UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 28 2002

OFFICE OF CONGRESSIONAL AND
INTERGOVERNMENTAL RELATIONS

The Honorable Hilda L. Solis
U.S. House of Representatives
Washington, D.C. 20515

Dear Congresswoman Solis:

Thank you for your letter of March 18, 2002 requesting information on the environmental and health effects of gravel mining operations in and around the area of Irwindale, El Monte, Baldwin Park, and Azusa, California. In particular, you requested information on the effects of stone quarry activities on the air quality and water quality in the area, and an estimate of the cumulative exposure of the residents as a result of such activities in the area. In the event that data was not available, you asked us to identify any data gaps and identify how they may be obtained.

In response, we have assembled and reviewed a considerable amount of publicly available information from U.S. EPA and California state programs. These sources provide much information on a variety of different aspects of potential environmental and health impacts in the Irwindale, El Monte, Baldwin Park, and Azusa area. To facilitate your review of the information from the wide range of sources, we have organized the information in one attachment, 19 tables, and a large number of tabs, and described that information in the enclosed Overview of Information.

If you have any additional questions or concerns, please contact me, or your staff may contact Sunny Nelson, Congressional Liaison, EPA Region IX at (415) 947-4255.

Sincerely,

Edward D. Krenik
Associate Administrator

Enclosures:

Overview of Information
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Overview of Information

Attachment #1 describes the 4 general steps of a cumulative exposure assessment, data needs specifically from gravel mining operations, and data formats. It also identifies 3 documents which could provide a good foundation to begin a cumulative exposure assessment from gravel mining operations in the Irwindale, El Monte, Baldwin Park, Azusa, California area.

In gathering the publicly available information, we looked for general, ambient and facility specific information in the following programs, and organized the U.S. EPA and state information by these same programs:

* National Environmental Policy Act (NEPA);
* Clean Air Act (CAA);
* Clean Water Act (CWA);
* Safe Drinking Water Act (SDWA);
* Comprehensive Environmental Response, Compensation and Liability Act (CERCLA);
* Resource Conservation and Recovery Act (RCRA); and
* Emergency Planning and Community Right-to-Know Act (EPCRA)

Table A provides general and ambient information: identifying the name of the document; providing a brief description including a point of contact for additional information; and identifying the tab number for the specific document. Table A includes:

* information on NEPA reviews;
* information on California Environmental Quality Act reviews;
* a summary of the Multiple Air Toxics Exposure Study for the South Coast Air Basin;
* information from the California Air Resources Board's Air Toxics "Hot Spots" Program;
* a summary of gravel mining activities in the San Gabriel River area near the cities of Azusa and Irwindale, California;
* information from the Azusa air monitoring station;
* Year 2001 Estimated Annual Average Air Emissions in the South Coast Air Basin;
* ambient surface water data for Reach 3 of the San Gabriel River;
* compliance monitoring data for the public water supply systems in the area;
* information on the groundwater contaminant plumes in the Baldwin Park Operable Unit Superfund site;
* general map of the RCRA facilities in the area;
* general map of the Superfund sites in the area; and
* general map of the Volatile Organic Compound (VOC) groundwater contaminant plume beneath the area.

Tables B1 through B17 provide quarry pit specific information: identifying the facility; identifying the program (e.g., Clean Water Act - NPDES permit); indicating whether the permit, document, or information is required or available; indicating whether the action was taken; providing a brief description of the permit, document, information, or action, including a point of contact for additional information; and identifying the tab number for the available document.

Table C provides available information which could not be linked with any certainty to any one of the seventeen quarry mining locations in the Irwindale, El Monte, Baldwin Park, and Azusa, California area: identifying the program; outlining the information, including a point of contact for additional information; and identifying the tab number for the available document.

Based upon our review of the available information, we find the available data are not sufficient to provide a meaningful cumulative exposure estimate from quarry mining operations for residents in the area. The quality and quantity of the available data do not lend themselves to meaningful aggregation and summation. As an example, there may be ambient and/or quarry specific air data. However, the:

* chemicals or constituents analyzed;
* analytical methods used;
* period of time sampling occurred;
* number of ambient sampling stations;
* number of ambient sampling stations actually sampled;
* number of active quarry mining operations;
* number of quarry mining operations actually sampled;

vary greatly or are not available over relevant periods of time. An analogous situation of fragmentation exists with the ambient surface water and groundwater data, and facility specific surface water, groundwater, and drinking water data.

ATTACHMENT 1

Cumulative Exposure Assessment re: Gravel Mining Operations in the Azusa, Baldwin Park, El Monte, Irwindale Area

Prepared by Gerald Hiatt, Ph.D., Regional Toxicologist
U.S. EPA Region 9
415-972-3064

General Aspects of Cumulative Exposure Assessment:

There are four general steps to performing an exposure assessment which attempts to estimate cumulative exposures related to a specific facility's activity (e.g., gravel mining) in relation to total environmental exposures impacting a designated "receptor" community (e.g., Azusa, Baldwin Park, El Monte, Irwindale).

1. Identify Compounds of Potential Concern (COPCs) associated with the specific activity under study (i.e., determine which compounds are used or present and therefore available for potential release into the environment).

2. Measure and/or estimate COPC levels in the community due to the specific activity (i.e., measure or model concentrations of COPCs in the receptor community's environment in such a fashion as to identify only those COPC levels caused by releases from the facilities under study).

3. Measure and/or estimate ambient levels of COPCs and other environmental pollutants in the community due to all other activities (e.g., transportation, releases from other facilities, pollution migration from other areas) in or near the receptor community (i.e., measure or model concentrations of all pollutants, including COPCs, in the receptor community's environment in such a fashion as to identify only levels caused by releases from other activities).

4. Summate cumulative exposure contributions from the specific activity under study and compare to those from other activities.

Cumulative Exposure Assessment - Data Needs Applied to Gravel Mining:

Following the four general steps, a thorough assessment of cumulative exposures for area residents to all sources of air and water pollution, specifically focusing on releases associated with local gravel mining operations, would require the following data:

- Thorough identification of specific compounds associated with gravel mining that are potentially released to the environment by local operations (i.e., identifying compounds of potential concern).

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For example, such an analysis might include acquiring data on the composition of the rock and gravel material being mined in the area (i.e., identifying compounds that are potentially released from the physical mining activity), compounds used in processing and compounds potentially released from vehicles (esp. diesel vehicles transporting rock and gravel) and other equipment used at the facilities.

- Comprehensive monitoring or modeling data on releases of those compounds to local ambient air (including deposition of airborne material to surface soil), shallow ground water and surface water bodies used by residents.

  The only such example we were able to find was an air monitoring study, conducted in 1991 in Azusa by the South Coast Air Quality Management District (SCAQMD), for the goal of determining Azusa Rock Company's compliance with SCAQMD Rule 403(c) - Fugitive Dust (Report of Micrometeorological and Ambient Air Quality Monitoring Conducted in Azusa in the Vicinity of Azusa Rock, Inc., SCAQMD, 1993). During this study, air samples were collected for 3 days in the immediate vicinities of the Azusa Rock, Calmat, Owl Rock and San Gabriel gravel mining operations; these samples were analyzed only for fugitive dust. In the context of quantifying cumulative exposures, an advantage of this study is that it specifically targeted releases from gravel mining operations. Disadvantages are that it measured only one general class of compounds (fugitive dust), and did not identify specific individual compounds; nor was dispersion modeling performed to estimate airborne concentrations at various points of exposure in the community. This report can be found under Tab 7.

- Comprehensive monitoring or modeling data on all pollutants in local ambient air, indoor air, surface soil, drinking water and surface water bodies used by residents,

  The 1998-1999 Multiple Air Toxics Exposure Study (MATES-II) study by the SCAQMD is a good example of the cumulative exposure concept as it is applied to ambient air exposures to toxic compounds. MATES-II, which is one of the most comprehensive air toxics exposures studies ever conducted in an urban environment, consisted of three elements: (1) a comprehensive air monitoring program, (2) an updated inventory of emissions from specific facilities and mobile sources, and (3) a modeling effort to fully characterize airborne toxics exposures in the South Coast Air Basin. Of immediate relevance is that although the Azusa, Baldwin Park, El Monte, Irwindale community is on the edge of the MATES-II study area, one of its monitoring stations was located close-by in South El Monte.

  A complete report of the MATES-II project is available at:
  http://www.aqmd.gov/matesiidf/matestoc.htm,
  and summary information is presented in Tab 5 of the attachments.

Data Format for Cumulative Exposure Assessment:

In order to aggregate and compare data from the various individual components of a cumulative exposure assessment in a meaningful fashion, there are specific data formats that are preferable:

First, sampling or modeling must be performed in such a fashion as to express individual data elements in substantially similar form and units. The data form most relevant to assessing exposure would be concentration of individual compounds at the points of exposure. Concentration data is expressed as the mass of each individual compound present in its relevant environmental media (e.g., 0.7 micrograms of benzene per cubic meter of air [ug/cm3], 5 milligrams of arsenic per liter of drinking water [mg/l]).

Second, individual data points must be summarized in a statistical fashion suitable for assessment of exposure. The statistical measure that is often most relevant to assessing long-term exposure is the annual average concentration.

Less useful data formats for cumulative exposure assessment include:

- emissions or concentration data for general compound classes as opposed to individual compounds (e.g., concentration of reactive organic gases vs. concentrations of benzene, 1,4-butadiene, etc.),
- daily/weekly/monthly/yearly maxima and minima as opposed to annual averages,
- number of days per year that a particular standard is exceeded vs. annual average concentrations (e.g., 237 ozone standard exceedance days per year vs. 0.07 ppm annual average ozone concentration).

Similarly, data on *actual* measured or modeled concentrations or release volumes are usually preferable to information on permitted release levels.

Existing Data and Information: Existing data and information relevant to assessing cumulative exposures in the Azusa, Baldwin Park, El Monte and Irwindale area are presented in the attached Tables A, B-1 through B-17, and C, and in the discussion below on identification of compounds of potential concern.

Identification of Compounds of Potential Concern (COPCs): Our review of data collected by the U.S. EPA and relevant state and local agencies found the following information on the identification of compounds of potential concern (COPCs) related to gravel mining operations:

- A reference (Abandoned Mine Lands Preliminary Assessment Handbook) to COPCs typically encountered at old (abandoned) mine sites. Although oriented to assessment of environmental impacts of underground ore mining, this reference contains some useful information relevant to other types of mining. Regarding identification of COPCs, the Handbook notes "[t]he most prevalent [COPCs] ... are heavy metals (e.g., lead, cadmium, metalloids (e.g., arsenic), some minerals (e.g., asbestos) and processing

[illegible] is attached as Tab 2.

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Name of Document	Description	Tab No.
National Environmental Policy Act (NEPA) Review	EPA has provided written comments to the U.S. Bureau of Land Management (BLM) on their Federal Environmental Impact Statements for the proposed "Soledad Canyon Sand and Gravel Mining Project" in Los Angeles County, California. The two attached letters illustrate the environmental issues that can be associated with sand and gravel mining operations in Los Angeles County. For further information contact David Tomsovic, U.S. EPA - Region 9, at 415-972-3858.	3
California Environmental Quality Act (CEQA) Review	The Governor's Office of Planning and Research maintains a database containing key information for all CEQA documents submitted to the State Clearinghouse for state review since 1990. This "CEQAnet" database provides summaries of Environmental Impact Reports (EIRs) and Negative Declarations (NDs) prepared under the CEQA, as well as Federal environmental documents prepared under the NEPA. To access the database go to www.ceqanet.ca.gov For further information contact Frank Ramirez, Governor's Office of Planning and Research, at 916-445-0613.	4

Clean Air Act (CAA)

Name of Document	Description	Tab No.
Executive Summary of the Multiple Air Toxics Exposure Study (MATES-II)	The MATES-II is a landmark urban toxics monitoring and evaluation study conducted for the South Coast Air Basin (Basin). The study was initiated as part of the Environmental Justice Initiatives adopted by the South Coast Air Quality Management District (District) Governing Board in October 1997. The study represents one of the most comprehensive air toxics programs ever conducted in an urban environment, and certainly much more comprehensive than a similar study (MATES-I) conducted by the District over a decade ago. The MATES-II project consists of several elements. It consists of a comprehensive monitoring program, an updated emissions inventory of toxic air contaminants, and a modeling effort to fully characterize Basin risk. To view the entire MATES-II study go to http://www.aqmd.gov/matesiidf/matestoc.htm For further information contact Carol Bohnenkamp, U.S. EPA - Region 9, at 415-947-4130.	5

Clean Air Act (cont.)

Name of Document	Description	Tab No.
California Air Resources Board Information - Air Toxics "Hot Spots" Program (AB 2588)	The Air Toxics "Hot Spots" Information and Assessment Act (AB, 2588, 1987, Connelly) was enacted in September 1987. Under this, stationary sources are required to report the types and quantities of certain substances their facilities routinely release into the air. Emissions of interest are those that result from the routine operation of a facility or that are predictable, including but not limited to continuous and intermittent release and process upsets or leaks. The goals of the Air Toxics "Hot Spots" Act are to collect emission data, to identify facilities having localized impacts, to ascertain health risks, and to notify nearby residents of significant risks. Data is provided for the 148 facilities (located within Azusa, Baldwin Park, El Monte, and Irwindale) that are required to report under AB 2588. That includes, but is not limited to, gravel mining operations. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6
Summary Report from South Coast Air Quality Management District (May 2, 2002)	Contains a summary of gravel mining activities in the San Gabriel River area near the cities of Azusa and Irwindale. It includes estimated emissions from these operations, available monitoring information, status of operation, facility identification number and a list of violations. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978 or Joe Cassmassi, South Coast Air Quality Management District, at 909-396-3155.	7

Clean Air Act (cont.)

Name of Document	Description	Tab No.
Monitoring Station Data	The tables show twenty years of monitoring data for all National Ambient Air Quality Standards (NAAQS) Pollutants for Azusa. There are current violations for ozone standard and the proposed fine particulate (PM2.5) standard. There were violations of the PM10 standard prior to1995, but there have been no violations of the PM10 standard since 1995. There have been no violations of the carbon monoxide, nitrogen dioxide, sulfur dioxide, or lead standards in the last 20 years. For further information contact Carol Bohnenkamp, U.S. EPA - Region 9, at 415-947-4130 or Joe Cassmassi, SCAQMD, at 909-396-3155.	8
	The Annual Toxics Summaries (since 1989) for Azusa, Los Angeles, El Monte (historical data), and Upland monitoring stations have also been obtained. The summaries include information on Volatile Organic Compounds, Polycyclic Aromatic Hydrocarbons, and Metals. The Annual Toxics Summaries can be found at http://www.arb.ca.gov/aqd/toxics/toxics.html	9
2001 Estimated Annual Average Emissions - South Coast Air Basin	The California Air Resources Board and local air pollution agencies collect, estimate and forecast emission inventory data throughout California. These data are used to estimate the quantity of emissions from different types of emission sources such as point sources, area sources, and mobile sources. Additional information can be found at http://www.arb.ca.gov/emisinv/emsmain/emsmain.htm For further information contact Carol Bohnenkamp, U.S. EPA - Region 9, at 415-947-4130 or Joe Cassmassi, SCAQMD, at 909-396-3155.	10

Clean Water Act (CWA)

Name of Document	Description	Tab No.
Reach 3 of the San Gabriel River	Ambient surface water quality data collected by the Department of Water Resources at their "Azusa Powerhouse" monitoring station from 1997 through 2000. Liquid media grab samples (#) for the following parameters: alkalinity (2), boron (5), calcium (6), chloride (6), flow (6), fluoride (3), magnesium (6), nitrate (5), pH (3), potassium (5), sodium (5), specific conductance (6), sulfate (6), temperature (6), total dissolved solids (6), total hardness (6), and turbidity (5). Data show that Reach 3 of the San Gabriel River is in attainment for surface water quality standards for these parameters. (Please note that some of these measured parameters do not have applicable water quality standards.) For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Renee DeShazo, Los Angeles Regional Water Quality Control Board, at 213-576-6783.	11

Verbal description
of Binder #2
Tab 11

Safe Drinking Water Act (SDWA)

Name of Document	Description	Tab No.
Safe Drinking Water Act - Public Water Supply Program	Drinking water compliance monitoring data (January 1994 to present) for active sources for seven public water systems (Azusa Light and Water, La Puente Valley CWD, Suburban Water System-San Jose, California Domestic Water Co., Valley County Water District and Covina Irrigating Co., San Gabriel Valley Water Company-El Monte/Whittier System). Summary sheet for each system to include well depths and highest level detected for individual contaminants is provided. All water delivered to customers meet federal and state drinking water standards. Source of data: State water quality database. For further information contact Corine Li, U.S. EPA - Region 9, at 415-972-3560 or Joseph Crisologo, District Engineer - Hollywood District, at 213-580-5743.	12

Name of Document	Description	Tab No.
Baldwin Park Superfund Site - Groundwater Contaminant Plumes	Once or twice a year, figures are prepared showing the approximate extent of groundwater contamination in the Azusa-Irwindale-Baldwin Park area. The figures are prepared by the Baldwin Park Operable Unit Potentially Responsible Parties and local water agencies, with EPA oversight. The first figure, labeled Figure 26, shows the locations of water supply wells and groundwater monitoring wells in the area. The city of Irwindale is located in the center of the figure. Figure 26 also shows two red lines (labeled A-A and B-B) which pass through wells used to prepare ten additional figures showing the approximate vertical extent of groundwater contamination (Figures 27 - 36). The ten figures consist of two vertical cross sections for each of five different contaminants found in the groundwater (carbon tetrachloride, NDMA, perchlorate, TCE, and tetrachloroethene). Each of the ten cross sections shows the approximate vertical extent of contamination, the locations of wells used to draw the cross sections, the depths of the wells, the depths of the well screen(s), and the contaminant concentration measured in samples collected from each well or well screen. The wells sampled include large public water supply wells owned by Covina Irrigating Company, California Domestic Water Company, La Puente Valley County Water District, San Gabriel Valley Water Company, Suburban Water Systems, and Valley County Water District. Also sampled are deep "multi-level" monitoring wells installed by EPA and the Potentially Responsible Parties (designated with the prefix MW), and shallow monitoring wells installed by the Potentially Responsible Parties. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181 or Carol Williams, San Gabriel Valley Water Master, at 626-815-1300.	13

Comprehensive Environmental Response, Compensation and Liability Act (cont.)

