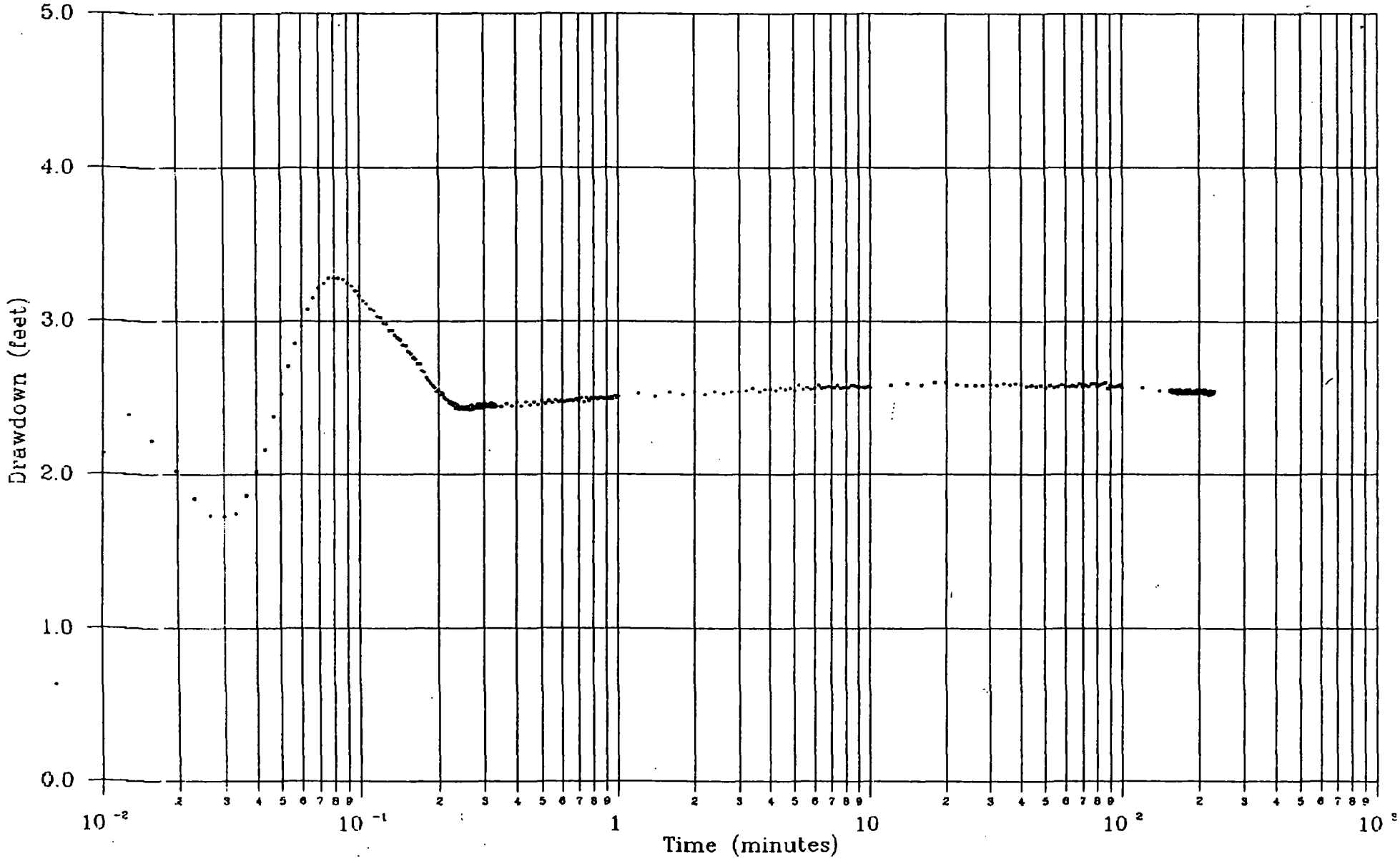
Two transducers set at different levels had to be used in order to collect information as the static water level had risen approximately 50 feet since the time the well was completed. The available transducers could only measure up to 50 feet of head above the probe. The second transducer was set at 70 feet from the top of the casing.

The pump test was started at 11:44 on August 19, 1993 and ended at 13:16 (92 minutes). The flow rate was adjusted to approximately 1.8 gpm. Water-level measurements were recorded by the datalogger at the same intervals as used on MW-11. Recovery was slow (8 hours for 86 percent).

Pumping Well: MW11
Pumping: Q at 660 gpm
Date/Start of Test: 07/17/93 16:07:10

PUMP TEST AT 660 gpm
For Pumping Well MW11

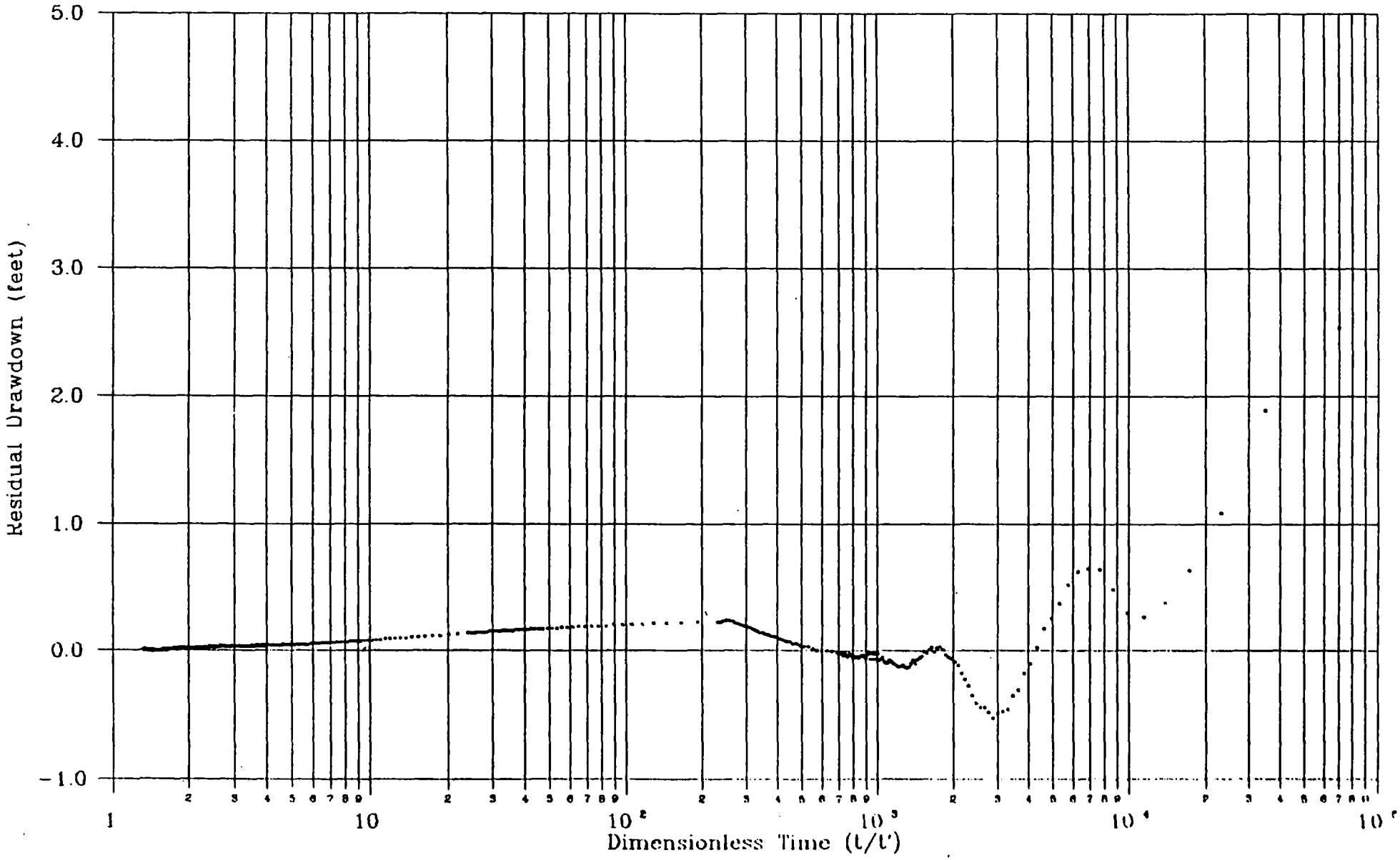
001-02
KJZ
File Name: MW11P1SL.GRF
Date Created: 08/24/93



Pumping Well: MW11
Pumptest: Q at 660 gpm
Date/Start of Test: 08/17/93; 16:07:10
Date/Time When Pumping Stopped: 08/17/93; 19:57:11

RECOVERY FROM PUMP TEST AT 660 gpm
For Pumping Well MW11

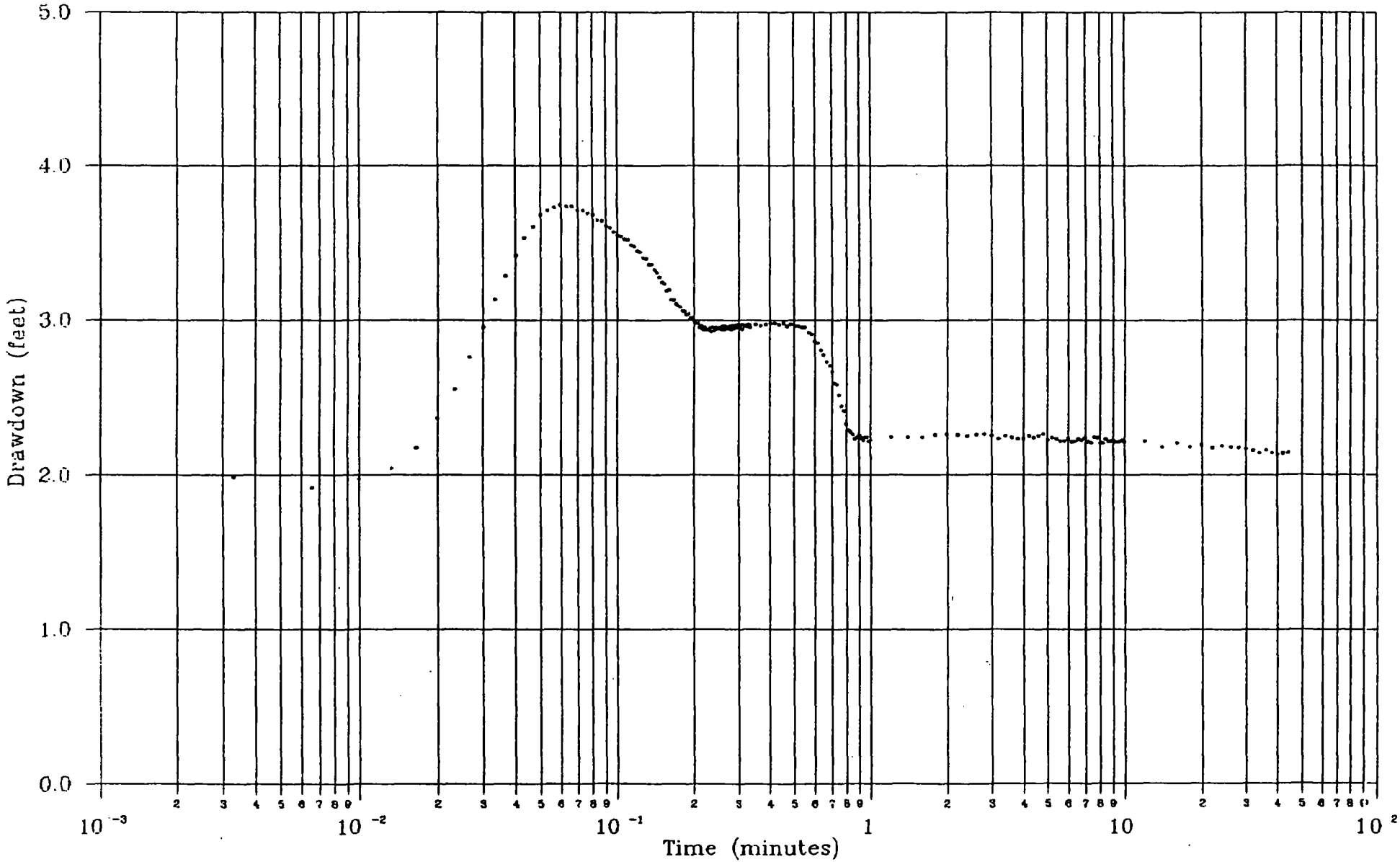
001-02
KJZ
File Name: MW11PR1GRP
Date Created: 08/24/93



Pumping Well: MW11
Pumptest: Q at 530 gpm
Date/Start of Test: 08/17/93; 11:28:56

STEP TEST AT 530 gpm
For Pumping Well MW11

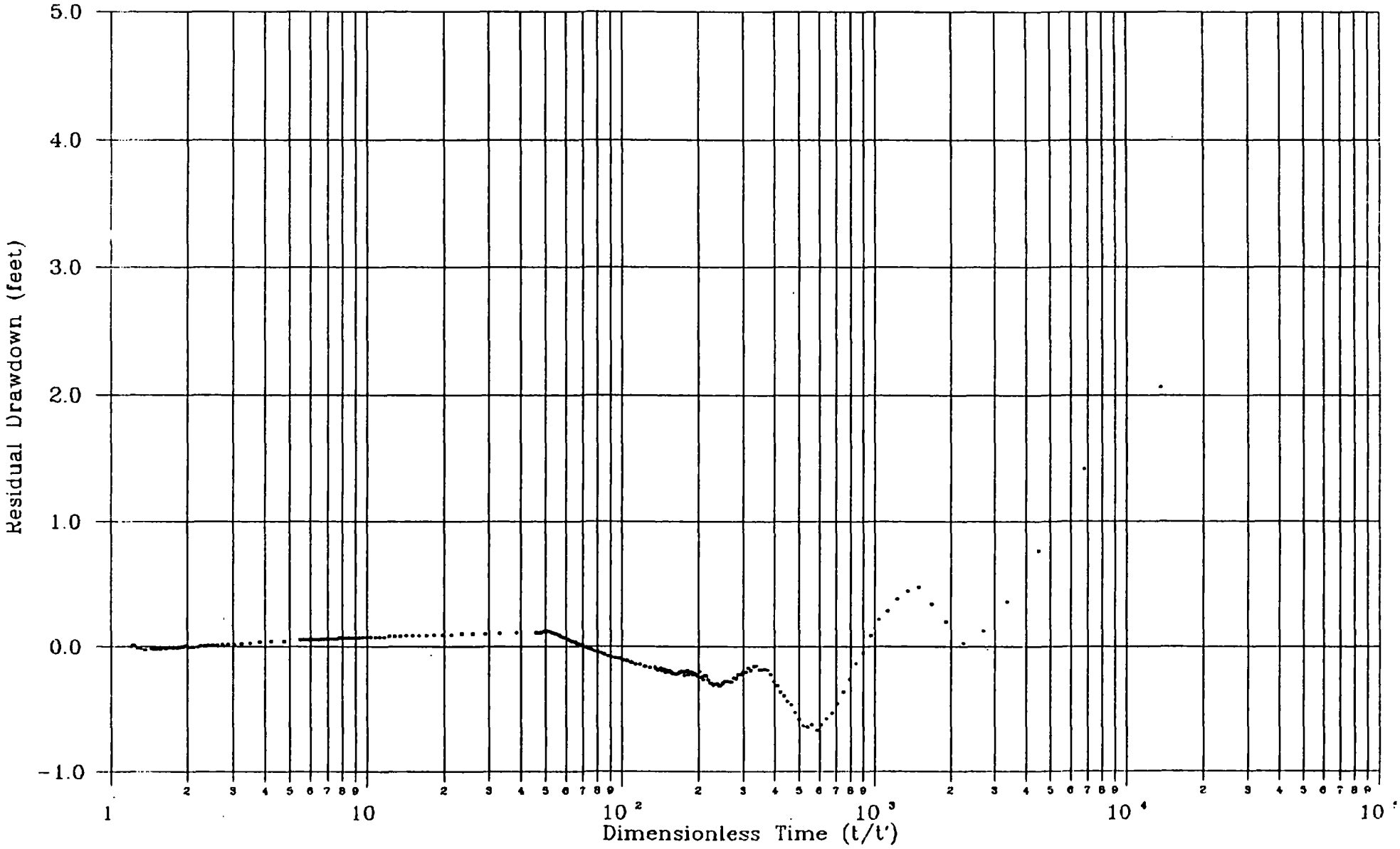
001-02
KJZ
File Name: MW11S1SL.GRF
Date Created: 08/24/93