Name of Document	Description	Tab No.
General Map of Superfund Sites	For further information contact Sunny Nelson, U.S. EPA - Region 9, at 415-947-4255.	14
Map of the 1997Groundwater Contaminant Plumes	For further information contact Sunny Nelson, U.S. EPA - Region 9, at 415-947-4255.	14

Resource Conservation and Recovery Act (RCRA)

Name of Document	Description	Tab No.
General Map of RCRA Facilities	For further information contact Sunny Nelson, U.S. EPA - Region 9, at 415-947-4255.	14
Solid Waste Information System (SWIS) Database - Maintained by the California Integrated Waste Management Board (CIWMB)	The SWIS database contains information on solid waste facilities, operations, and disposal sites throughout the State of California. The types of facilities found in this database include landfills, transfer stations, material recovery facilities, composting sites, transformation facilities, waste tire sites, and closed disposal sites. For each facility, the database contains information about location, owner, operator, facility type, regulatory and operational status, waste types received, and local enforcement agency. To access the database go to http://www.ciwmb.ca.gov/SWIS/	15

TABLE B-1
FACILITY SPECIFIC INFORMATION

Name of Facility: **Azusa Western**

Owner: **Vulcan**

Contact: **Gary Gold**

Address: **3200 San Fernando Road, Los Angeles, CA 90065**

Phone Number: **(323) 258-2777**

OPERATING PERMITS

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed or issued for this facility. However, not all facilities are subject to Title V. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	No	No listing at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978 or Rod Millican, South Coast AQMD, at 909-396-2591.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Azusa Landfill (File No. 59-102, CI 2567): This site has been named by the USEPA as a lesser PRP in the clean-up of the San Gabriel Valley Superfund site. The site is located in a portion of an active gravel mining pit. Mining operations are being conducted in another portion of the pit by Cemex California Aggregates, Inc. A description of this operation is discussed separately and included with the water quality data for Azusa Landfill. Groundwater monitoring data are available (since 1984); however, this data primarily reflects the results of discharges from other industrial sites in the area. Due to three landfill-specific constituents detected in groundwater, the landfill is currently undergoing corrective action. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

TABLE B-2
FACILITY SPECIFIC INFORMATION

Name of Facility: **United Rock #1**

Owner: **United Rock Products**

Contact: **Arnold Brink, Op Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **(626) 358- 4558**

COMPLIANCE AUDIT

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

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Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	United Rock Products Pit No. 1 (File No. 01-084, CI 8316): This site has been recently permitted as an inert landfill. Water quality analytical data at the pit--obtained from 1993 to 1996--indicate that exposed groundwater is not contaminated. The site operator is required to start groundwater monitoring in 2002. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

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South Coast Air Quality Management District (AQMD) Permit	No	No listing at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978 or Rod Millican, South Coast AQMD, at 909-396-2591.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

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Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

TABLE B-2
FACILITY SPECIFIC INFORMATION

Name of Facility: **United Rock #1**

Owner: **United Rock Products**

Contact: **Arnold Brink, Op Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **(626) 358- 4558**

COMPLIANCE AUDIT

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	United Rock Products Pit No. 1 (File No. 01-084, CI 8316): This site has been recently permitted as an inert landfill. Water quality analytical data at the pit--obtained from 1993 to 1996--indicate that exposed groundwater is not contaminated. The site operator is required to start groundwater monitoring in 2002. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This facility address is in LA City is under the Jurisdiction of the LA City CUPA. We have no information by name or address on this facility. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Azusa Landfill (File No. 59-102, CI 2567): This site has been named by the USEPA as a lesser PRP in the clean-up of the San Gabriel Valley Superfund site. The site is located in a portion of an active gravel mining pit. Mining operations are being conducted in another portion of the pit by Cemex California Aggregates, Inc. A description of this operation is discussed separately and included with the water quality data for Azusa Landfill. Groundwater monitoring data are available (since 1984); however, this data primarily reflects the results of discharges from other industrial sites in the area. Due to three landfill-specific constituents detected in groundwater, the landfill is currently undergoing corrective action. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA Section 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

TABLE B-2
FACILITY SPECIFIC INFORMATION

Name of Facility: **United Rock #1**

Owner: **United Rock Products**

Contact: **Arnold Brink, Op Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **(626) 358- 4558**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This Business has submitted a Hazardous Materials Business Plan. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	United Rock Products Pit No. 1 (File No. 01-084, CI 8316): This site has been recently permitted as an inert landfill. Water quality analytical data at the pit--obtained from 1993 to 1996--indicate that exposed groundwater is not contaminated. The site operator is required to start groundwater monitoring in 2002. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active Gravel Pit
END 2011

TABLE B-3
FACILITY SPECIFIC INFORMATION

Name of Facility: **United Rock #2**

Owner: **United Rock Products**

Contact: **Arnold Brink, Op Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **626-358-4558**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This Business has submitted a Hazardous Materials Business Plan. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active Gravel Pit

TABLE B-4
FACILITY SPECIFIC INFORMATION

END 2000 ?

Name of Facility: **United Rock Plant**

Owner: **United Rock Products**

Contact: **Arnold Brink, Op Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **(626) 358-4558**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	Yes	AQMD Facility ID: 065341 For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This Business has submitted a Hazardous Materials Business Plan. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at.415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. Expired provisional EPA ID Number (CAP400478646). Not in ARIS. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

PROPOSED PIT AS OF '99

TABLE B-5
FACILITY SPECIFIC INFORMATION

Name of Facility: **Bubalo Sierra Pit**

Owner: **Bubalo Construction**

Contact: **John Schiller**

Address: **P.O. Box 1048, Monrovia, CA 91017**

Phone Number: **(626) 574-7570**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		Could not find any information under this name or address. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Peck Road Gravel Pit (File 82-17, CI 6650): This site is located in territory belonging to the City of Monrovia, at the border of the City of Irwindale. It occupies the same gravel pit as Hanson Aggregates Quarry. The Los Angeles RWQCB has water quality data, including general minerals, trace metals, and VOCs, that were obtained between 1996 and 2001. These data indicate that groundwater at the site has not been contaminated. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Attachment No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Attachment No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Attachment No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active Gravel Pit
END 2020

TABLE B-6
FACILITY SPECIFIC INFORMATION

Name of Facility: **Calmat Azusa Largo Main Plant Site**

Owner: **Vulcan**

Contact: **Gary Gold**

Address: **3200 San Fernando Rd., Los Angeles, CA 90065**

Phone Number: **(323) 258-2777**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address.. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This facility address is in LA City is under the Jurisdiction of the LA City CUPA. We have no information by name or address on this facility. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

INACTIVE PIT
CLOSED

TABLE B-7
FACILITY SPECIFIC INFORMATION

Name of Facility: **Calmat Baldwin Park Pit**

Owner: **Archdiosese of L.A.**

Contact: **Rev. Monsignor Fleming**

Address: **3424 Wilshire Blvd., L.A. , CA 90010**

Phone Number: **(213) 637- 7255**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	Not in our system under this name or owner address. Address is LA city address and could be under LA City CUPA. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

ACTIVE GRAVEL PIT
END 2008

TABLE B-8
FACILITY SPECIFIC INFORMATION

Name of Facility: **Calmat Durbin Pit**

Owner: **Vulcan**

Contact: **Gary Gold**

Address: **3200 San Fernando Rd., Los Angeles CA 90065**

Phone Number: **(323) 258-2777**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	None

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		Not in our system by address or name. LA City address. Could be LA City CUPA. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Attachment No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Referred to as United Rock #1 in Irwindale Study?
Active Landfill
Mining was scheduled to end in 2002

TABLE B-9
FACILITY SPECIFIC INFORMATION

Name of Facility: **Irwindale Pit**

Owner: **Crow Family Holdings**

Contact: **David Nazaryk**

Address: **3 Park Plaza Suite 100, Irvine, CA 92614**

Phone Number: **(949) 477-9122**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	Not in our system by name or address. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Developed (Irwindale Raceway)
CLOSED

TABLE B-10
FACILITY SPECIFIC INFORMATION

Name of Facility: **Miller Brewery Calmat Reliance #1**

Owner: **Miller Brewing Co.**

Contact: **Victor M. Franco**

Address: **15801 E. First St., Irwindale, CA 91706**

Phone Number: **(626) 969-6239**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		This Company has submitted a Hazardous Materials Business Plan For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	TRI Facility ID: 91706MLLRB15801 EPA Facility ID: CAT080011067 For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	17

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. This facility is a Large Quantity Generator and therefore has an EPA ID Number (CAT080011067). TSD - No Compliance Info - 1 inspection w/violations 9/24/1990 Last updated 8/18/1980 For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active Landfill
No End Date found

TABLE B-11
FACILITY SPECIFIC INFORMATION

Name of Facility: **Calmat Reliance # 2**

Owner: **Vulcan**

Contact: **Gary Gold**

Address: **3200 San Fernando Rd., Los Angeles, CA 90065**

Phone Number: **(323) 258-2777**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	Yes	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This facility address is in LA City is under the Jurisdiction of the LA City CUPA. We have no information by name or address on this facility. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Reliance Pit No. 2 Landfill (File 91-060, CI 7106): This site has been permitted by the Los Angeles RWQCB as an inert landfill since 1991. The site is permitted to receive uncontaminated soil, broken concrete, bricks, broken asphalt, inert aggregated mining wastes, and other inert solid wastes. Groundwater monitoring data for general minerals, trace metals, and VOCs from 1994 to 2001 are available at the RWQCB. Lower Azusa Reclamation Project (File No. 86-061, CI 771): This site is located in a territory that belongs to the City of Arcadia, at the border to the City of Irwindale. The Los Angeles RWQCB adopted WDRs for the site in 1996; however, the facility did not receive waste until late 2001. Groundwater is exposed in the pit. The RWQCB has water quality data, including general minerals, trace metals, and VOCs, that were obtained between 1996 and 2001. These data indicate that groundwater at the site is not contaminated. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Non-313	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active GRAVEL Pit
END 2005

TABLE B-12
FACILITY SPECIFIC INFORMATION

Name of Facility: **United Rock #3**

Owner: **United Rock Products**

Contact: **Arnold Brink, Opr Mgr**

Address: **1245 E. Arrow Hwy., Irwindale, CA 91706**

Phone Number: **(626) 358-4558**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	Yes	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		This Business has submitted a Hazardous Materials Business Plan. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	United Rock Products Pit No. 3 (File No. 73-32, CI 5801): This site has been permitted by the Los Angeles RWQCB as an inert landfill since 1973; however, no significant quantity of inert solid wastes has been disposed of at the site. In the future, the operator plans to fill the pit with inert wastes. Groundwater is exposed at the pit. Water quality analytical data obtained from 1993 through 1996 indicate that the exposed groundwater is not contaminated. Under a recently revised WDR adopted by the RWQCB, the operator is required to start groundwater monitoring at the site in 2002. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Active Gravel Pit
END 2005

TABLE B-13
FACILITY SPECIFIC INFORMATION

Name of Facility: **Livingston- Graham Irwindale Plant**

Owner: **Hanson Aggregates**

Contact: **Ken Barker**

Address: **16080 Arrow Highway, Irwindale, CA 91706**

Phone Number: **(626) 856-6785**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	Yes	AQMD Listing: Hanson Aggregate Facility ID: 020774 For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	Total emissions (NO_x, SO_x, etc.) as reported by facility.	7
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	This company is found under the name of Blue Diamond but has not submitted this year. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. This facility is a Large Quantity Generator and therefore has an EPA ID Number (CAD982028565). TSD - No Compliance Info - None Last updated 7/6/1987 For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

CLOSED
Zoned for Commercial/Rec.

TABLE B-14
FACILITY SPECIFIC INFORMATION

Name of Facility: **Miller Brewery Kincaid Plant**

Owner: **Miller Brewing Co.**

Contact: **Victor M. Franco**

Address: **15801 E. First Street, Irwindale, CA 91706**

Phone Number: **(626) 969- 6239**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information		None	None
California Toxic Hot Spots (AB2588)		No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	None

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		This Company has submitted a Hazardous Materials Business Plan. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. EPA ID Number (CAT080011067) For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

City Landfill
County Retention Basin
Zoned for Housing

TABLE B-15
FACILITY SPECIFIC INFORMATION

Name of Facility: **City of Irwindale/ LA County** Manning Bros in 99

Owner: **City of Irwindale**

Contact: **Steve Blancarte/ C Mgr**

Address: **5050 N. Irwindale, CA 91706**

Phone Number: **(626) 430-2217**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	None

Clean Air Act (cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program	No	Can not find a plan under this name or address. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Ta No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Manning Pit (File No. 61-101, CI 3066 and CI 6149): The northern portion of Manning Pit is currently owned and operated by the City of Irwindale. It is permitted by the Los Angeles RWQCB as an inert landfill. The site has been inactive since 1996 due to lack of inert waste source. The southern portion of the pit is currently operated by the County of Los Angeles for disposal of sediments collected from flood control facilities. No groundwater monitoring data is available for the pit. The RWQCB is revising the WDRs for the inert landfill. Groundwater monitoring data will become available in the next few years. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

TABLE B-16
FACILITY SPECIFIC INFORMATION

Name of Facility: **Alpha Pit**

Owner: **Pit was reclaimed, divided and sold as individual parcels**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	N/A		7
South Coast Air Quality Management District (AQMD) Permit	No	No record at AQMD under this site name or owner address. For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information	N/A	None	None
California Toxic Hot Spots (AB2588)	N/A	No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6
Risk Management Program	No	Can not find a plan under this name or address. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	No	For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	None

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Attachment No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Attachment No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

Inert Landfill

Zoned for Park, Rec., Commercial

TABLE B-17
FACILITY SPECIFIC INFORMATION

Name of Facility: **Nu- Way Industries**

Owner: **Mnoian Management**

Contact: **Jim Mnoian**

Address: **766 South Ayon Ave., Irwindale, CA 91706**

Phone Number: **(626) 334- 0719**

Clean Air Act (CAA)

Program	Permit or Document Available?	Additional Information	Tab No.
Federal Operating Permit (Title V Permit)	No	To date no Title V permit is proposed (not all facilities are subject to Title V) For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast Air Quality Management District (AQMD) Permit	Yes	AQMD listing: Nu-way Live Oak located at 13620 Live Oak Lane, Irwindale Facility ID: 106711 For further information contact Nahid Zoueshtiagh, U.S. EPA - Region 9, at 415-972-3978.	7
South Coast AQMD Information		None	None
California Toxic Hot Spots (AB2588)		No record under this site name or owner address. For more information about this program go to http://www.arb.ca.gov/ab2588/ab2588.htm	6

Clean Air Act (Cont.)