Pumping Well: MW11
Pumptest: Q at 530 gpm
Date/Start of Test: 08/17/93; 11:28:56
Date/Time When Pumping Stopped: 08/17/93; 12:13:45

RECOVERY FROM STEP TEST AT 530 gpm
For Pumping Well MW11

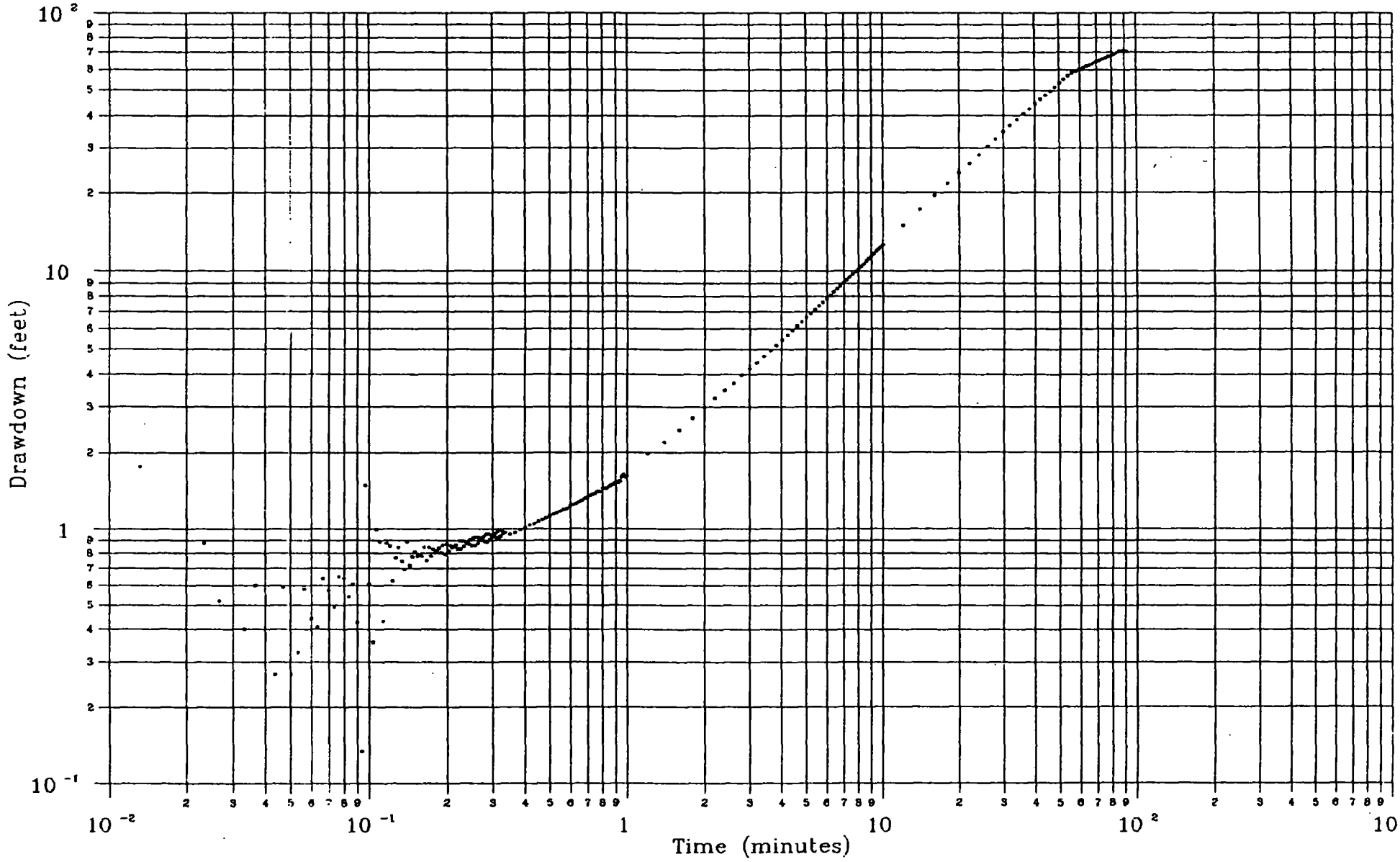
001-02
EJZ
File Name: MW11SR1.GRF
Date Created: 08/24/93



Pumping Well: MW10
Pumptest: Q at 2 gpm
Date/Start of Test: 08/19/93; 11:44:51

PUMP TEST AT 2 gpm
For Pumping Well MW10

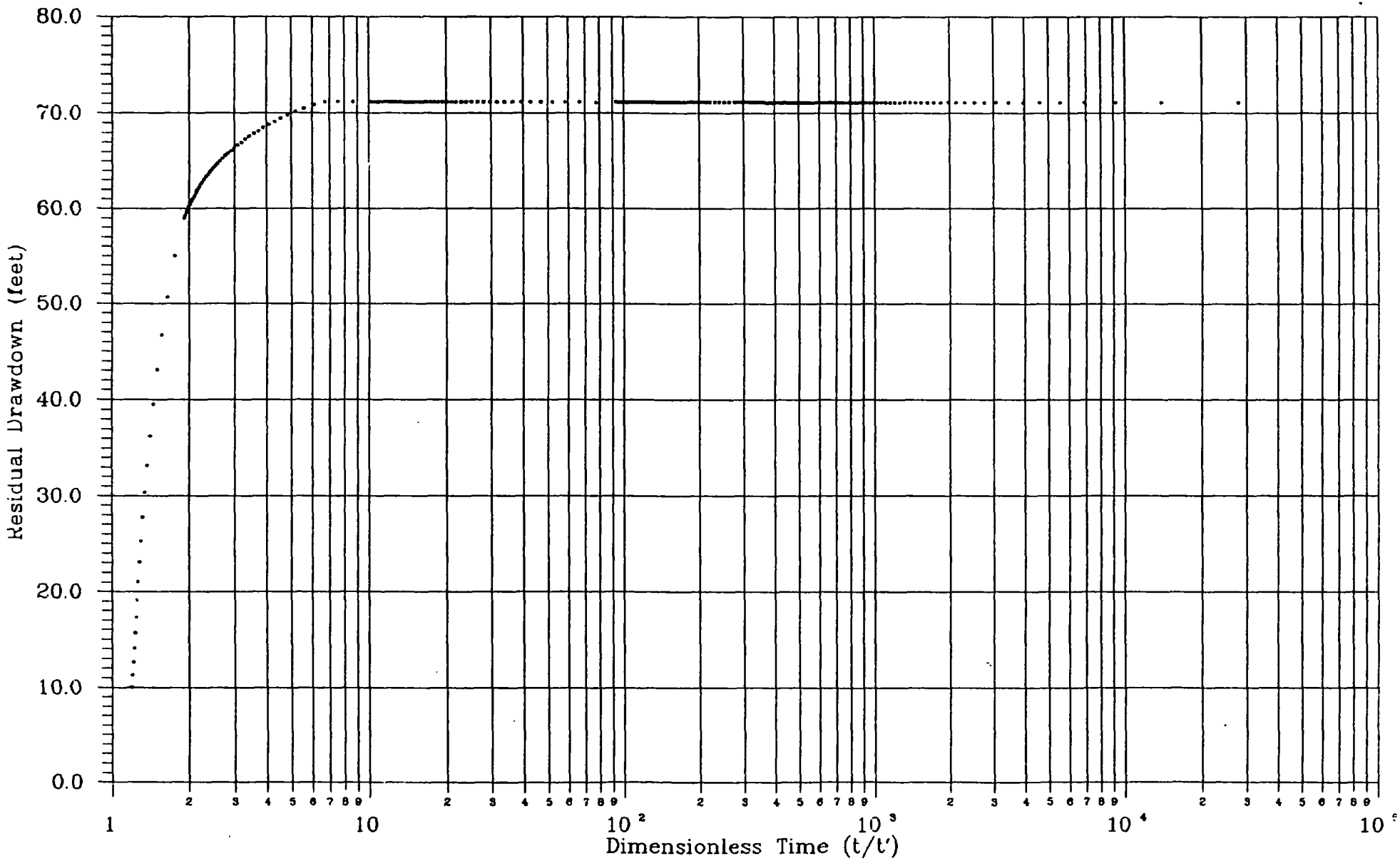
001-02
KJZ
File Name: MW10P.GKF
Date Created: 08/24/93