Program	Permit or Document Available?	Additional Information	Tab No.
Risk Management Program		Could not find any Business Plan under this name or address. For further information contact Al Fischer, U.S. EPA - Region 9, at 415-972-3084 or Walter Uroff, LA County Fire Department, at 323-890-4043.	None

Clean Water Act (CWA)

Program	Permit Required?	Additional Information	Tab No.
Clean Water Act - NPDES Permit (Surface Water)	No	An NPDES permit to this gravel operation is not required, as such permits are only required for the discharge of pollutants from point sources to surface waters. Discharge(s) from gravel pit operations are to ground water and not to surface water. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524.	None

Program	Permit Required?	Additional Information	Tab No.
Los Angeles RWCQB Waste Discharge Requirements (WDR for Shallow Groundwater)	Yes	Nu-Way Industrial Landfill (File No. 68-013, CI 5563): The Los Angeles RWQCB has permitted this facility as an inert landfill since 1969. However, no wastes have been disposed at the site since 1993. The 92-acre site has been fully developed by construction of the Irwindale Speedway (an auto racing facility) and other paved facilities. Groundwater monitoring data for this site, including general minerals, trace metals, and VOC, obtained from 1988 to 2000 are available at the RWQCB. These data indicate that groundwater at the site is generally not contaminated, except for one down-gradient groundwater monitoring well (MW-1), where arsenic concentrations have occasionally exceeded the 50 ppb drinking water MCL (maximum concentration 210 ppb). However, analyses of filtered samples may be just in solid particles, not in dissolved form. No elevated arsenic concentrations have been detected in other monitoring wells in the vicinity of MW-1. RWQCB staff do not believe that groundwater at the site is contaminated by arsenic.. Nu-Way Live Oak Landfill (File No. 83-017, CI 6728): This site is an inert landfill that is in full operation. The site is permitted to receive uncontaminated soil, broken concrete, bricks, broken asphalt, inert aggregated mining wastes, plasterboard, and other inert solid wastes. Groundwater monitoring data for general minerals, trace metals, and VOCs--from 1994 to 2001--are available at the RWQCB. For further information contact Robyn Stuber, U.S. EPA - Region 9, at 415-972-3524 or Paula Rasmussen, LA RWQCB, at 213-620-6791.	16

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Program	Action Taken?	Additional Information	Tab No.
Groundwater Contaminant Plumes - Ambient Groundwater Data	Yes	See Table A. For further information contact Wayne Praskins, U.S. EPA - Region 9, at 415-972-3181.	13
Site Assessment	None	No site assessments performed. For further information contact Betsy Curnow, U.S. EPA - Region 9, at 415-972-3093.	None

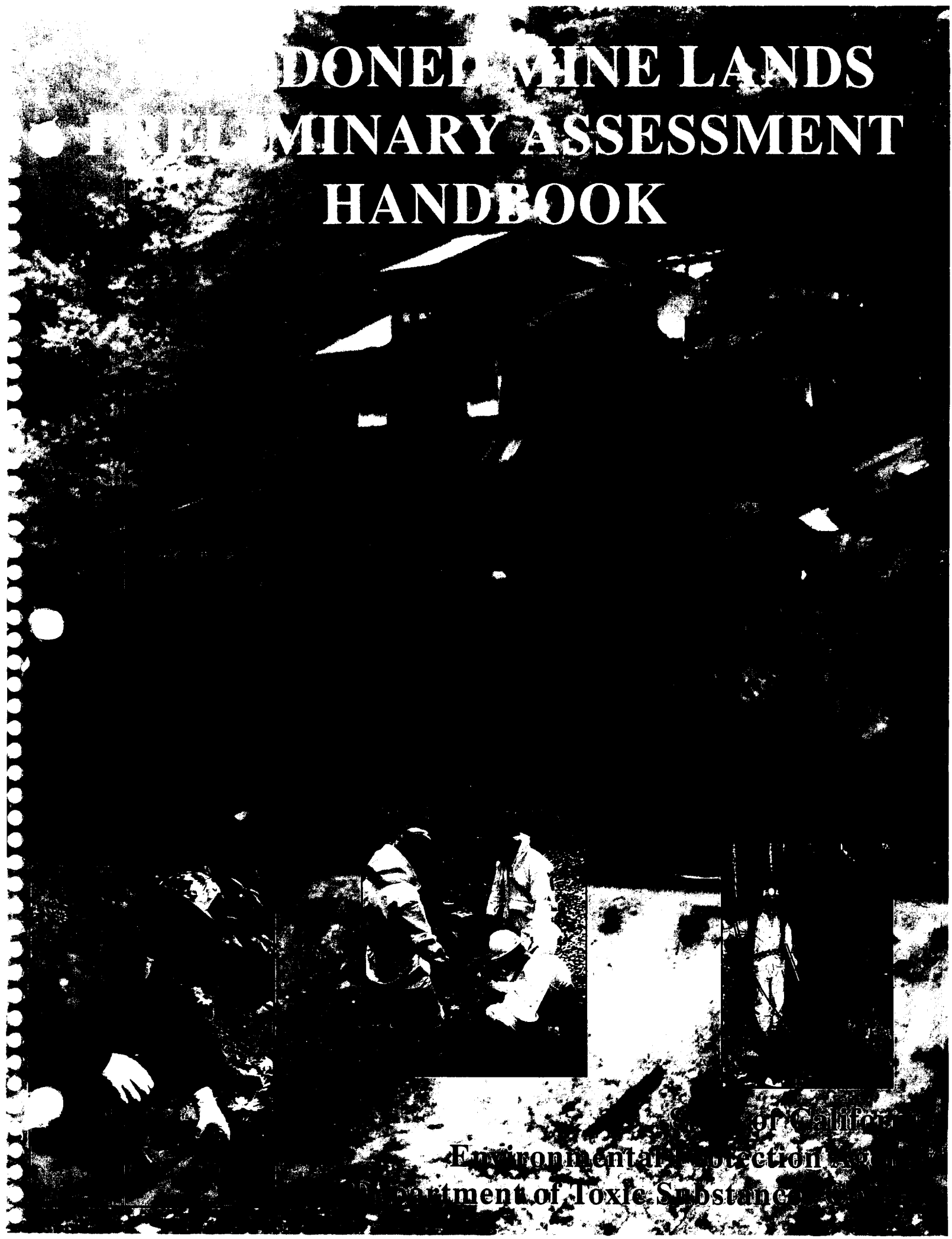
Emergency Planning and Community Right-to-Know Act (EPCRA)

Program	Information Submitted?	Additional Information	Tab No.
EPCRA Sections 302-312	No	No listing under this site name or owner address.	None
EPCRA 313 (Toxic Release Inventory)	No	Gravel quarries do not have to report under TRI since they are not in a covered Standard Industrial Classification code. For further information contact Adam Browning, U.S. EPA - Region 9, at 415-947-4178.	None

Resource Conservation and Recovery Act (RCRA)

Program	Permit Required?	Additional Information	Tab No.
RCRA - Hazardous Waste	No	RCRA hazardous waste permits are only required at facilities that treat, store, or dispose of regulated hazardous wastes. This facility is a Transporter and therefore has an EPA ID Number (CAR000017657). TSD - No Compliance Info - None BDC Spec Waste Service @ 766 S. Ayon Ave. in Azusa, CA 91702 Last updated 10/23/1997 For further information contact Steve Armann, U.S. EPA - Region 9, at 415-972-3352.	None
RCRA - Solid Waste SWIS Database	No	No listing at CIWMB under this site name or owner address.	15

ABANDONED MINE LANDS PRELIMINARY ASSESSMENT HANDBOOK



State of California
Environmental Protection Agency
Department of Toxic Substances Control

ABANDONED MINE LANDS

PRELIMINARY ASSESSMENT HANDBOOK

January 1998

PREFACE

The idea for the Abandoned Mine Lands Preliminary Assessment Handbook (AML Handbook) emerged from a 1994 Abandoned Mine Workshop sponsored by the Department of Toxic Substances Control (DTSC) and the California Conference of Directors of Environmental Health, when it became evident that guidance was necessary for evaluating California's abandoned mine lands (AML). The guidance document needed to serve a dual purpose: 1) provide non-technical information explaining the concerns associated with AML sites to AML property owners, developers whose projects may be on or adjacent to AML sites, and local planners who make land use decisions; and 2) provide technical information for environmental consultants, local environmental health officials, and other state and federal agencies who must evaluate California AML sites. Funding to create the guidance document was provided by a grant from the United States Environmental Protection Agency (U.S. EPA).

DTSC formed a core group whose members are familiar with AML issues, and represented the California State Water Resources Control Board, the Department of Conservation, the U.S. Geological Survey (USGS), and U.S. EPA. Initial discussions included the former U.S. Bureau of Mines. Additional input was solicited from the U.S. Forest Service and Bureau of Land Management, who are addressing abandoned mine issues on federally owned land. The purpose of the group was to develop an AML preliminary assessment handbook.

Developing a single guidance document to cover historic mining of more than 60 types of commodities proved to be a daunting, if not unrealistic task. However, most commodities are limited to a few mine sites (e.g., rare earth metals) whereas a few commodities have been mined extensively throughout California (e.g., gold, mercury, and copper). Chemical concerns are often associated with hardrock mines (e.g., copper and gold). Other types of mining operations (e.g., limestone and aggregate) rarely have chemical concerns. Illegal dumping of chemicals or leaking fuel tanks can produce problems at any site. Many AML sites have physical hazards. Some AML sites have erosion problems; mine wastes may wash into streams or be a source of wind-blown dust, which may have negative impacts on adjacent properties and the environment.

This preliminary assessment handbook combines the "Preliminary Endangerment Assessment Guidance Manual" (January 1994), by DTSC and the draft "Abandoned Mine Land Inventory and Hazard Evaluation Handbook" (May 1994), by the former U.S. Bureau of Mines. Chapter 8 (Ecological Screening Evaluation) of this handbook is a slightly modified version of "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part B: Scoping Assessment" (July 1996), developed by the Human and Ecological Risk Division, Office of Scientific Affairs, DTSC. The USGS wrote Appendices A, B, and G which address mineralogy, ore deposit location, environmental interactions, and acid generating potential. Appendix A also provides maps illustrating past and present producing mines, physiographic provinces of California, lode gold mines, base metal mines, and mercury mines.

The AML Handbook incorporates much of the information required for completion of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) preliminary assessment (PA) and site inspection (SI) investigations. It covers background information requirements similar to a Phase I Environmental Assessment which is required by most lending institutions prior to commercial real estate transactions. Although an AML investigation is more comprehensive than the requirements for the PA/SI and Phase I Assessments, information gathered for an AML investigation may also be useful for those purposes. The approach taken in this AML handbook is designed to be flexible and can be tailored to meet the objectives of the investigator.

AML sites will continue to impact California's environment and pose even greater risks to public health as development pushes closer to once isolated AML areas. Issues surrounding AML sites are diverse and complicated. DTSC, in an effort to address hazardous waste and hazardous substances sites, including AML sites, has developed a Voluntary Cleanup Program to provide regulatory oversight and technical assistance for investigation, remediation, and certification of sites. This fee-for-service program can be tailored to specific needs. A fact sheet describing this program is included in Appendix K.

ACKNOWLEDGEMENTS

This document was developed under the direction of Mr. James L. Tjosvold, P.E., Chief, Northern California–Central Cleanup Operations Branch, DTSC, and Ms. Fran E. Anderson, Chief, Sacramento Responsible Party Unit, DTSC. Principal writer of this document was Mr. Daniel V. Ziarkowski, Hazardous Substances Scientist, DTSC.

We thank Mr. Roger P. Ashley, USGS, and Mr. Charles N. Alpers, USGS, for authoring appendices A, B, and G.

We would like to thank Ms. Rachel Loften, U.S. EPA, who helped us circumnavigate the obstacles we encountered during the development of the "Abandoned Mine Lands Preliminary Assessment Handbook" (AML Handbook). We thank Mr. Nick Zilka and Mr. Dale Avery and other staff of the former U.S. Bureau of Mines who developed the draft "Abandoned Mine Land Inventory and Hazard Evaluation Handbook", but did not have the opportunity to see their effort reach fruition. We also thank the staff of DTSC who developed the "Preliminary Endangerment Assessment Guidance Manual" that is the foundation for the AML Handbook.

We appreciate the efforts of Mr. Timothy P. Snellings, Director, Nevada County Environmental Health Department, and his staff, and Mr. Michael Israel, Director, Amador County Environmental Health Department, to enlighten us about the difficulties they face trying to resolve AML issues at the county level.

It is not possible to list the many scientists (private, academic, and government), consultants, and regulatory officials from California and other western states who helped to identify and comment on abandoned mine lands issues and provided suggestions for the AML Handbook.

A special thanks to the abandoned mine core group, especially Mr. Roger P. Ashley, who helped to focus the many complicated issues and provided thoughtful comments and suggestions during the development of this document. Core Group members included:

Charles N. Alpers, Ph.D.; USGS
Fran Anderson, MS; DTSC
Roger P. Ashley, Ph.D.; USGS
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Sean P. Hogan; US EPA
Rick Humphries; SWRCB
James Pompy; DOC
James J. Rytuba, Ph.D.; USGS
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Brad Shipley; US EPA
Daniel V. Ziarkowski; DTSC

Assistance with formatting figures and tables was provided by Ms. Madeleine English, DTSC. Assistance on document formatting was provided by Ms. Kathy Mitchell, California Office of State Publishing.

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Inset Photographs: DTSC file photos.

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PART I

GENERAL INFORMATION

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND

California has a vast legacy of economic prosperity and innovative technological development stemming from its historic mining activities. Minerals recovered from California have been used to improve many facets of American life. Unfortunately, another legacy associated with historical mining is significant degradation of the environment. The main reason environmental damage occurred is that historic mining operations were not subject to current environmental protection laws.

More than a century of placer and hard-rock mining has created thousands of Abandoned Mine Lands (AML) sites with hundreds of millions of tons of solid wastes. California's rapidly growing population is encroaching on areas of historic mining activities, creating a greater potential for adverse effects to human health and the environment.

Abandoned and inactive mines are found on both private and public lands. While not all AML sites are hazardous, an assessment of each AML site must be conducted before land use decisions are made and/or development occurs. If development has already occurred on an AML site, it should be assessed to determine whether threats to human health or the environment exist. In addition, proper evaluation of mine wastes should be conducted prior to using these materials for construction, landscaping, or other purposes on or off-site.

Abandoned mines and associated mining wastes may pose both physical and chemical hazards. Many of these hazards are the result of historic mining practices, ore processing techniques, improper closure procedures, or the surface exposure of ore deposits. Potential hazards vary greatly from one mine to the next. Each abandoned mine and associated mine waste piles need to be evaluated individually to determine which concerns are associated with it. Some AML sites may only pose physical hazards and have no chemical hazards associated with the mine wastes (e.g., limestone quarry).

Physical hazards at AML sites can vary greatly and are the most common source of death and injury to people. AML sites often contain structures, tunnels, and waste piles, which attract adventurous explorers who are usually unaware of the potential dangers.

In addition to the physical hazards, AML sites can contain chemical hazards. Chemical hazards are usually associated with heavy metals and/or acid mine drainage (AMD). Many of the chemical concerns of mine waste piles depend on the type of mining and ore processing techniques that were used either on site or at the parent mine.

1.2 ABANDONED MINE LANDS PRELIMINARY ASSESSMENT HANDBOOK

The Abandoned Mine Lands Preliminary Assessment Handbook (AML Handbook) provides basic information for conducting an initial investigation of AML sites. This document will aid the AML investigator in identifying physical hazards at AML sites and determining whether chemicals are present that may pose a risk to human health or the environment. In addition, the AML Handbook provides technical information specifically addressing concerns associated with historic hardrock mines. Supplemental technical information is provided in appendices.

This handbook does not address investigative techniques for chemical releases not normally associated with AML sites, e.g., wastes from other commercial or industrial activities or illegally dumped hazardous wastes. If such contamination is suspected, refer to the Department of Toxic Substances Control's (DTSC) Preliminary Endangerment Assessment Guidance Manual (DTSC, 1994) or consult with local environmental health officials or with DTSC for further information.

Specific objectives of the AML investigation include:

- Determining if physical hazards are present;
- Determining if chemical hazards are present at concentrations that pose a potential risk to human health based on residential (unrestricted) land use or through the secondary use of mine wastes;
- Determining if environmental degradation has occurred or is occurring; and
- Determining if a quick response is necessary to reduce an existing or potential threat to public health or the environment.

It is recommended that the AML investigator consult with a professional geologist, scientist, or engineer (e.g., Registered Geologist, Registered Engineering Geologist, Registered Hydrologist, Mining Engineer, Civil Engineer, or Environmental Scientist) with experience addressing abandoned mine issues. Issues surrounding AML sites can be complicated. Consulting a professional can help to expedite the investigation in a cost efficient manner.

1.3 LIMITATIONS OF THE HANDBOOK

The AML Handbook is designed to provide general guidance for technical consultants, regulatory officials, and other interested parties conducting an AML investigation. This handbook is not designed to provide guidance for conducting a complete AML site characterization (e.g., Remedial Investigation /Feasibility Study), but should complete characterization be necessary, the AML Handbook will provide a foundation on which to conduct further work. The AML Handbook provides guidance for AML sites of most sizes and types. It addresses commonly encountered hazards, but does not identify every possible physical or chemical hazard (e.g., additional radiological considerations would be necessary when evaluating uranium mine tailings). The AML Handbook is not intended to be a "cookbook" of mandatory ingredients required to produce an AML report. Rather, it presents general procedures and explains how to tailor them to specific AML sites. An AML investigation requires a high degree of judgement on the part of the investigator to recognize and address site-specific concerns.

The human health risk is determined by comparing data collected from the site with Preliminary Remediation Goals (PRGs) developed by the U.S. Environmental Protection Agency (U.S. EPA) or DTSC's Preliminary Endangerment Assessment Guidance Manual's (PEA) human health screening evaluation. Because this is a general guidance document, residential land use is assumed, which requires the most conservative evaluation approach to determine potential impacts to human health. If land use other than residential is intended (e.g., commercial), different screening levels may apply and consultation with DTSC or a toxicologist is recommended. U.S. EPA PRGs are reviewed annually (an updated version is due in December 1997).

The environmental and ecological assessment is based on a qualitative approach rather than a quantitative approach. Chemical interactions within ecosystems can be extremely complex. Identifying the full range of potential interactions of numerous chemicals with a multitude of biological species is not practical. Most AML-related environmental damage is readily visible in terms of lack of vegetation and aquatic life. Observations of habitat degradation at AML sites can support the assessment of ecological impacts. The AML Handbook identifies "symptoms" of environmental damage. However, environmental degradation can occur and not be visible. For example, metals can bioaccumulate in the environment (e.g., mercury in fish) and not show any visible signs. The potential for this type of environmental damage is dependent on the contaminant(s) and site specific factors. A detailed evaluation of environmental degradation should be conducted by a properly trained field biologist if full ecological characterization is required.

The DTSC acknowledges that background evaluation of heavy metals or asbestos in highly mineralized areas can be complicated and that background may influence site-specific concentrations at some AML sites. It is beyond the scope of this document to provide complete background characterization guidance, in part, because background evaluation is highly site specific. If background levels of heavy metals or asbestos are believed to have significantly impacted the site, it may be necessary to contact a professional geologist, soil scientist, environmental

scientist, environmental engineer or other qualified professional to conduct a site-specific background study. Background for the purposes of a screening evaluation is discussed in sections 5.2.4 and 6.5.4 of this document.

1.4 ORGANIZATION OF THE HANDBOOK

The AML Handbook is organized in three main parts. Part I provides general background information to non-technical people to aid in their understanding of AML issues. Part II provides technical information for conducting an AML Preliminary Assessment investigation. Part III provides a suggested reporting format. An acronym list, glossary (defining many terms used throughout this document), and bibliography are also provided. Appendices provide information to supplement several topics discussed in the AML Handbook. This guidance handbook includes colored photographs illustrating principal topics described in the text.

A brief description of chapters within this document follows:

Part I General Information

- Chapter One provides an introduction to this document outlining its purpose and indicating its limitations;
- Chapter Two provides a general overview of the mineral industry; and
- Chapter Three discusses physical and chemical hazards associated with abandoned mines.

Part II Abandoned Mine Lands Preliminary Assessment Investigation

- Chapter Four outlines the initial steps for conducting an AML investigation;
- Chapter Five discusses data collection, sampling strategies, and workplan preparation;
- Chapter Six discusses sample analysis;
- Chapter Seven discusses procedures for conducting a human health screening; and
- Chapter Eight outlines the approach for conducting an ecological evaluation.

Part III Suggested Report Format

- Chapter Nine provides a suggested format for preparing an AML report.

APPENDICES

The appendices to the AML Handbook elaborate on several topics and provide supplemental information to aid the AML investigation:

- Appendix A describes the characteristics and distribution of California mineral deposits, and their environmental impacts;
- Appendix B describes how mineral deposits interact with the environment;
- Appendix C contains a description of typical mineral processing methods;
- Appendix D contains a description and sampling strategy for specific types of mine waste;
- Appendix E provides information on augering and trenching;
- Appendix F discusses surface water evaluation;
- Appendix G discusses acid generating potential;
- Appendix H discusses health and safety;
- Appendix I provides information on public participation;
- Appendix J provides information on the Waste Extraction Test;
- Appendix K contains a Voluntary Cleanup Program (VCP) fact sheet; and
- Appendix L provides a list of state and federal agencies.

CHAPTER TWO
MINERAL INDUSTRY OVERVIEW

A variety of mineral commodities and mining and milling methods may be encountered in AML sites. This chapter provides a brief overview of the mineral industry. A detailed description of four selected mineral processing methods can be found in Appendix C.

Mineral commodities can be grouped into three categories: metallic minerals, nonmetallic (industrial) minerals, and solid energy fuels. Metallic minerals, commonly called "ore minerals", include the precious metals (gold, silver), base metal sulfides (sulfides of copper, lead, zinc), and oxides of major metals (aluminum, iron, titanium). Examples of nonmetallic minerals include asbestos, calcite, dolomite, gypsum, and quartz. They are not processed for the metals they contain, rather, their value lies in their chemical and physical properties. Solid energy fuels include coal, tar sands, and uranium (although uranium is mined and processed like a base metal). See Table 2-1.

There are two basic types of mines: surface and underground. The selection of a mining method depends on the nature and location of the deposit and cost considerations.

Surface mining, which includes open-pit mining, is used for large, near-surface deposits which generally have low commodity value per unit volume. In

COMMODITIES PRODUCED IN CALIFORNIA

rock and abrasives	gem stones	salines
antimony	gold	salt
arsenic	graphite	sand and gravel
asbestos	gypsum	shale
asphalt and bituminous rock	iron	silver
barite	kyanite and andalusite	sodium carbonate
bismuth	lead	sodium sulfate
black sand	limestone	speciality sands
boron	lithium	stone (crushed and dimension)
bromine	magnesite	strontium minerals
cadmium	magnesium	sulfur
calcite	manganese	talc and soapstone
calcium chloride	mercury	tin
chromite	mica	titanium
clay	molybdenum	tungsten
coal	peat	uranium
cobalt	pumice and related rocks	wollastonite
copper	pyrite	zeolite
diatomite	pyrophyllite	zinc
dolomite	quartz	zirconium and hafnium
feldspar	quartzite	
fluorspar	rare earth elements	

Table 2-1

many hard-rock surface mines, rock is drilled, blasted, loaded into trucks, and hauled to a facility where it is crushed and ground to a fine particle size. Surface mining also includes placer mining, which involves removing sand and gravel, usually deposited by present or ancient river systems, by methods ranging from small scale (pick and shovel, suction hose) to large scale (dragline, hydraulic, or dredge). Gold, the valuable mineral in many placer deposits in California, is extracted using rockers, sluice boxes, or more sophisticated gravity separation devices. In historic gold mining, mercury was often placed at the bottom of a sluice box to aid in the extraction of gold from sand and gravel because gold alloys (amalgamates) with mercury. While the use of mercury improved gold recovery, some mercury unavoidably escaped into the environment during mining operations. Enormous quantities of sand and gravel have been processed for gold over the decades in California, especially in the Sierra Nevada.

Underground mining methods are used when they are less costly than surface mining (e.g., mineralized rock occurs deep beneath the Earth's surface) or when it is no longer practical to use open-pit mining techniques. To reach the ore body, remove ore and waste, and provide ventilation, miners must excavate either a vertical or inclined shaft, a horizontal tunnel called an adit, or a gently inclined tunnel called a decline. Within the ore deposit, horizontal passages called drifts (parallel to the vein or ore body) and crosscuts (across the vein or ore body) are developed on several levels to access stopes (openings in the ore body). Blasted rock is hauled away from the stopes by trains, loaders, or trucks that may take it directly to the surface or transport it to a shaft where it is hoisted to the surface and sent to a crushing facility.

Ore to be concentrated is transported to a mill where the metallic minerals are separated from the nonmetallic minerals and from each other by gravity or flotation methods. Flotation involves bubbling air through a mixture of crushed ore, water, and surfactants and other chemicals. The chemical reagents modify the surface properties of the minerals such that certain minerals (generally the mineral of value) selectively attach themselves to the bubbles, float to the surface, and are skimmed off. Mineral processing plants (mills) are not always located next to mines, and crushing facilities may be separate from concentrating facilities. Crushed ore can be transported to mills via slurry pipelines, conveyor systems, trucks, or rail.

Mineral concentrates produced by gravity, flotation, or stripping of leach solutions are shipped to processing, smelting, and refining plants where they are converted to metal in the form of bars, ingots, sheets, or wire. These metals, often alloyed, are then used in the manufacture of products. Some processing plants are located on the same site as the mining operation.

Modern extraction techniques are more efficient than historic techniques. The ore to be leached is stacked on an impervious pad in large piles composed of many layers of crushed ore. Chemical solutions sprinkled on the ore percolate down, dissolving the metallic minerals. The metal-bearing solution is collected at the base of the pile and pumped to a processing plant where the metal is recovered from solution. This extraction method is relatively new and typically not found at older AML sites.

Waste materials left over from mining, crushing, leaching, concentrating, and other processing are commonly stored in piles. Fine materials in slurries are stored behind impoundment dams, or are returned underground to backfill mine workings (backfilling stopes). Both coarse and fine wastes have been used as construction aggregate and fill material.

Underground mining also includes solution mining. In this process, a liquid is pumped into the ground and the commodity of value is dissolved in situ and removed from the ground via extraction wells.

CHAPTER THREE
HAZARDS AT ABANDONED MINE SITES

3.1 INTRODUCTION

AML sites need to be evaluated individually to determine if physical or chemical hazards are present. The goal of this chapter is to enable the reader to visually identify physical hazards and obtain a general understanding of chemical hazards.

Many of these hazards result from outdated mining practices and ore processing techniques, or improper closure procedures. Potential hazards can vary greatly from one mine to another. See Appendix H for information on health and safety precautions at AML sites.

3.2 PHYSICAL HAZARDS

The leading cause of injury and death at AML sites is by falling into mine openings. Numerous types of physical hazards can be found at a single AML site. The hazards may include dangerous mine openings such as shafts and adits, glory holes, and subsidence pits. **PHYSICAL HAZARDS MAY NOT BE CLEARLY VISIBLE**! Although it may appear solid, the ground surrounding mine openings is often composed of weak, fractured rock that may break loose suddenly; **ALWAYS STAY WELL BACK FROM THE EDGE OF SHAFTS, PITS, AND GLORY HOLES.** Other safety hazards include falling rocks, dangerous mine gases, dilapidated buildings and structures, mechanical and electrical equipment, explosives, unstable ground, and tram cables.

3.2.1 Underground Workings

Underground workings, including tunnels, shafts, adits, stopes, raises, glory holes, and ventilation shafts, present the physical hazards of greatest concern. Entryways into abandoned underground workings can be extremely dangerous owing to failure of support timbers, usually from decay. Unsupported rock in and around these openings can suddenly collapse if disturbed. Vertical or inclined shafts may enter below tunnels (winzes) or above them (raises). These openings may be difficult to see, especially water-filled winzes. In addition to the possibility of rock failure in underground workings, unstable explosives, oxygen-deficient air, toxic gases, or explosive gases may exist in the workings and can result in severe injury or death. Most (if not all) AML sites have no lights or maps to aid would-be rescuers should someone become lost in the underground workings. **UNDER NO CIRCUMSTANCES SHOULD UNTRAINED PERSONNEL ENTER UNDERGROUND WORKINGS.**

3.2.2 Highwalls, Pits, and Ditches

Highwalls are escarpments left by mining in open pits and quarries. The risk of injury from a fall depends on the highwall height, slope, and stability. Small pits and trenches do not necessarily pose a hazard unless they are concealed. The same is true for ditches unless they have been used to route mine water, tailings, AMD, or other potentially contaminated fluid which may pose a chemical hazard.

3.2.3 Subsidence Features and Landslides

Ground subsidence can occur when underground openings or workings collapse. The resulting subsidence features can be a hazard. Failure can be rapid or slow and may be triggered by surface activity (e.g., driving a vehicle over weakened subsurface structures). Underground failure may be expressed at the surface as an opening or a depression. Once subsidence has occurred, additional subsidence is possible.

Large volume mine waste piles, especially waste piles discarded on sloped topography, have the potential for catastrophic failure. Landslides can have significant impact on structures or drainage systems, which may become blocked.

3.2.4 Explosives and Blasting-Related Items

Materials used for blasting are classified into three general groups: explosives, initiators, and accessories. Explosives are designed to be relatively insensitive and must have initiators to start the chemical reaction of the blast. Initiators (e.g., cast boosters) on the other hand, are very sensitive, even when fresh from the factory. Accessories include electrical generators, gauges, and miscellaneous items needed for blasting.

The most widely used explosives in mining have been black powder, dynamite, and ammonium nitrate with fuel oil (ANFO). Black powder was used exclusively in the 1800s, but gradually was replaced by dynamite after the turn of the century. Black powder may be found in cans, kegs, or bags.

Dynamite is manufactured in the familiar sticks, which are approximately 8 inches long and 1 inch in diameter, and may be packed in wooden or cardboard boxes. Dynamite is composed of nitroglycerine and an inert filler, such as sawdust or clay, with the mixture wrapped in a paper roll. Nitroglycerine alone is very unstable, but when mixed with a filler it is relatively stable. Unfortunately, over a period of years, nitroglycerine can seep out of the filler into the packing box or on to the underlying shelf, floor, or ground. **NITROGLYCERINE CAN EXPLODE IF DISTURBED; OLD DYNAMITE IS EXTREMELY DANGEROUS.**

ANFO has gained popularity in mining since it was introduced in the mid-1930's. The two ingredients, ammonium nitrate and fuel oil, are relatively inert by themselves. Only when thoroughly mixed together in the correct proportions will they form a mixture that can cause a blast, and even then a strong explosive such as dynamite or a cast booster must be used to initiate the blast. ANFO may be found in metal or cardboard containers or paper bags.

Initiators used with explosives include blasting caps, detonation cord, and cast boosters. Blasting caps are 1-inch-long metal tubes that are about the diameter of a pencil. Two types of blasting caps have been produced: electrical and non-electrical. **THESE ITEMS CAN EXPLODE IF MISHANDLED AND THUS ARE EXTREMELY DANGEROUS. IF YOU DISCOVER EXPLOSIVES AND BLASTING-RELATED ITEMS CONTACT THE LOCAL EMERGENCY AUTHORITIES.**

Electrical blasting caps have two thin, color-coded wires emerging from one end. In blasting operations, caps are connected by wire to an electricity-generating blasting machine. Non-electrical blasting caps are designed to be used with a time fuse (a fabric or plastic-covered cord with black powder in the center). The blasting cap is attached to one end of the fuse and the opposite end is lit with a flame. Time fuse is relatively stable.

Cast boosters are used to propagate the explosion in a blasting agent, such as ANFO. Cast boosters consist of high explosive in a shaped package the size of a soft drink can, with a hole in the end for the insertion of a blasting cap. **CAST BOOSTERS SHOULD NOT BE DISTURBED!** This is especially true if there is a blasting cap or wires protruding from this hole.

Like a time fuse, detonation cord also has a fabric or plastic outer layer and an inner core of explosive. Detonation cord must be initiated by a blasting cap and, when detonated, explodes along its entire length. Detonation cord is relatively stable.

REMEMBER:
EXPLOSIVES CAN BE DEADLY!!

3.2.5 Buildings and Mechanical Equipment

The structural integrity of a mine or mill building is dependent upon the preparation of the foundation, the type of construction materials used, the age of the structure, and the climate. Although the availability of funds and materials were controlling factors, many buildings were intended to be temporary shelters and were constructed accordingly.

Abandoned buildings also can pose threats in ways unrelated to collapse. Old mill buildings may have chemical process residues soaked into the wood or other materials in the buildings. Buildings offer excellent habitat to a variety of potentially dangerous animals such as snakes, scorpions, spiders, bees, wasps, hornets, rodents, and other wild animals (some of which carry potentially fatal diseases such as rabies and hanta virus). In recent years illegal drug manufacturers have discovered and taken advantage of the remoteness of AML site buildings. These drugs and their chemical precursors and waste products can be very dangerous if inhaled. Some will explode. The hazards of entering such buildings extend beyond the presence of such reagents. Operations are frequently protected by armed guards and/or booby traps. **IF AN ILLEGAL DRUG OPERATION IS DISCOVERED OR SUSPECTED, VACATE THE SITE IMMEDIATELY AND CONTACT THE PROPER LAW ENFORCEMENT AUTHORITIES.**

A variety of equipment can be found at AML sites and some can be hazardous. Equipment can include crushers, grinders, engines, boilers, flotation cells, screens, vats, trams, ore cars, conveyors, and bins. All can cause injury, especially if not well secured.

3.2.6 Scrap Materials

AML sites often contain large quantities of scrap lumber, nails, metal, and other materials. Cuts and punctures can result from handling such materials, along with injuries due to tripping.

3.2.7 Impoundments

Impoundments often are used as a water supply for mining or milling operations or as settling ponds for tailings slurries. Under certain circumstances, such as heavy rainfall, the impoundment dam may fail and release water, sediment, or contaminants to the surroundings. These dams are sometimes large and not built to any safety standards.