Pumping Well: MW10
Pumptest: Q at 2 gpm
Date/Start of Test: 08/19/93; 11:44:51
Date/Time When Pumping Stopped: 08/19/93; 13:16:58

RECOVERY FROM PUMP TEST AT 2 gpm
For Pumping Well MW10

001-02
KJZ
File Name: MW10PR1.GRF
Date Created: 08/24/93



APPENDIX E

APPENDIX E

Drilling and Construction of Monitor Wells

APPENDIX E

DRILLING AND CONSTRUCTION OF MONITOR WELLS

Drilling

A Gardner Denver 15W drill rig was used to drill the monitor wells at the Molycorp Questa tailings ponds in June and July 1993. This drill rig was outfitted with an air rotary casing hammer which was used to drive 11¾-inch and 9⅝-inch drive casing to prevent unstable formations from caving into the borehole. Upon completion of well drilling/well construction, the drive casing was extracted from the borehole with a hydraulic jacking system.

Well Construction

Monitor wells were constructed of 2-inch and 6-inch Schedule 40 PVC flush-threaded well casing with factory slotted 020 screens. Monitor well MW-11 was completed with 8-inch schedule 80 PVC flush-threaded well casing and screen. MW-11 has a screen filter pack of ⅜-inch silica gravel. All other monitor wells drilled at this time were constructed with 10/20-mesh Colorado silica sand. Bentonite chips (⅛-inch to ⅜-inch) were used as a seal on top of the sand/gravel filter pack.

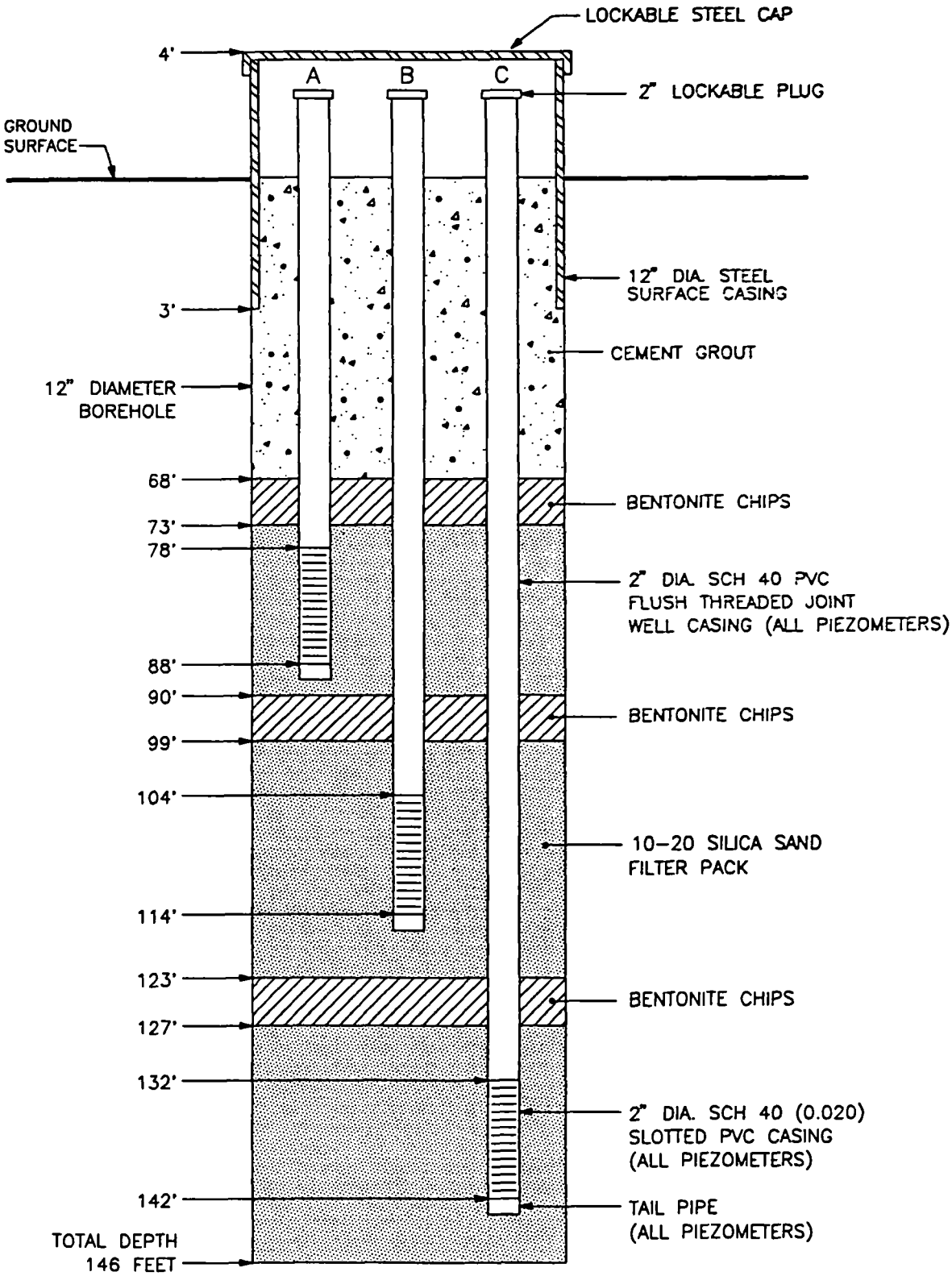
Wells were cemented to the surface. Cement was mixed into a suitable slurry and then pressure-pumped down a 1-inch steel tremie pipe. The driver casing was extracted from each borehole as cementing operations proceeded. Maintenance of the extracted drive casing at approximately 5 feet above the cementing zone helped to prevent borehole collapse. A 3-foot stickup, protected by an upright traffic-visible lockable well vault, was constructed.

Well Development and Logging

The 2-inch piezometer wells were developed by bailing for a period of 4 hours. The 6-inch and 8-inch wells were developed by air-lift for a period of 4 hours.

Cuttings were collected at the cyclone outlet and described for each 10-foot interval. Return water samples were collected in a plastic cup and, after 10 minutes for settling, measured for Ph, conductivity, and Total Dissolved Solids. Water samples were taken from moist zones above static water levels as well as below static levels. Variations in the amount of foaming agent used during drilling, variations in the amount of water discharged to the borehole from the formation, and the frequent instability of the field meters in muddy solutions caused highly erratic readings. The results of these field measurements were considered too unreliable to use as indicators of water quality.