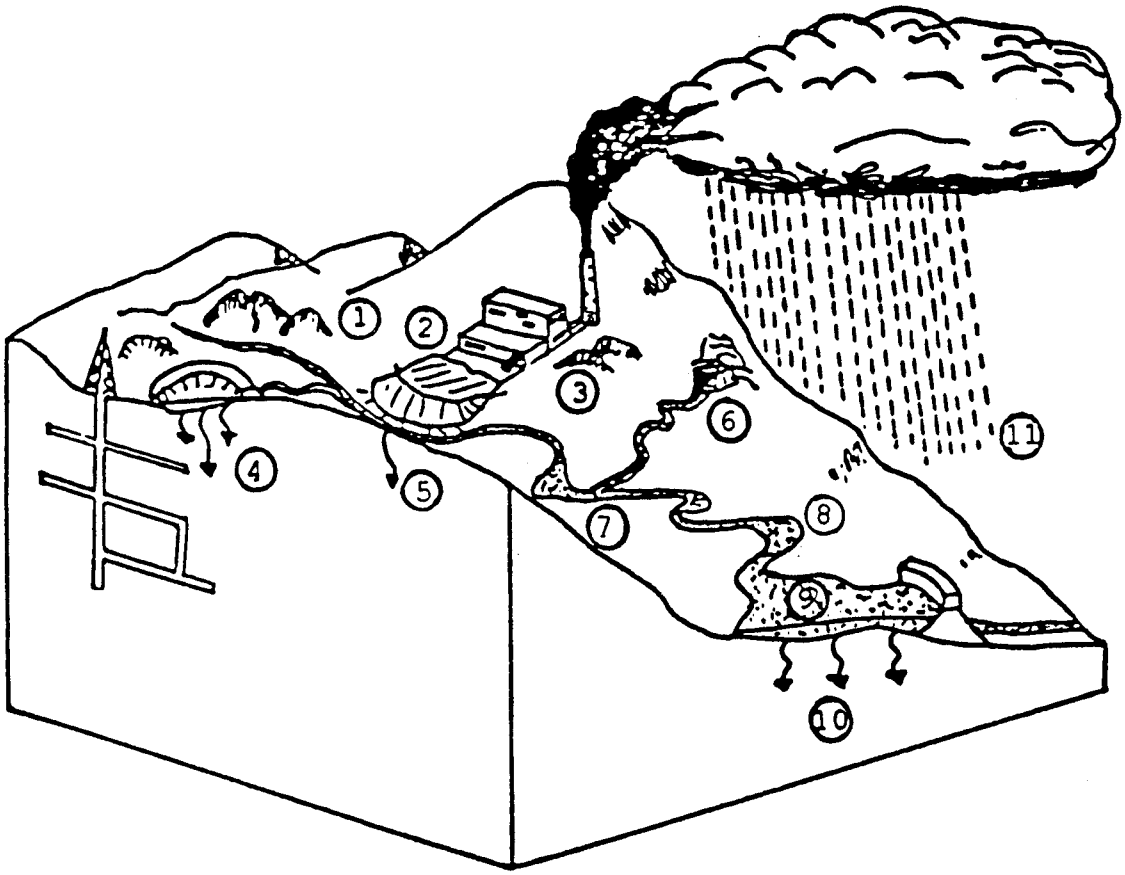
3.3 CHEMICAL HAZARDS

Human health threats and environmental degradation can exist at or near AML sites, owing to toxic, corrosive, radioactive, or otherwise noxious metals, chemicals, or materials, or unusual environmental conditions resulting from past mining, milling, and/or smelting operations (see Figure 3-1). The hazards may or may not represent violations of present day environmental laws. Part II of this document outlines the investigative techniques needed to determine if chemical hazards are present that can cause adverse effects to human health and/or the environment.

3.4 HAZARDS RELATED TO MINERALS

Toxic hazards are associated with elevated levels of some metals (e.g., chromium, copper, lead, mercury, nickel), metalloids (arsenic, selenium), or nonmetallic minerals such as asbestos (especially amphibole asbestos). All hazardous minerals and associated metals occur naturally to some extent as a result of mineral deposition processes. Copper, lead, zinc, and mercury are of economic interest, whereas arsenic (usually associated with gold deposits) is often considered an unusable byproduct. The Chemical of Concern (COC) may or may not be related to the commodity intended to be mined.

TYPES OF CONTAMINATION RESULTING FROM HARDROCK MINING *



1	Waste Rock	7	River/Creek Sediments
2	Tailings	8	Floodplain Sediments and Soil
3	Slag	9	Reservoir/Impoundment Sediments
4	Ground Water Beneath Surface Impoundments	10	Ground Water Beneath Reservoir
5	Ground Water Beneath Mine Wastes	11	Soils from Air Pollution
6	Acid Mine Drainage		

* modified from Figure 1 by Moore and Luoma (1990) in Environmental Science and Technology, "Hazardous Wastes from Large-Scale Metal Extraction", Vol 24.

Figure 3-1

PART II

ABANDONED MINE LANDS PRELIMINARY ASSESSMENT INVESTIGATION

CHAPTER FOUR
BEGINNING AN AML INVESTIGATION

4.1 INTRODUCTION

This chapter outlines the components of conducting an efficient AML preliminary assessment investigation. The initial tasks include: 1) scope the project, 2) develop a conceptual site model to identify potential exposure routes, 3) collect and review background information and available chemical data, 4) conduct a site visit, and 5) determine if background information and site inspection indicate a complete screening investigation is required. Figure 4-1 provides a diagram of the overall AML preliminary assessment process. The following sections describe the five tasks in detail.

NOTE: The AML investigator is encouraged to review appendices A and B prior to collecting background information. Appendix A describes the characteristics of California mineral deposits, which can be helpful in determining what potential AML problems may be associated with that deposit. Appendix B describes the environmental effects of mining and ore processing (e.g., particle size, weathering, formation of secondary minerals).

4.2 SCOPING

Properly scoping a project will ensure that investigations address site-specific conditions and objectives. Scoping minimizes ineffective expenditure of time and money.

Scoping the AML investigation involves:

- determining the purpose for the investigation;
- obtaining historical information;
- locating possible sources of information having limited availability;
- obtaining previously collected data;
- recognizing potential COCs; and
- developing a conceptual site model (if chemical hazards are suspected).

Scoping the AML investigation will identify:

- specific project objectives;
- data required to conduct human health and environmental screening;
- the need to inform the public of potential concerns;
- health and safety requirements for site investigation; and
- a schedule for activities.

4.3 CONCEPTUAL SITE MODEL

A conceptual site model helps to develop a preliminary understanding of an AML site's potential chemical impacts. Conceptual site model development is a dynamic process that starts with acquiring all existing information for an AML site. To develop the conceptual model, the investigator identifies the potential COCs and their sources, and links them to potential receptors through release mechanisms, pathways, and exposure routes. Examining the conceptual site model results in identification of information and data needed to determine the extent of sources, identify exposure mechanisms, and identify receptors. Release mechanisms, pathways, and exposure routes identified in the conceptual site model provide rationale for sampling. The sampling plan can then be designed to determine sources of contamination, presence of potential migration pathways, and exposure potential. The conceptual site model is updated using information derived from site inspection, sampling, and data evaluation. An improved model provides a basis for the human health and environmental assessments. See schematic presentation in Figure 4-2.

ABANDONED MINE LAND PRELIMINARY ASSESSMENT (PA) PROCESS DIAGRAM

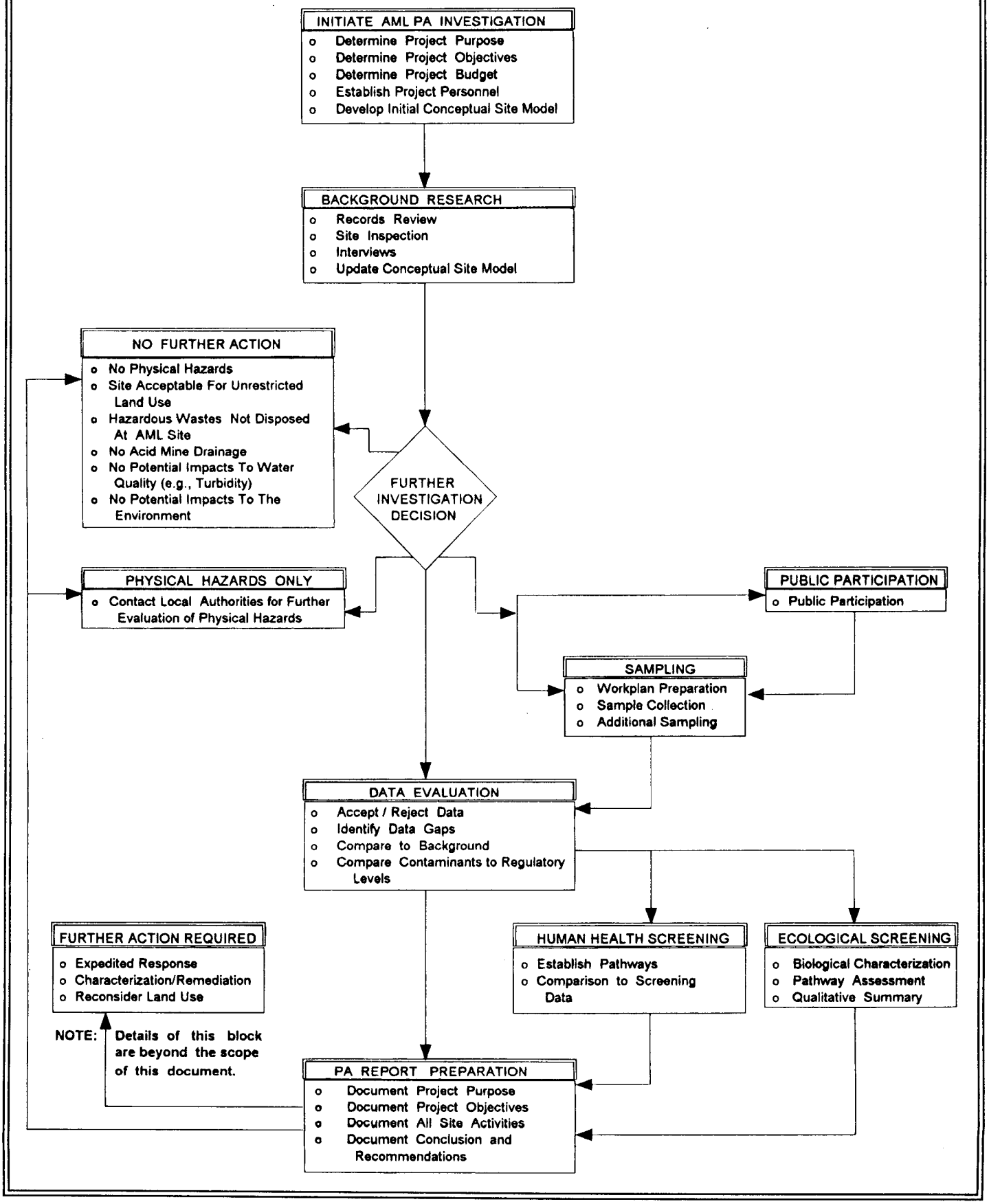


Figure 4-1

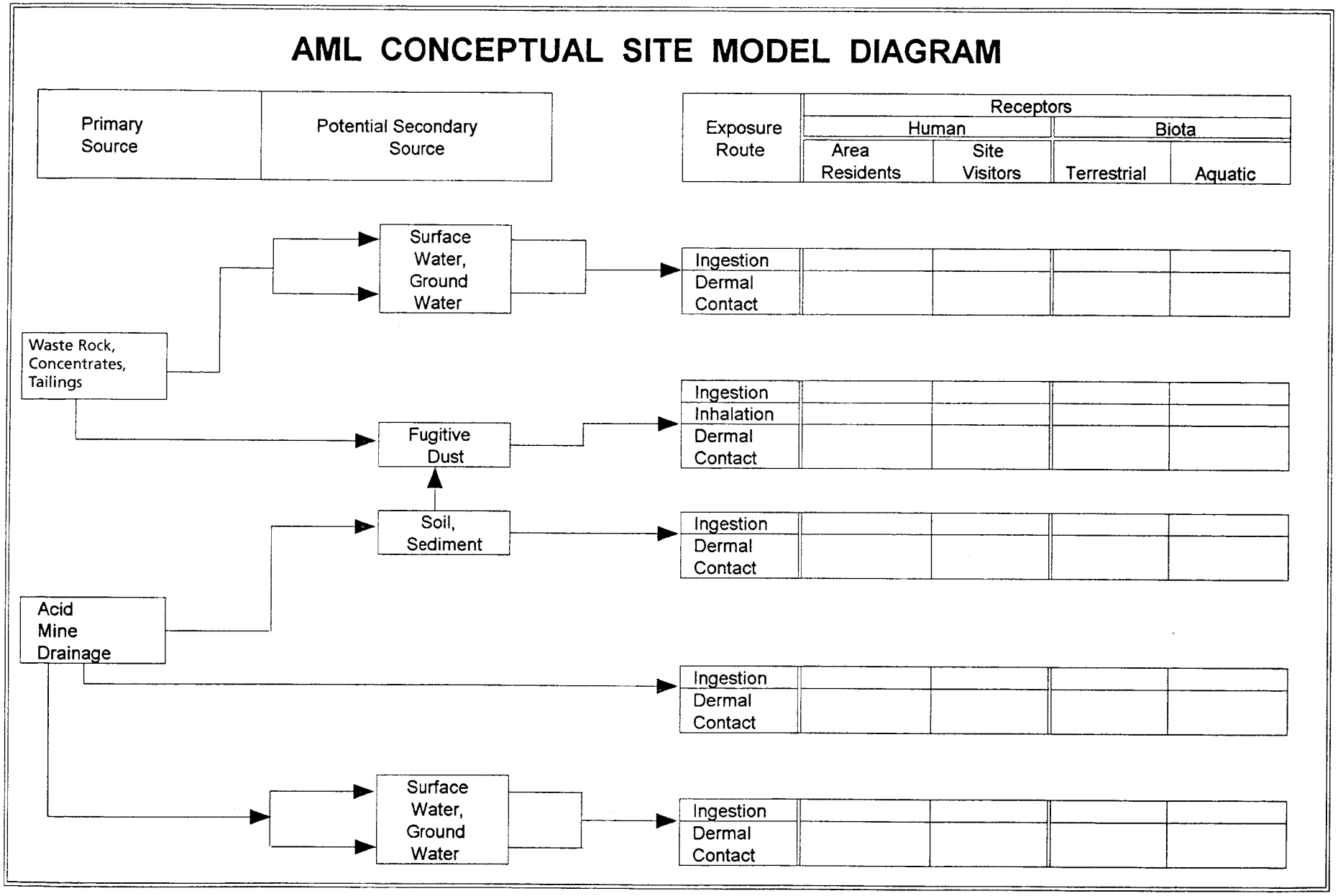


Figure 4-2

A CONCEPTUAL SITE MODEL HELPS IDENTIFY POTENTIAL SOURCES, PATHWAYS, AND RECEPTORS WHICH MAY NEED TO BE ADDRESSED IN FIELD INVESTIGATIONS. KEEP IN MIND THAT DIFFERENT SITES HAVE DIFFERENT SOURCES, RELEASE MECHANISMS, AND PATHWAYS. AFTER CREATING THE LEFT SIDE WITH SITE-SPECIFIC PATHWAYS, THE MODEL IS COMPLETED BY MARKING THE APPROPRIATE RECEPTOR BOXES ON THE RIGHT.

4.4 BACKGROUND RESEARCH

Complete and accurate site information is essential for determining problems likely associated with the site, the potential exposure pathways and receptors, and the sampling needs for the investigation. The purpose of the background research is to collect pertinent site information about the following:

- setting;
- physical and environmental characteristics;
- property boundaries (current and historical);
- historical mining operations and ownership;
- mine waste management practices;
- previous site investigations;
- zoning;
- regulatory status;
- current land use; and
- land use in immediate area that might influence on-site conditions (e.g., another mine).

Background research should include review of reports, records, and interviews for information to develop the conceptual site model and to prepare for the site inspection.

4.4.1 Sources of Information

A vast body of mine and minerals related information has been collected and recorded. This section provides public sources of background information. Following is a list of these sources, with descriptions of types of information provided:

1) Local, State, and Federal Agency reports and files: These files can provide information on specific mines, such as year of discovery, mined commodity, processing techniques and chemicals, size of operation, site maps, mine waste management, and current status. Each agency should be contacted by telephone prior to making a visit to review files. Appointments may be necessary and fees are usually charged for copying.

Local

a) County offices that may have site information include the Environmental Health Department, County Planning Department, Public Works Department, Air Pollution Control District, County Agriculture Commissioner, and County Tax Assessor.

State

b) The Department of Conservation, Division of Mines and Geology (DMG) is probably the best single source of information on mineral properties in California. The DMG's publications, library, unpublished files, and property reports contain descriptions of specific mining operations, processing techniques, locations and characteristics of ore deposits, mineral resource potential, and mineralogy. Some information dates back to 1880, the year the agency was formed. Several publications are devoted solely to specific geographic areas (e.g., counties) or mineral commodities. Most information is in the Sacramento office.

The DMG has many published and unpublished maps of geology, ore deposits, and individual mines. It also maintains a library of photographs of mining operations, many taken in the late 1800s.

The DMG maintains MINEFILE, a digital database with information on over 27,000 mines and mineral properties throughout California. Despite some limitations, it is currently the only actively-maintained comprehensive database available to researchers and the public. Ongoing DMG efforts to maintain MINEFILE include: periodic updating of entries; identification and correction of errors and inconsistencies; and modifications to make the database more amenable for Geographic Information System (GIS) use.

Several geologists at DMG have conducted field studies of mineral resources throughout

California and are available to answer specific questions. The areas of most extensive mineral resource study are the Sierra Nevada, Mojave Desert, and all major sources of aggregate.

c) The Regional Water Quality Control Boards have watershed location, hydrology, and drainage systems information and descriptions. In addition, information on site-specific water quality investigations, cleanup activities, and current site status may be available.

d) The DTSC information covers past and ongoing DTSC investigations of potential human health and environmental hazards, and cleanup activities. The DTSC maintains a database, CalSites, on properties in California where a known hazardous substances release has occurred. CalSites is used as an informational tool, primarily by the DTSC's staff, to evaluate and track activities at properties that may have been affected by the release of hazardous substances.

e) The California Secretary of State's Office may have records of corporate ownership and associated contact information.

Federal

f) The U.S. Environmental Protection Agency (U.S. EPA) has information on specific site investigations including Preliminary Assessment (PA) and Site Inspection (SI) reports, and cleanup activities. The U.S. EPA maintains the Federal computerized inventory of potential hazardous waste sites: Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). Also, the U.S. EPA's STORET database contains water quality data for streams, rivers, lakes, or reservoirs.

g) The U.S. Geological Survey (USGS) collects, compiles, and analyzes geologic, hydrologic, and topographic information, which is available in several formal report series (Bulletins, Professional Papers, Water Supply Papers, Circulars), informal report series (Open-file Reports, Water-Resources Investigation Reports), thematic map series (7.5-minute quadrangles, orthophotomaps, orthophotoquads, county and quadrangle maps at scales of 1:50,000 and 1:100,000), and digital data series (CD-ROMs).

Obsolete USGS publications series, including Annual Reports, Memoirs, and Geologic Folios, and topographic maps (mainly 15-minute quadrangles) contain historical information on mining operations.

The USGS maintains the Mineral Resource Data System (MRDS) an extensive mineral occurrence data base that emphasizes geologic characteristics of U.S. mineral prospects and deposits. It can be searched at some USGS offices.

Unpublished field notes and data are archived at the office of the USGS in Denver, Colorado; the USGS library and Earth Science Information Center, both in Menlo Park, California, can assist in locating and copying unpublished information, as well as arranging for MRDS data base searches. Most of the USGS file information is non-confidential.

h) The Bureau of Land Management (BLM) has information for mining claims and mineral leases on Federal lands, including mining claim records, mineral survey records, mineral inspection reports, lease information, mineral materials sales contracts, and notices and plans of operation. The BLM's On-line Recordation Case Access (ORCA) data base facilitates finding pertinent records. Data base searches can be performed at district BLM offices (see Appendix L).

i) The U.S. Forest Service (USFS) has information on mining claims and mineral leases on the USFS lands.

j) The former U.S. Bureau of Mines (USBM) was the principal Federal agency responsible for gathering information on production and consumption of mineral resources from 1910 through 1995. The USBM was abolished in 1996 and certain mineral information functions were transferred to the USGS. In addition to results of analysis and research in the fields of mineral economics, minerals utilization, mining engineering, ore processing, and mine safety, many of the USBM reports contain site-specific mine information that covers all aspects of mining, processing, and recovery. Formal report series include Reports of Investigations (RI series), Information Circulars (IC Series), Bulletins, and Mineral Yearbooks. Informal reports include Open-file

Reports, Mineral Commodity Reports, Mineral Land Assessment Reports, and various special publications.

The USBM maintained the Minerals Availability System/Mineral Industry Location System (MAS/MILS) data base, a worldwide mineral occurrence data base that emphasizes production, reserves, and development information.

Detailed unpublished information on mining properties resides in the USBM's mineral property files. Some of the information in these files is confidential and cannot be disclosed without the property owner's written permission. These files and the MAS/MILS data base are now in the custody of the USGS, and procedures for gaining access are similar to those for unpublished USGS materials.

k) Defense Minerals Exploration Administration (DMEA) Reports: From 1952 to 1974 the Federal Government funded two units, the Defense Minerals Exploration Administration and the Office of Minerals Exploration (OME), to make loans to individuals and corporations for exploration and development of strategic mineral resources. All pertinent information, including proposals, exploration agreements, property survey data, geologic data, results of physical exploration, summaries of assay results, owner's progress reports and reports of program officers, including results of field examinations, are included in a docket file for each property. Obtaining information from these files is difficult because much is confidential, and ownership changes subsequent to program involvement are not tracked. Also, some materials in the files are difficult and expensive to reproduce, and program files are no longer maintained regionally, but have been consolidated into archives at only a few locations. The USGS is the custodian of these files, and inquires should be made in the same manner as for unpublished USGS material.

2) Educational institutions: Sources of information include, but are not limited to, college and university departments of geology, mining, geophysics, hydrology, history, economics, and social science, and their respective libraries (the Bancroft Library at U.C. Berkeley and the Stanford University Library have extensive historical documents and photographs). University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, maintains a clearinghouse and copying service for doctoral dissertations which may contain information on almost any topic.

3) Private sector: Business and nonprofit organization sources of information include mining and mineral exploration companies, historical societies and museums, industry and trade associations, and mining and geological consultants. Commercial bibliographic data bases such as DIALOG and GEOREF provide references to published literature. Information on these data bases is available at university libraries, some college libraries, and the USGS library in Menlo Park, California. Some libraries will perform searches of these data bases on a reimbursable basis.

4) Maps and photographs: Maps and photographs are useful for obtaining an overview of a site and its surroundings, establishing the physical setting of the site, and identifying historical developments and property uses at various times.

a) 7.5-minute topographic quadrangle maps produced by the USGS provide the basic map information available for civilian use throughout the country.

b) Aerial photographs are available from the USGS, USFS, U.S. Department of Agriculture (Natural Resources Conservation Service), California Department of Conservation, other state agencies, and private sources. Satellite imagery is available but its usefulness for investigation of small sites is limited.

c) Historical photographs reside in private collections, libraries of local governments, colleges and universities, and historical societies. Collections are available for inspection, but options for copying photographs are often limited.

5) Periodicals such as newspapers and mining newsletters and journals have information on specific mines. Local newspapers maintain archives; back issues of discontinued periodicals are often maintained by historical societies and local museums. Mining newsletters and journals are available in university earth science libraries and the USGS library.

4.4.2 Interviews

Interviews with former employees, site owners, site neighbors, and local officials can be useful to obtain information on historical conditions and past mining operations. Information based on personal experience can provide insight as to how the mine may have operated, and other uses of the site. Personal accounts may confirm information found in agency files and provide additional details. Information obtained from interviews may differ from or contradict that obtained from agency files or published records. In these instances additional research may be required to determine what information is accurate. Notes taken during interviews may be used as reference documents to support the AML preliminary assessment report. Telephone interviews may also be conducted with State and local agencies to obtain supplementary information not included in files.

4.5 SITE INSPECTION

A site inspection is essential to document the current conditions on the site, verify information obtained from the records search, or obtain site information. Documentation developed on site may represent the only information available, and be the sole basis for a decision as to whether additional detailed work is necessary; thus, accuracy is imperative. People conducting the site visit should be trained to recognize and identify physical and chemical hazards. The following subsections provide guidance for conducting a site inspection.

4.5.1 Preparing for a Site Visit

It is very important to be prepared when conducting the site inspection. Prior to the site visit: review all available information, develop a health and safety plan (see Appendix H), determine equipment needs (suitable clothing, camera, maps, pH paper, note book, compass, drinking water, first aid kit, etc.), determine access routes, and determine the need for permission to access the site. **IT IS STRONGLY RECOMMENDED THAT PEOPLE WORK IN PAIRS WHEN IN AREAS OF PAST MINING ACTIVITIES.**

4.5.2 On-Site Inspection

The initial site inspection consists of a walk-through of the site. Observations during the site inspection should focus on identifying, locating, and describing features on a site map so that they can be found on future site visits (Appendices D and F provides information on collecting soil and water samples, but also contains information on visual indicators of AML problems). Important features to identify and locate are:

- structures and processing areas;
- mine openings (shafts and open pits);
- potential physical and chemical hazards (as described in Chapter Three);
- mine waste piles; and
- nearby surface waters and any drainage pathways to the surface water body.

Once these features are located, it is important to:

- determine approximate size of disturbed area;
- determine approximate volumes of mine wastes;
- determine if acid drainage is occurring, noting areas of discoloration or crystal formation on soil surfaces, or abrupt changes in vegetation (stressed, dead, or absent);
- determine if observed land use is consistent with the land use identified in the background research;
- note site location relative to inhabited areas;
- correlate significant features to the site map; and
- take photographs.

Careful observations of site conditions will be needed to develop a sampling plan.

4.6 BACKGROUND AND SITE INSPECTION ASSESSMENT

Once the background research and site inspection has been completed, the AML investigator can determine if a complete site screening is necessary. Three possible conclusions after the initial background investigation is completed are: no further action required, physical hazards only, and further screening evaluation required (see figure 4-1). The remainder of this section explains these conclusions.

4.6.1 No Further Action

A "no further action" conclusion is possible if: no physical hazards are present; the site is acceptable for unrestricted land use; hazardous wastes were not disposed of at the AML site; no potential exists for acidic or metal-rich mine drainage; no potential exists for impacts to water quality (e.g., increased turbiditydue to waste pile erosion); and no environmental degradation has occurred.

4.6.2 Physical Hazards Only

If an AML site contains physical hazards, but no chemical or other human health or environmental concerns (as outlined in the preceding paragraph), then the "physical hazards only" conclusion can apply. Physical hazards can be evaluated and abated by the current property owner or local authorities if necessary.

Note: Mine openings (e.g., adits and shafts) may provide habitat for bats, and completely sealing these openings can destroy this habitat. If public safety concerns require these openings be sealed, then installation of bat-friendly gates is recommended.

4.6.3 Further Assessment Required

If background information and site inspection observations can not support either a "no further action" or "physical hazards only" conclusion as discussed in sections 4.6.1 and 4.6.2, then further investigation is required as outlined in figure 4.1.

4.6.4 Documentation

If a "no further action" or "physical hazards only" conclusion is drawn, the basis for the conclusion should be documented following the general report format outlined in chapter 9. However, only applicable sections need to be documented (e.g., all background information, site description, site inspection observations, and conclusions). The report should provide clear rationale for all conclusions.

Megan Cambridge

California's rapidly growing population is encroaching on AML sites. Photograph shows a subdivision on an AML site.

Megan Cambridge

Photograph shows a subdivision adjacent to an AML site.

Dan Ziarkowski

Photograph shows a residential property built on mine tailing with high arsenic levels. A 100 pound black Labrador retriever is in the center of the dust cloud.

Fidencio Lopez

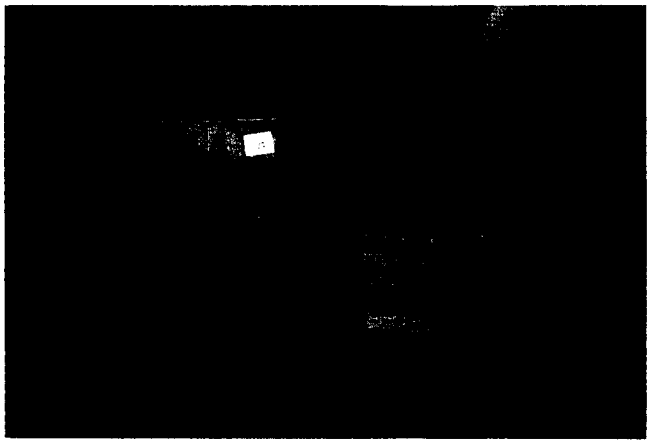
Large AML sites can adversely impact many acres.

Dan Ziarkowski

Exploratory tunnels may be the only indication of mining activity.

Dan Ziarkowski

Small AML sites can adversely impact less than an acre.



Dan Ziarkowski

Dynamite maybe stored in boxes or found in loose sticks.

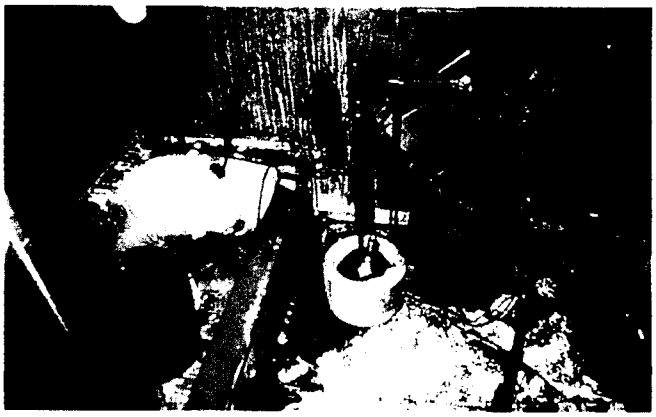
Explosives were used at most AML sites.

Dan Ziarkowski

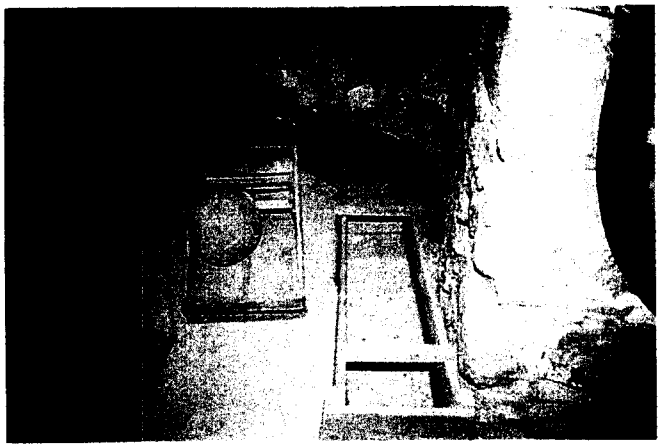
Dan Ziarkowski

Boost Casters.

In addition, illegal drug operations sometimes use explosives as booby-traps. Contact local enforcement authorities immediately if either explosives or illegal drug operations are found.

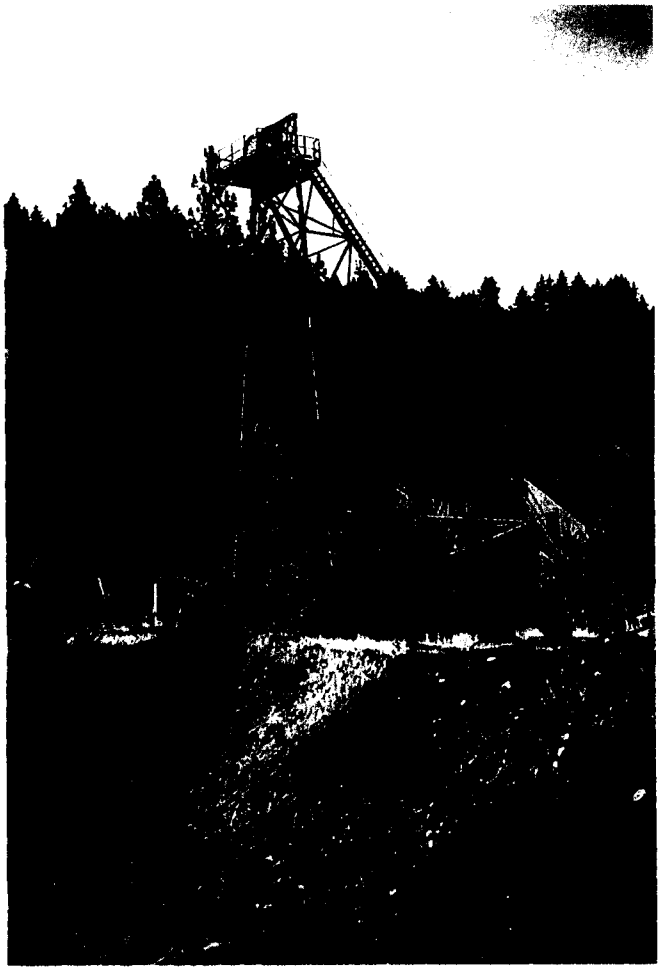


Caroline Rudolph



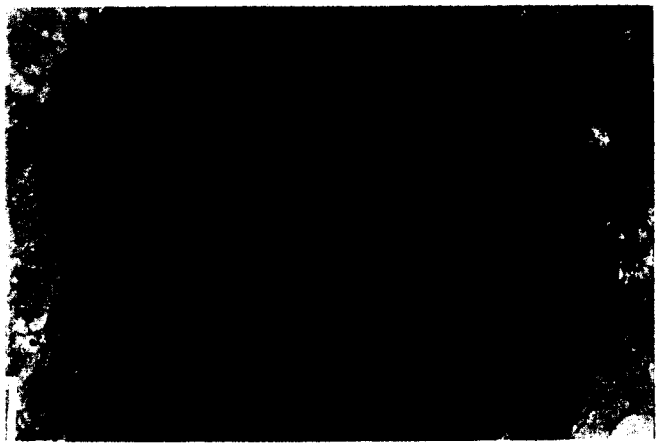
Dan Ziarkowski

Early placer mining used dry sieves, pans, and sluice boxes (North Star Power House Museum, Grass Valley).



Dan Ziarkowski

Hardrock mine headframe.