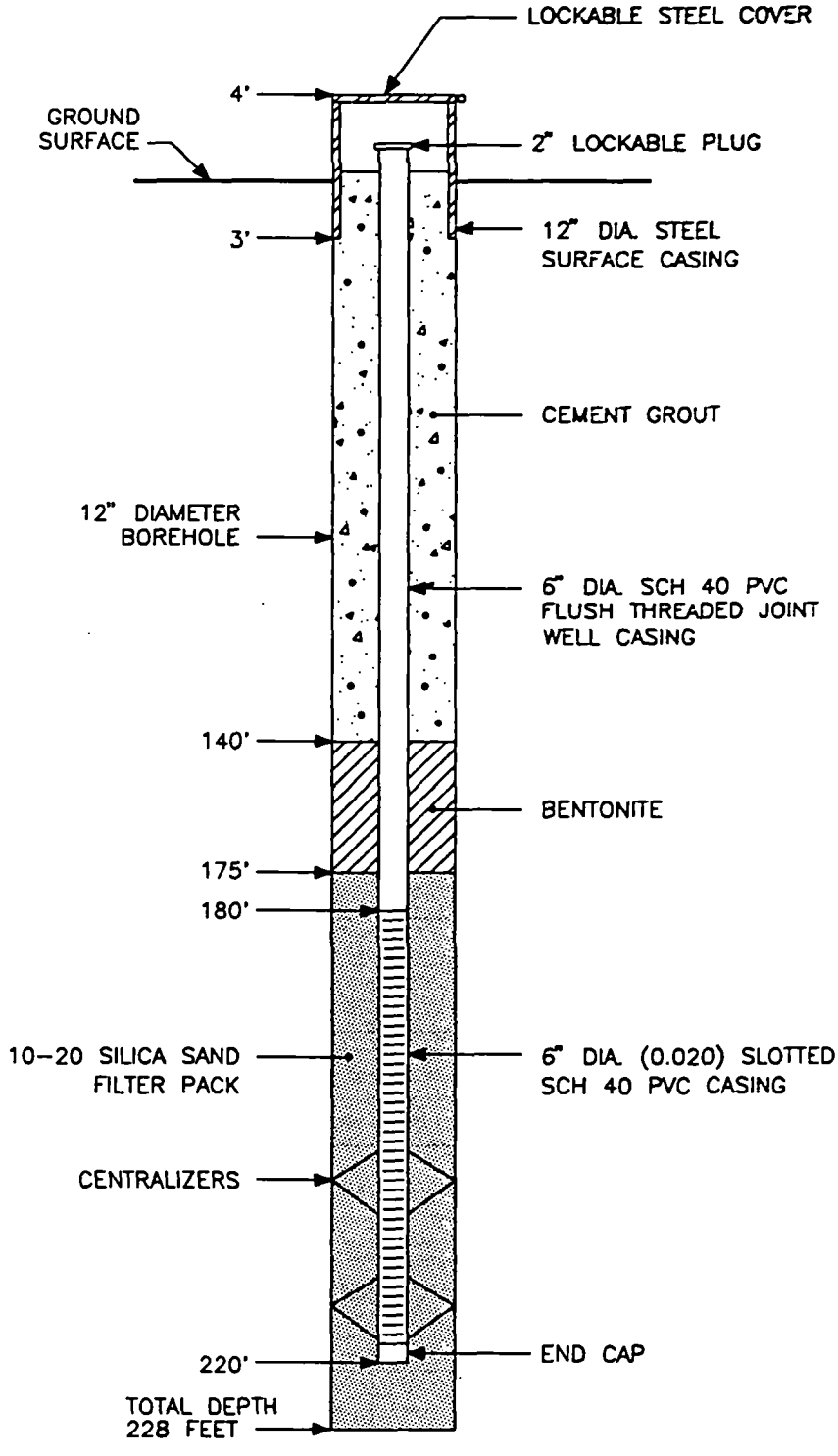
SCHEMATIC OF WELL CONSTRUCTION



NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				WELL CONSTRUCTION MW-7 A,B,C Molycorp, Inc. Questa, New Mexico	FIGURE:
PROJECT No.: 001-02	DATE: 9-22-93	AUTHOR: JCh	DRAWN BY: M.O'M.		E1

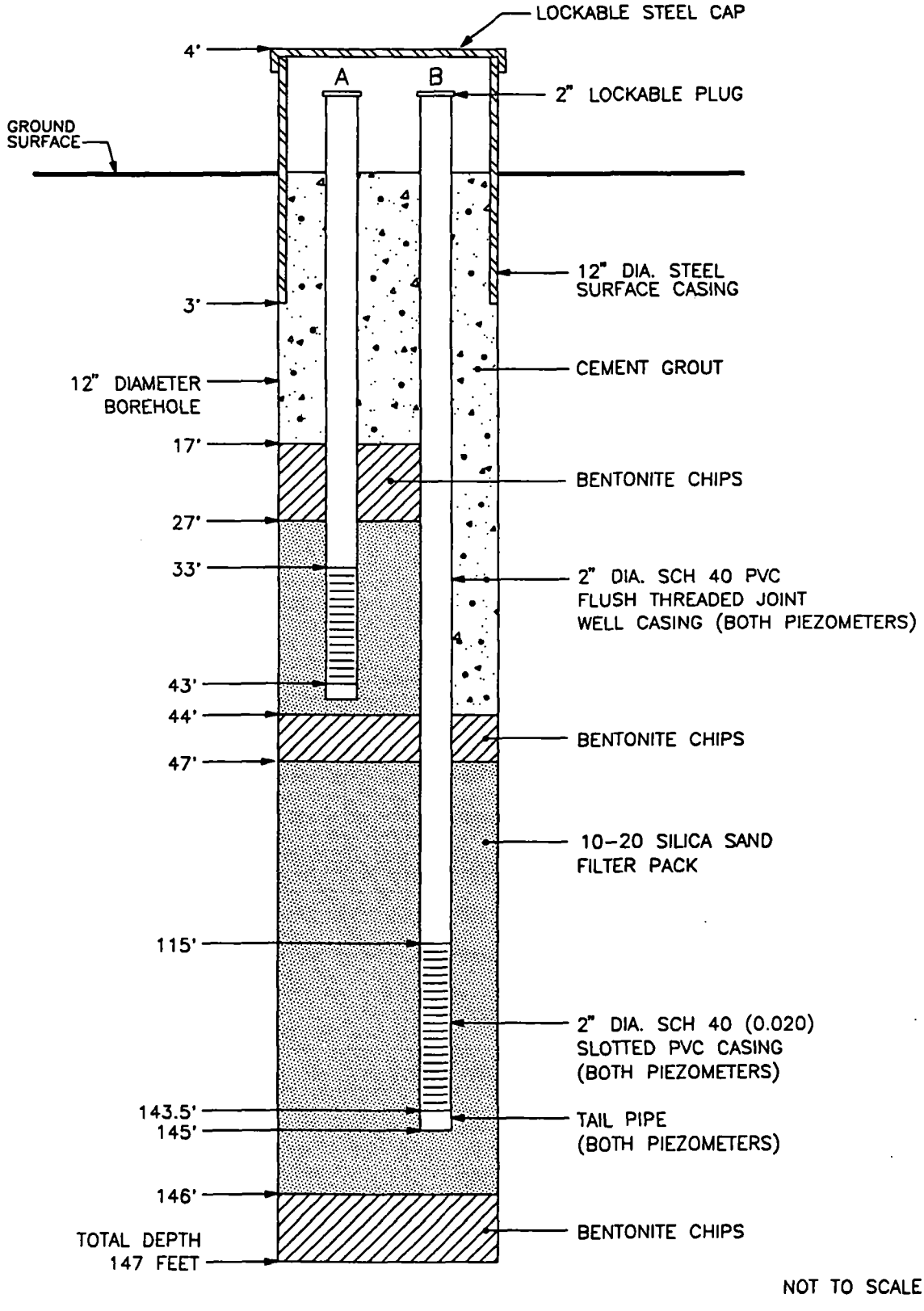
SCHEMATIC OF WELL CONSTRUCTION



NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				WELL CONSTRUCTION DETAIL MW-8 Molycorp, Inc. Questa, New Mexico	FIGURE: E2
PROJECT No.: 001-02	DATE: 9-22-93	AUTHOR: JCL	DRAWN BY: M.O'M.		