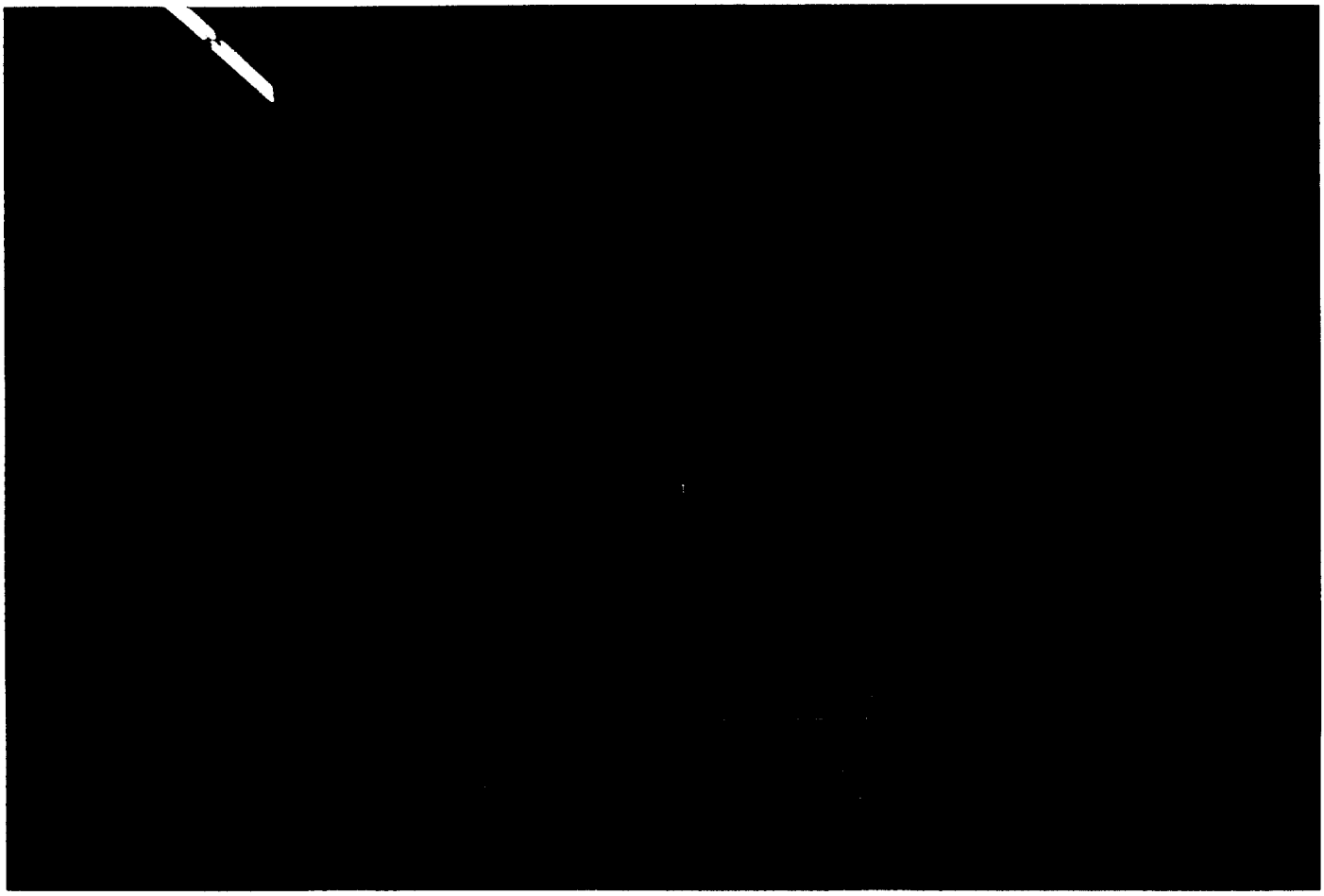


DTSC file

Hardrock mines often used timbers to support adits and tunnels. Timbers weaken over time and lead to unstable conditions.

DTSC file

Surface mines pose physical hazards from rock falls and collapsing walls.

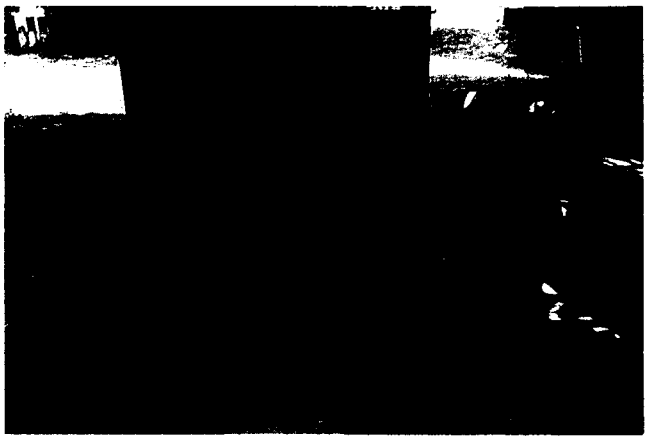


Dan Ziarkowski

Stamp battery and concentrating table (North Star Power House Museum, Grass Valley).

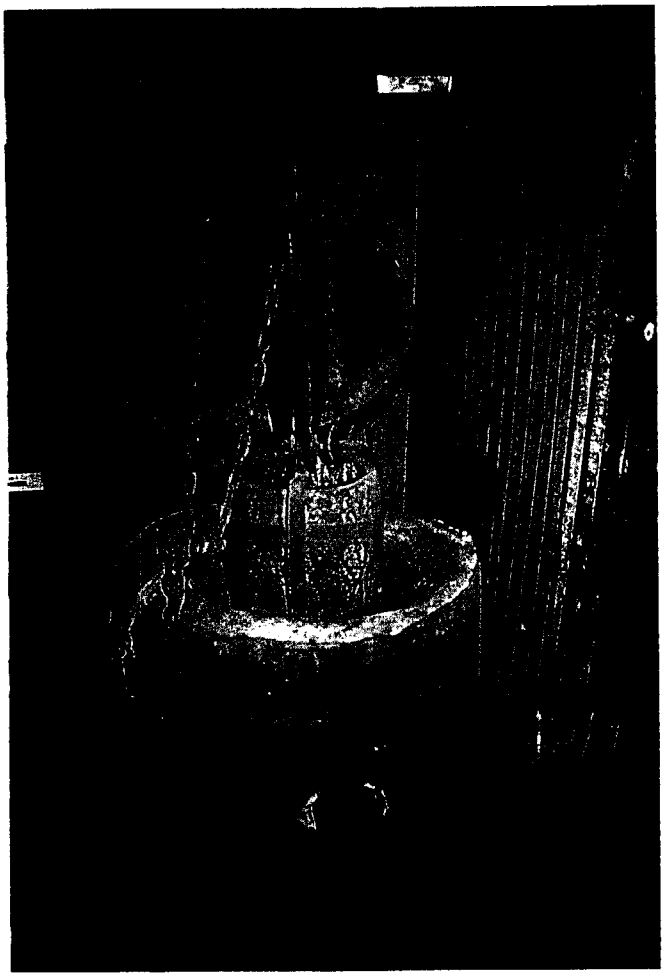
Dan Ziarkowski

Kraut flotation cells (North Star Power House Museum, Grass Valley).



Dan Ziarkowski

Slimes Thickener.



Dan Ziarkowski

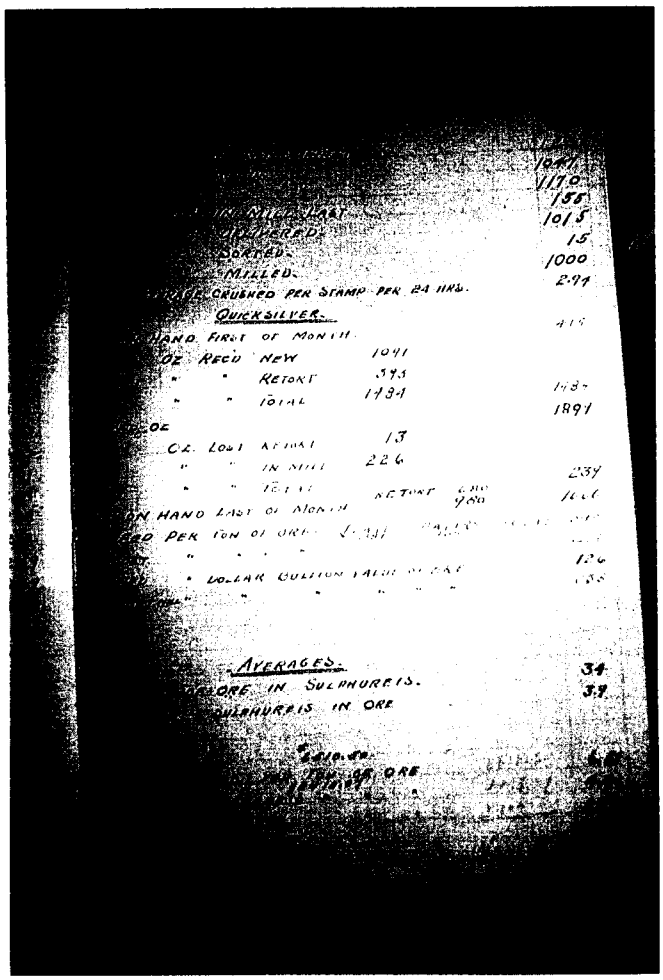
Mercury Retort. (North Star Power House Museum, Grass Valley).

Dan Ziarkowski

Zinc precipitation tank used to extract gold from a cyanide solution.

Dan Ziarkowski

Cyanide plant building.

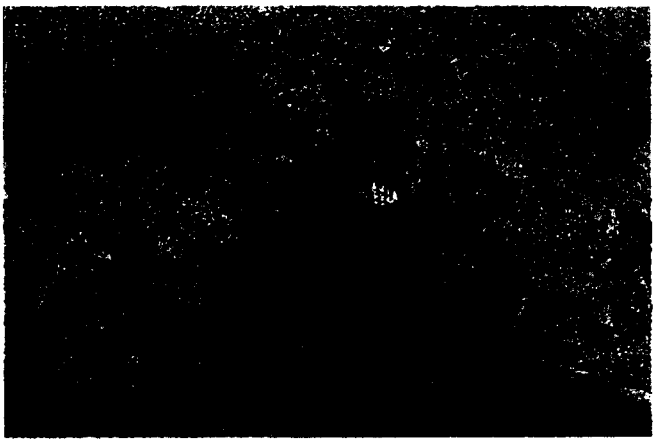


Kelly Chandler

Log book indicating the use and loss of mercury in mining operations (North Star Power House Museum, Grass Valley).

Dan Ziarkowski

Cyanide plant foundation.



Dan Ziarkowski

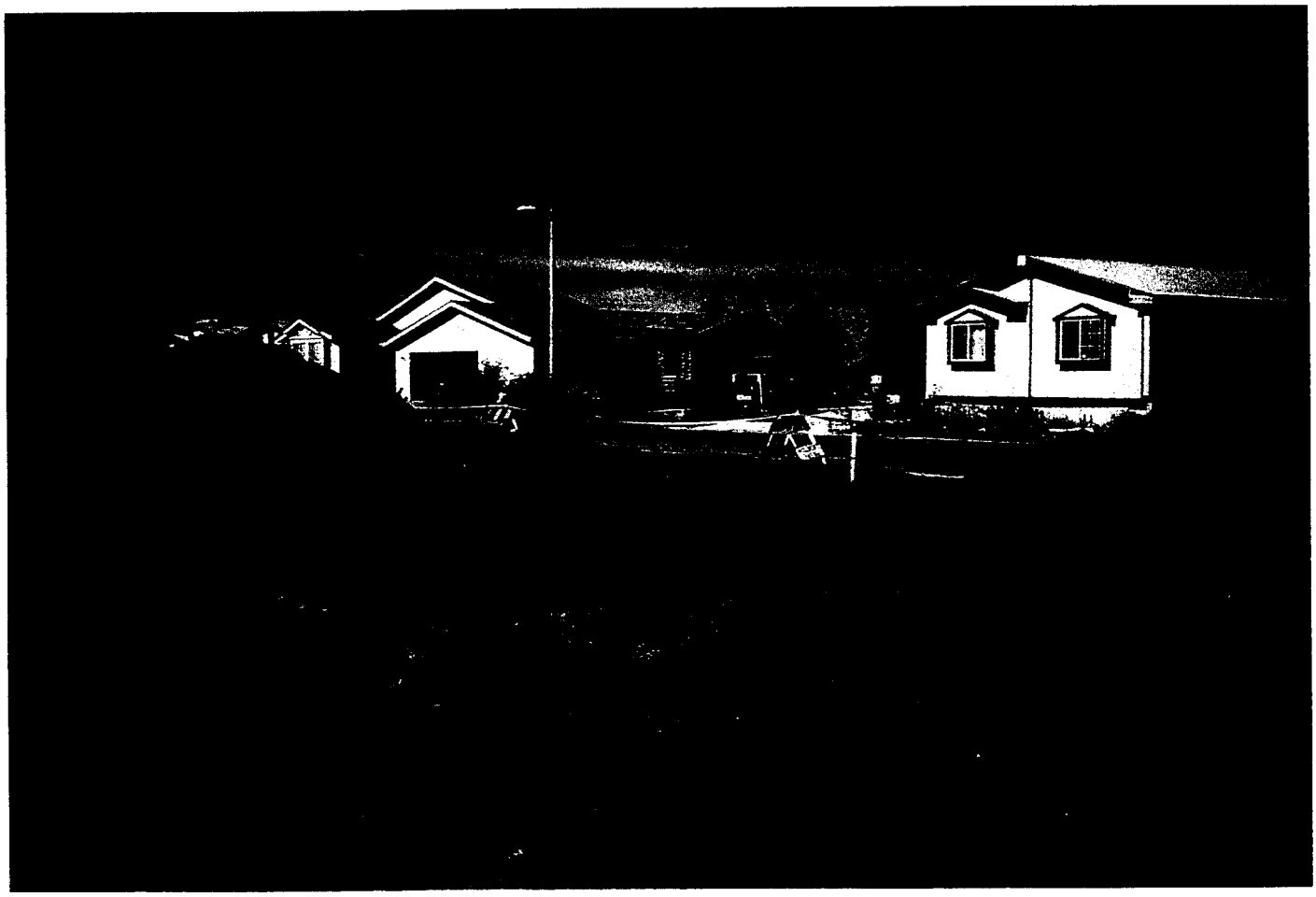
AMD discharge pipe.

Dan Ziarkowski

Mixture of waste rock, scrap metal, and garbage.

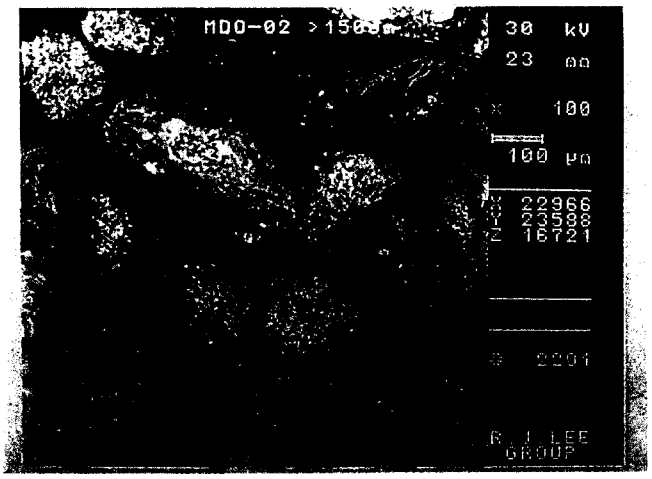
Dan Ziarkowski

Heterogeneous waste rock.



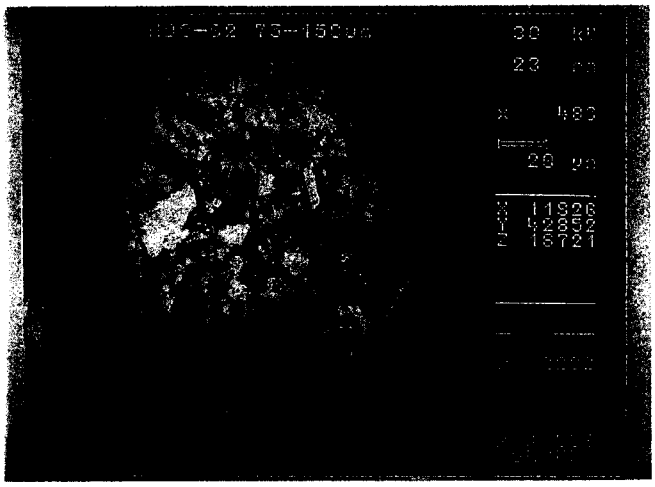
Dan Ziarkowski

Mine tailings from a hardrock gold mine next to native soil.