SCHEMATIC OF WELL CONSTRUCTION

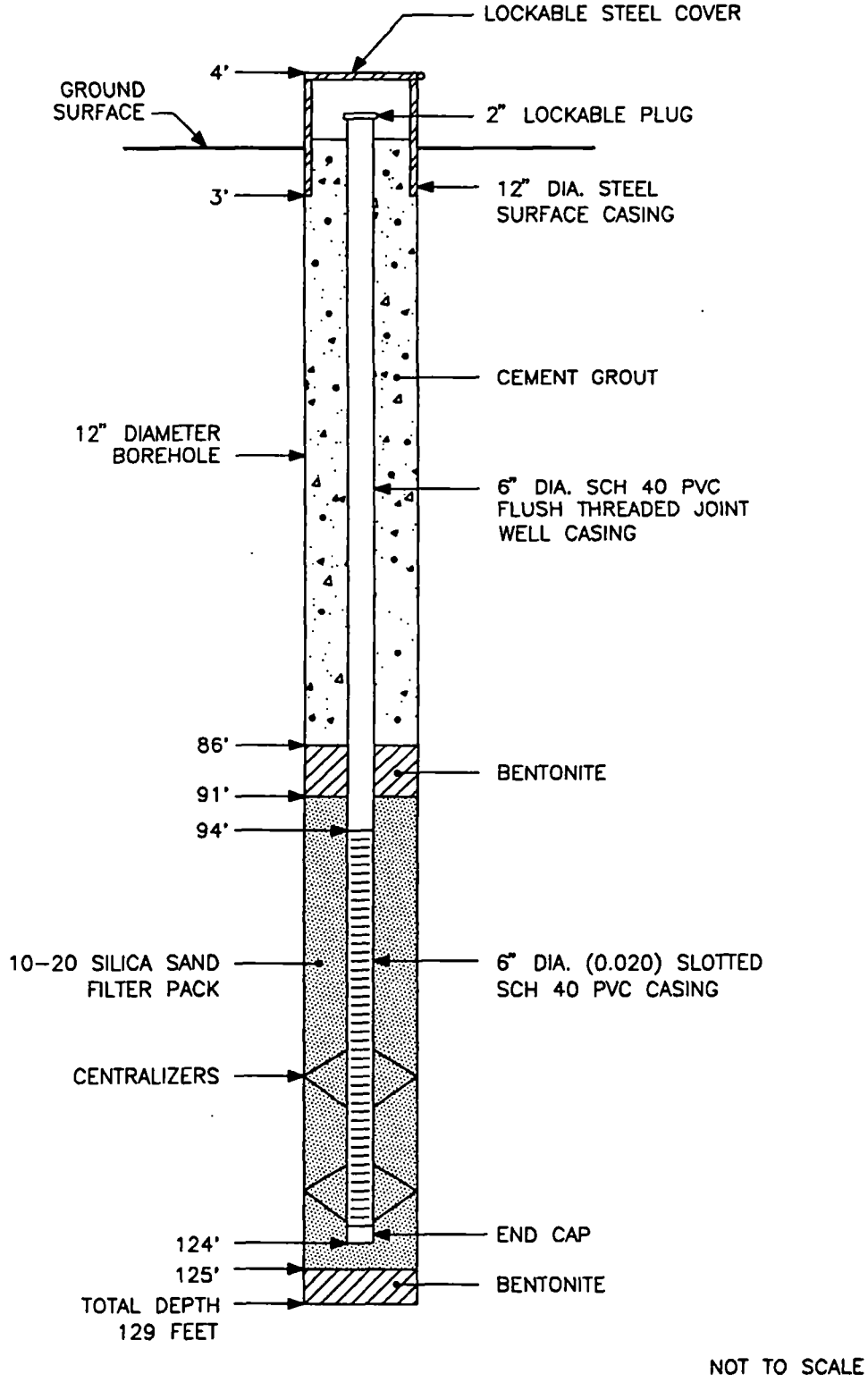


NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				WELL CONSTRUCTION MW-9 A,B Molycorp, Inc. Questa, New Mexico	FIGURE: E3
PROJECT No.: 001-02	DATE: 9-22-93	AUTHOR:	DRAWN BY: M.O'M.		

MW-10WELL

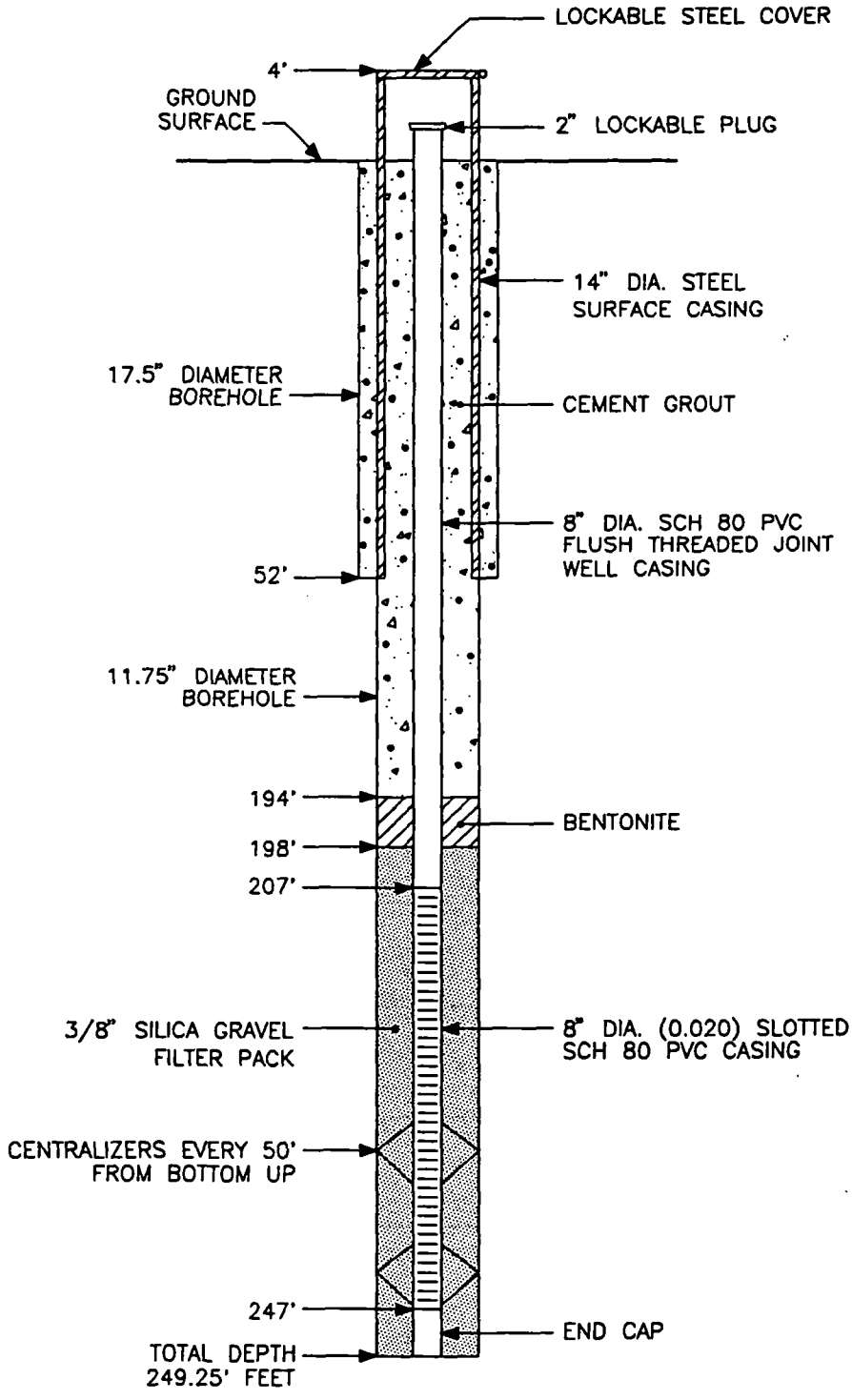
SCHEMATIC OF WELL CONSTRUCTION



SOUTH PASS RESOURCES, Inc.				WELL CONSTRUCTION DETAIL MW-10	FIGURE:
PROJECT No.: 001-02	DATE: 9-22-93	AUTHOR:	DRAWN BY: M.O'M.	Molycorp, Inc. Questa, New Mexico	E4

MW-11WEL

SCHEMATIC OF WELL CONSTRUCTION



NOT TO SCALE

SOUTH PASS RESOURCES, Inc.				WELL CONSTRUCTION DETAIL MW-11 Molycorp, Inc. Questa, New Mexico	FIGURE:
PROJECT No.: 001-02	DATE: 9-22-93	AUTHOR:	DRAWN BY: M.O'M.		E5

RECEIVED
MAY 28 1993
6W-PS

Water Information Network
P.O. Box 4524
Albuquerque, NM 87106
505-255-4072 (O), 505-262-1864 (Fax)

May 25, 1993

Ms. Ellen Caldwell
Permits Branch (6W-PS)
U.S. EPA
1445 Ross Avenue
Dallas, TX 75202-2733

Re: Request for Public Hearing and Preliminary Comments on Application of Molycorp, Inc. to Discharge to Waters of the United States, NPDES Permit No. NM0022306, Draft Permit

Dear Ms. Caldwell:

Pursuant to 40 CFR 124.10 and 40 CFR 124.12, the Water Information Network ("WIN") herein requests a public hearing on the application of Molycorp, Inc. for an NPDES Permit No. NM0022306 to discharge to waters of the United States. This request is based on information supplied in the Environmental Protection Agency's April 17, 1993, public notice and on our preliminary review of the application and related documentation.

WIN submits as initial reasons for this request and as preliminary comments on the application the following:

1. The draft permit authorizes two new outfalls or discharge points, identified as "outfalls 004 and 005 - periodic mine drainage, including collected storm water," (Proposed Permit, p. 5.)

These new outfalls have not been previously permitted and are at least 10 miles away, a very significant distance, from previously permitted outfalls. In addition, the new outfalls will discharge flows from a different source than

permitted outfalls 001 and 002, which discharge portions of seepage not caught by existing collection trenches from under the tailings.

The new outfalls may be considered "new sources" because they are both 1.) new discharge points and 2.) "new" - as in previously unregulated - sources or mine drainage points. The technical capability of the new outfall works to control all discharges to the Red River and to prevent unpermitted bypasses is not demonstrated. Demonstration of the technical capability of the new outfall works must be required before discharges to waters of the United States are permitted.

2. The proposed permit overestimates the flow from outfall 001. There is little or no flow when the mine is not operating, as is the case today, and overestimation of flow leads to unnecessary, massive discharges under SUM1 limits for manganese and molybdenum, two of the most significant pollutants from the mine. There are no concentration-based limits for these two pollutants. This situation is also true for cobalt, selenium, beryllium, silver, chlordane, and chlorine which are picked up under SUM2. EPA must issue concentration limits for these metals in order to meet the goals of the Clean Water Act.

3. The proposed permit allows for insufficient monitoring of discharges from outfalls 001 and 002, compounding the problem with overestimation flow. Monitoring must occur on a daily basis for effluents with concentration limits. Otherwise, periodic massive releases of metals will be not be accounted for.

4. The proposed permit "whole effluent toxicity testing" allows too much dilution of mixture for testing. A mixture of 36% should be used for most tests. In addition, the permit should require biomonitoring testing for individual samples of effluent from all outfalls. Composite sampling must not be allowed because of the significant distance between outfalls.

5. In a 1989 "Report on Ground Water Seepage Below Molycorp's Existing

Tailings Dams Near Questa, New Mexico" by Vail Engineering, Inc. and submitted to the New Mexico Environment Department (NMED) on behalf of Molycorp, Inc., indicates that:

> ' . . .seepage from the tailings pond area is emanating from higher horizons and in areas not previously detected and that a significant part of such seepage is not being intercepted and collected by the barriers at 002 and 003," p. 6. (See Appendix A.)

NMED files do not indicate that the remedial action to address this problem have been installed or have proven effective. In addition, NMED files indicate a persistent pattern of seepage, including "seepage leaving Molycorp properties," as evidenced in a "Seepage Survey" conducted by Vail Engineering, Inc. on behalf of Molycorp, Inc. (See Appendix B.) These seepage areas are below the "higher horizons" indicated for the "new" seepage discussed in the 1989 Report (referenced above).

6. It appears that Molycorp, Inc. has been unable to demonstrate that it can collect all discharges to prevent contamination of waters of the United States, therefore, the Water Inforamation Network requests that a public hearing be held for Molycorp's NPDES Permit No. NM0022306.

Thank you very much for the extension of time to comment on this application.

Sincerely,

Lila Bird, Executive Director

Enclosures
Appendix A - "Report on Ground Water Seepage," Vail Engineering, Inc. (p. 4-6)
Appendix B - "Seepage Survey," by Steven Rae, P.E., Ralph Vail Consulting Engineers

APPENDIX A

VAIL ENGINEERING, INC.

PHONE: (505)
988-3375

1308 SAN MATEO LANE
SANTA FE, NEW MEXICO
87501

REPORT ON GROUND WATER SEEPAGE BELOW MOLYCORP'S EXISTING TAILINGS DAMS NEAR QUESTA, NEW MEXICO

August 24, 1989

RECEIVED
SEP 05 1989
GROUND WATER BUREAU

of the accretion is concentrated in two groups of springs. The upper group extend from the entrance to Red River gorge along the north side of the river for a distance of a few hundred feet upstream. Most of the discharge from these springs appears to be directly from the alluvium; however, some water emanates from the volcanic rocks at the lower part of this group.

No significant springs are present for a distance of nearly a mile downstream from the upper springs. The lower springs emanate from the volcanic talus slopes and are concentrated along a river reach of a few thousand feet. The spring water temperature is several degrees warmer in the lower volcanic springs than it is in the upper alluvial springs.

History of Seepage

Initially, the only visible seepage from the tailings ponds appeared below the toe of Dam No. 1. Sometime after construction of Dam No. 4, seepage from the Pond in Section 35 started to appear along the east slope of the narrow ridge between the two arroys and downstream of Dam No. 1. The seepage emanated along a discrete horizon, indicating that the drainage from Section 35 pond was being conducted as perched water atop a layer of clay.

Several years after initiation of tailings disposal at the site, elevated concentrations of molybdenum were detected in several wells down gradient from Pond No. 1.

Subsequently, Molycorp excavated a deep cut-off trench across the arroyo below dam No. 1 and for a distance up the slopes on each side. The cut off trench was located several hundred feet downstream of Dam No. 1 and below the seepage coming from the Ponds in Section 36. The cut-off trench was bottomed out in a clay layer over much of its length. An impermeable plastic liner was installed over the downstream side of the trench. Perforated pipe was installed near the bottom of the trench and graded to carry the drainage flow to a manhole near the low point of the arroyo. Clean gravel was

placed around the perforated pipe and in the trench to near the surface. The cut off trench effectively intercepted the surface and shallow groundwater flow with the result that after several months the quality of the water in several of the wells down gradient of Dam No. 1 began to trend toward ambient concentrations. The seepage barrier and collection system below Dam No. 1 has been designated as Discharge Point 002.

The initial groundwater flow interrupted by the cutoff trench was on the order of 150 gpm. This gradually increased over several years to a peak of about 300 gpm. Concentration of molybdenum and other constituents in the water from 002 are nearly the same as those in the surface discharge from the tailings ponds. This indicates that the water collected by 002 is nearly all drainage from the pond area with little or no dilution by natural groundwater flow.

After the installation of the cutoff trench, disposal of tailings continued to raise the pond elevations and to increase the area of drainage. As the elevation of the pond in Section 35 rose, it was noted that there were progressively higher horizons of seepage along the ridge east of the Section 35 Pond. It was also noted that the amount of seepage in the original lower horizons diminished with time. There is no noticeable flow from these lower horizons at the present time. Seepage also appeared in a canyon on the east side of the ridge a considerable distance downstream of the 002 seepage barrier. Subsequently, a cutoff trench was installed to intercept this drainage and the flow was piped to the discharge line from 002. The collection works for the new drainage area was designated as discharge point 003.

Initially, the drainage flow from point 003 amounted to only a few gallons per minute and the quality of the water was not significantly different from ambient ground water concentrations. The flow from 003 gradually increased to a peak of about 100 gpm. There was a gradual increase in molybdenum and other constituents to concentrations approaching those recorded for 002.

After the installation of the seepage barrier at 003, the concentrations of molybdenum in the monitor wells downgradient from Dam No. 1 continued to decrease and at one time, were at or below groundwater standards in most of the wells.

Molycorp ceased mining and milling operations in 1986 and reduced employment at the Questa Division from about 980 down to 11 personnel. In consideration of the continuing decline in molybdenum concentrations in the water in wells below Dam No 1, the monitoring program for these wells was also substantially reduced. Subsequently, however, indications were noted that the declining trend had ended in many wells and possibly even reversed in some wells during the past several months. In consideration of this, Molycorp initiated new field surveys, investigations and studies including this Report.

These investigations and studies indicate that seepage from the tailings pond areas is emanating from higher horizons and in areas not previously detected and that a significant part of such seepage is not being intercepted and collected by the barriers at 002 and 003. Specifically, a surface flow is present in the arroyo channel below 002 and it is suspected that some subsurface flow may also be present. Presence of high-water demand plant growth below 003 strongly indicates that there is significant shallow subsurface flow bypassing the collection system. A small amount of seepage was also discovered in another canyon located between 002 and 003.

Subsurface Drainage Below Dam No. 4

Below the toe of Dam No. 4 there is a narrow bench which is covered with a superficial layer of silt, sand gravel and clay in which Pope Lake, the final clarification pond, has been constructed. Volcanic rock exists beneath the superficial alluvial deposits in the vicinity of Pope Lake. Molycorp's property extends for a few hundred feet south of Pope Lake. South of Molycorp's property, the volcanic rock is exposed in a

APPENDIX B

RALPH E. VAIL CONSULTING ENGINEERS

PHONE (505) 988-5575

616 DON GASPAR AVE.
SANTA FE, NEW MEXICO
87501

September 11, 1979

Ms. Obby Davidson
Molycorp, Inc.
Questa, New Mexico 87756

Subject: Seepage Survey
Tailings Disposal Area

Dear Ms. Davidson:

On September 5th, 1979, a "walk through" survey for locating uncontrolled seepage was repeated in order to compare the findings with those of the initial survey conducted on April 24th, 1979. On September 5th, the low earthen dam used to divert water into Seepage Barrier No. 2 was found to be washed out and uncontrolled seepage was observed leaving the properties of Molycorp, Inc. which may be considered a violation of Molycorp's NPDES permit.

In addition, an area below and at the southeast end of Tailings Dam No. 1 was found to be saturated with seepage. Another area above Seepage Barrier No. 2 was also found to be saturated with seepage to a much greater extent than that observed at the time of the initial survey.

Enclosed is a copy of the findings of September 5th and a copy of the findings of April 24th. It is recommended that seepage leaving the properties of Molycorp, Inc. be controlled as soon as possible by making repairs or replacing Seepage Barrier No. 2. It is also recommended that the saturated areas at the southeast end of Tailings Dan No. 1 and above Seepage Barrier No. 2 be inspected by your Tailings Area consultants for stability.

Please contact me if you have any questions regarding this survey. I am including a number of photographs which were taken at locations along the survey route.

Sincerely,

Steven R. Rae

Steven R. Rae, P.E.

Seepage Survey

Tailings Disposal Area
Molycorp, Inc.
September 5, 1979

Please see accompanying map for locations of arroyos and seepage along survey route.

Arroyo No. 1

Seepage from this arroyo is controlled by Seepage Barrier No. 1 which collects groundwater and carries it to the Red River through an outfall line. This discharge is authorized as Outfall No. 002 under Molycorp's NPDES permit. No flowing water was observed in this arroyo. Some standing water was observed around an observation well located above the seepage barrier. An area located immediately below and at the southeast end of Tailings Dam No. 1 was found to be saturated with seepage.

Arroyo No. 2

Seepage was found to be flowing in this arroyo at a rate somewhat higher than that observed during the initial seepage survey conducted on April 24th, 1979. Seepage from this arroyo disappeared into a sandy area prior to entering private property.

Arroyo No. 3

No seepage was observed

Arroyo No. 4

No seepage was observed entering the main channel below this arroyo.

Arroyo No. 5

No seepage was observed entering the main channel below this arroyo.

Arroyo No. 6

Seepage from this arroyo was found to be entering the main channel at a point above Seepage Barrier No. 2. The low earthen dam used to divert water into the drain line of the seepage barrier was washed out and water was observed flowing down the main channel and entering private property. It is recommended that seepage leaving the properties of Molycorp, Inc. be controlled as soon as possible by making repairs or replacing Seepage Barrier No. 2. If replacement is necessary, the location of Seepage Barrier No. 2 and the capacity of its outfall line should be reviewed.

Arroyo No. 7

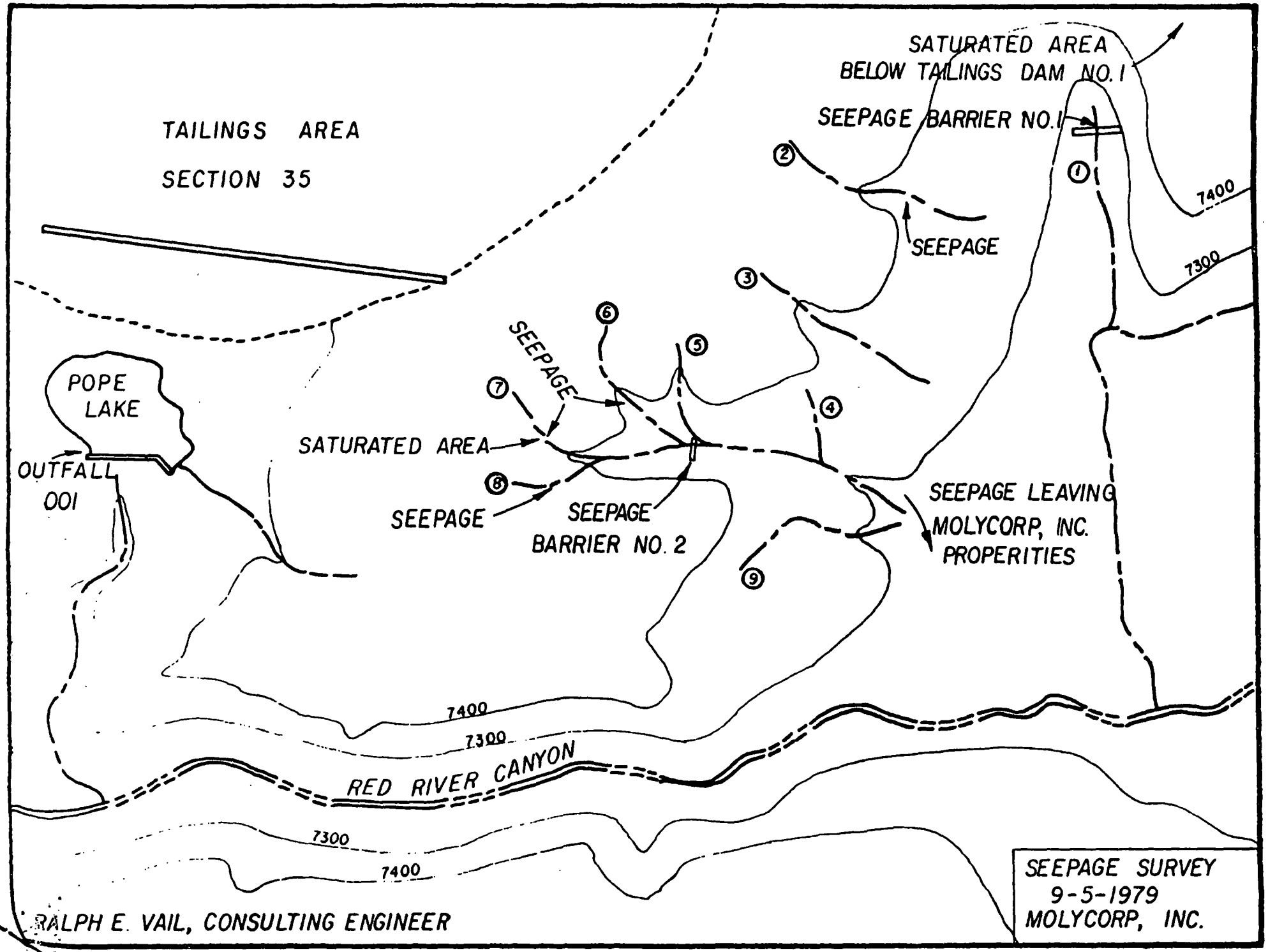
The saturated area at the upper end of Arroyo No. 7 was found to have increased substantially since the initial seepage survey. A large muddy area overgrown with weeds was found at the point where the power lines cross Arroyo No. 7. A white precipitate was found on rocks and gravel in the area. A number of dead or dying pinon trees were also observed along the upper end of Arroyo No. 7. The flow from Arroyo No. 7 to the seepage barrier appears to have increased since the initial seepage survey.

Arroyo No. 8

Seepage was observed entering the main channel below this arroyo. The flow appears to be approximately the same as that observed at the time of the initial seepage survey.

Arroyo No. 9

No seepage was observed.


TAILINGS AREA
SECTION 35
SATURATED AREA
BELOW TAILINGS DAM NO. 1
SEEPAGE BARRIER NO. 1
SEEPAGE
7400
7300
POPE
LAKE
OUTFALL
001
SEEPAGE
SATURATED AREA
SEEPAGE
SEEPAGE
BARRIER NO. 2
SEEPAGE LEAVING
MOLYCORP, INC.
PROPERITIES
7400
7300
RED RIVER CANYON
7300
7400
RALPH E. VAIL, CONSULTING ENGINEER
SEEPAGE SURVEY
9-5-1979
MOLYCORP, INC.