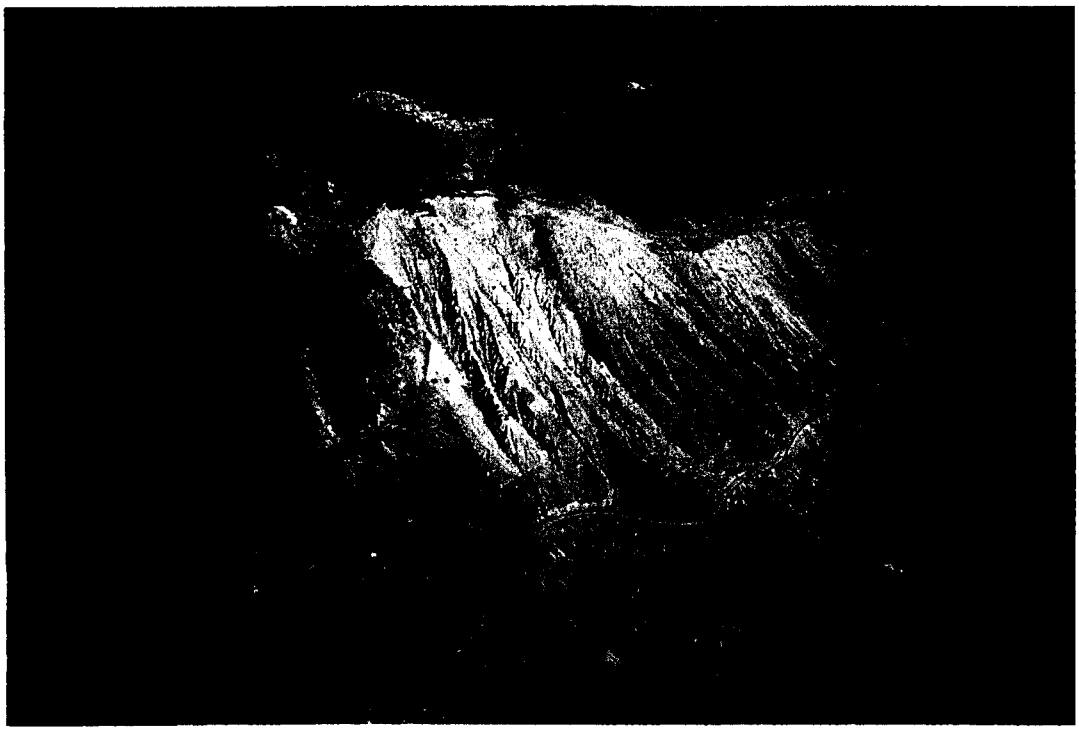
Randy Dahlgren

Photomicrograph of tailings. Angular quartz and potassium feldspar particles result from mechanical crushing (note 100 micrometer scale above right-center).



Randy Dahlgren

Photomicrograph of a single tailings particle. White flakes are amorphous iron-oxide coatings, many containing trace metals such as As, Zn, and Cu (note 20 micrometer scale above right-center).



DTSC file

Large-volume base metal mine waste.

Dan Ziarkowski

Small-scale base metal mine waste rock piles.

Charlie Alpers

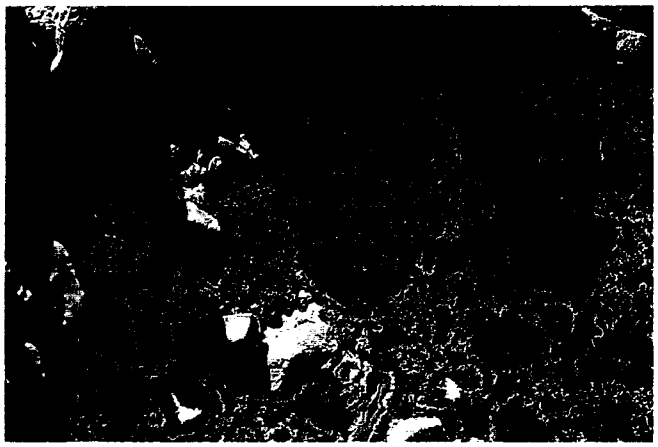
AML sites can impact the environment for many decades.

Charlie Alpers

Some AML sites can impact both soil and water (water color is a result of lime treatment of AMD).

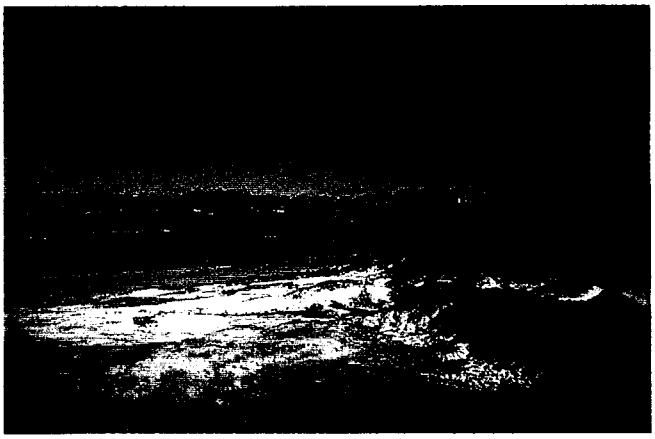
Dan Ziarkowski

Intermittent AMD drainage through a tailings pile.



Charlie Alpers

Efflorescent metal salts in this drainage are highly soluble.

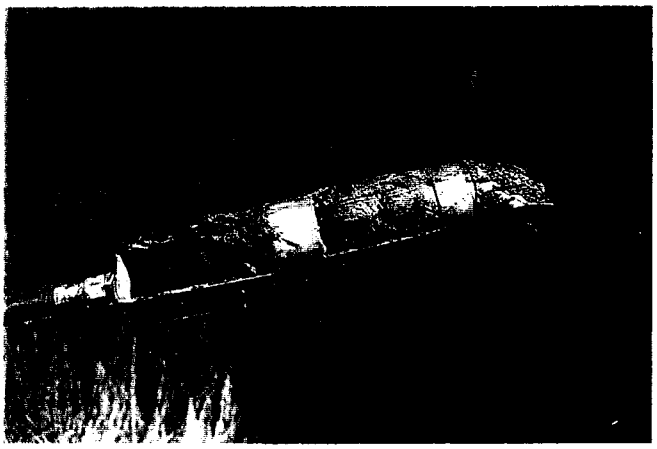


Dan Ziarkowski

Efflorescent metals salts can also form on mine waste piles.

Marvin Woods

Surface soil sample collection.

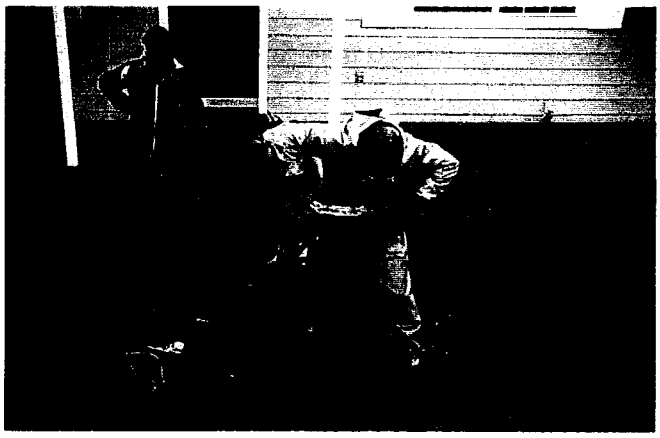


Marvin Woods

Hand auger sample of mine tailings.

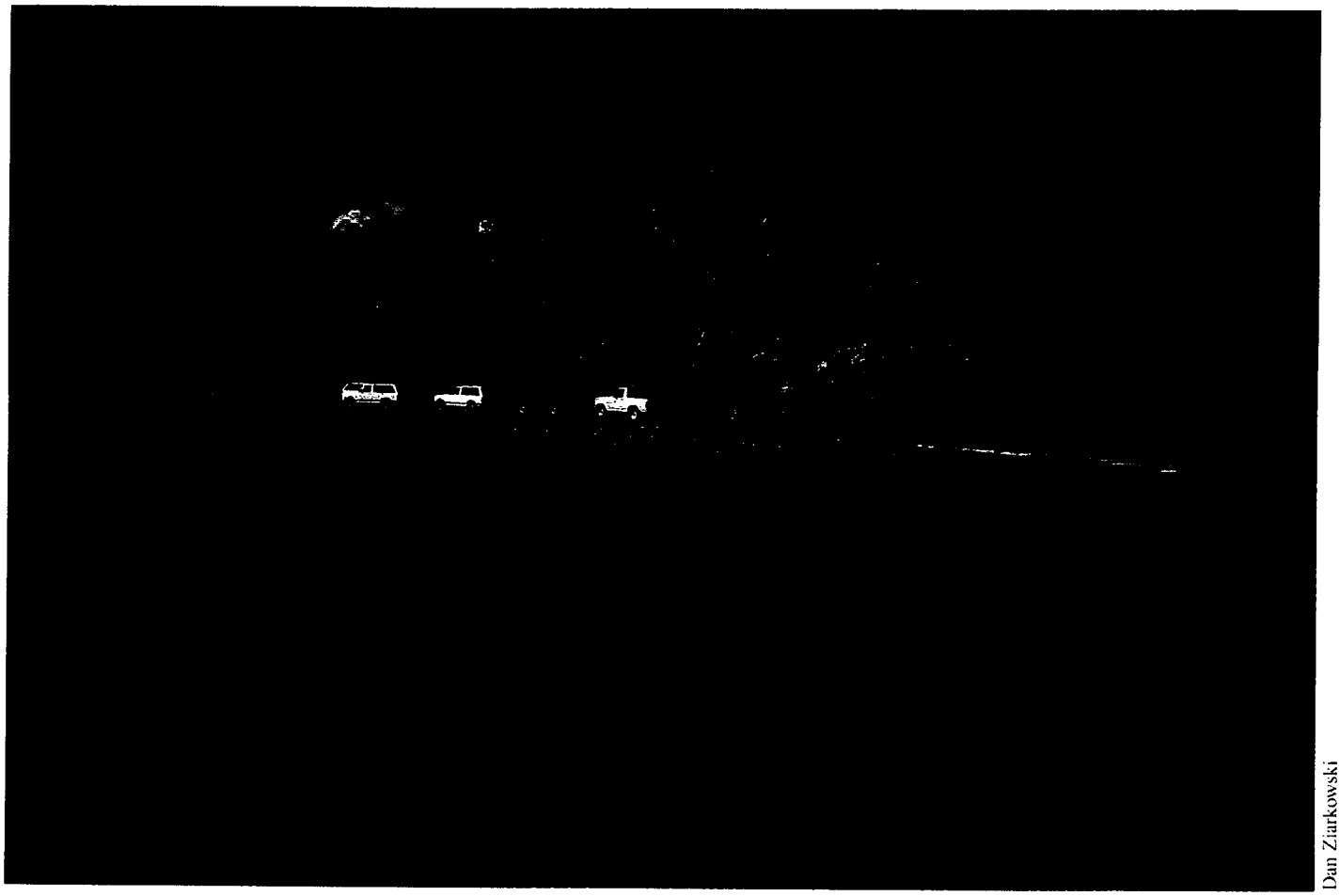
Marvin Woods

A water sample is being collected from a sink hole located on a large tailings pile.



Dan Ziarkowski

A power auger can be used for mine tailings, but may be impractical for waste rock or isolated AML sites.

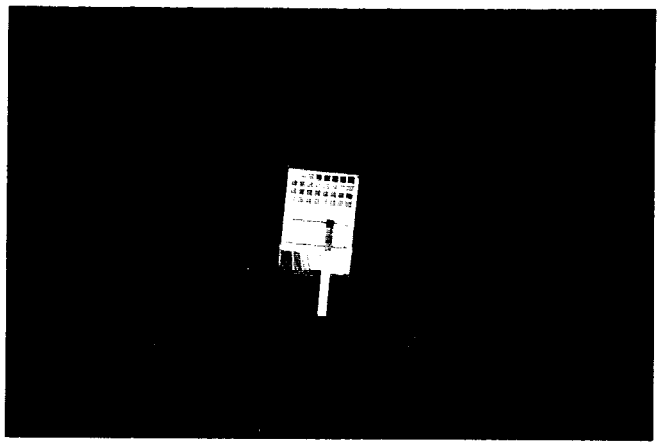


Dan Ziarkowski

Large surface impoundment of AMD.

D. K. Nordstrom

Small pool of AMD.

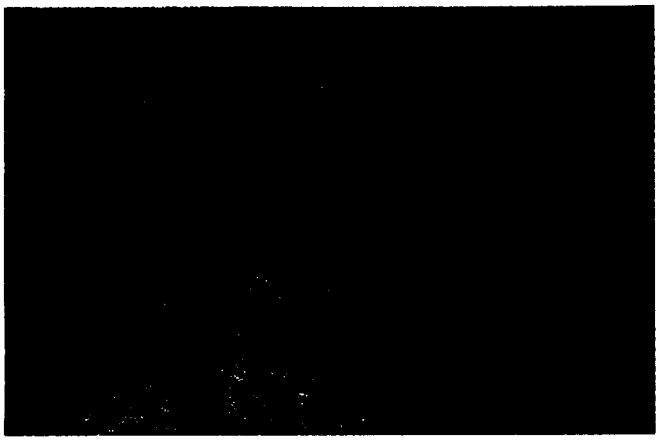


Dan Ziarkowski

pH paper is a quick way to determine water pH.

DTSC file

Large-scale AMD release to the Sacramento River.



Dan Ziarkowski

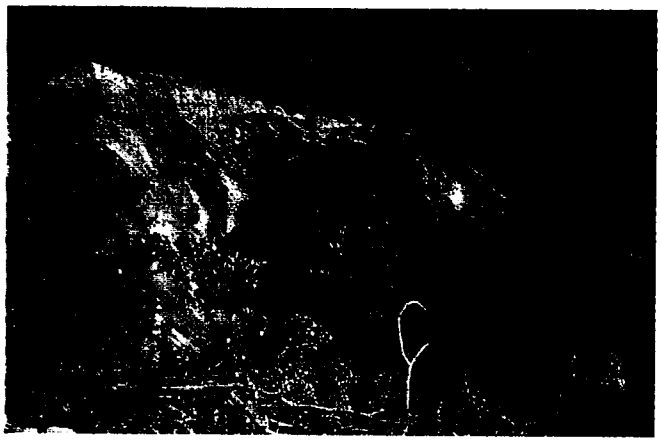
Small-scale AMD release. AMD can adversely impact creeks miles from the AML source.

Mike Hunerlach

AMD can be released seasonally or year-round. AMD from a small copper mine is impacting the Trinity River.

Dan Ziarkowski

Strong storms cause the release of arsenic laden mine tailings to a small creek.



DTSC file

Mine wastes are very susceptible to erosion.

Dan Ziarkowski

The confluence of two creeks illustrates the high mobility of tailings.

Dan Ziarkowski

Large boulder of mercury ore.

Char lpers

Some of the world's most acidic water is produced as ground water percolates through the underground workings of the Richmond Mine at Iron Mountain. Blue-green mineral is zinc-copper bearing melanterite.

Dan Ziarkowski

AML sites can expose mineralized rock.

CHAPTER FIVE
DATA COLLECTION, SAMPLING STRATEGY, AND WORKPLAN PREPARATION

5.1 INTRODUCTION

This section explains the general strategy for collecting samples and evaluating the quality of the data collected. The investigator should have a clear idea of the data needed and sampling strategy required based on the project objectives and indications of potential chemical hazards revealed during the background research. It is important to identify and evaluate past sampling to ensure that new sampling efforts yield data that are needed. A workplan should be developed prior to conducting any sampling.

The scope and type of sampling needed will depend upon the history of the site, sampling objectives, potential COCs, and data gaps identified in the Conceptual Site Model. If sampling has been conducted in the past, the results and related information should be reported and evaluated as part of the background AML investigation. Sampling is required unless prior data are of sufficient quality and quantity to meet all objectives and Quality Assurance /Quality Control (QA/QC) requirements. For DTSC or local agency oversight, past sampling must meet current QA/QC requirements, as discussed later in this section.

5.2 GENERAL SAMPLING STRATEGY

The primary objective of sampling during the AML Preliminary Assessment Investigation is to provide analytical data of known and sufficient quality which identify the contaminant concentrations at the site (or determine acid generating potential). These data will be used with other site information to estimate the risk to public health and the environment using conservative screening criteria. In the absence of special criteria for AML screening, the same criteria should be used for mined lands as for other industrial sites with solid wastes. Standard practice for site screenings is to base estimates of potential risk on the highest concentrations of each contaminant detected. Sampling should include locations that would be most likely to contain high contaminant concentrations or are likely to generate acid. Sample all mine waste piles if it is not possible to determine the most likely "hot spots."

A second objective of the sampling is to determine the general spatial extent of contamination in order to assess immediate potential risks and anticipate removal and remediation needs. Although results may be preliminary, sufficient information should be gathered to determine the need for immediate action such as restricting site access, and to identify parts of the site with levels of contamination that could require remediation.

Potential sample media include waste piles, surface soils, subsurface soils, bedrock, ground water, surface water, and air. The mix of media should be based on available historical information, available analytical data, suspected contamination sources, probable migration routes, potential exposure pathways, and location of potential receptors.

Sampling can be done in one episode or it can be addressed in a phased approach, depending on the information available prior to sampling (e.g., background information and site inspection) and the goals of the investigation. Sites with little known or suspected contamination may require only one sampling event to gather sufficient information whereas sites with extensive suspected contamination and numerous migration routes may require a phased approach. In a phased approach the nature and general extent of soils contamination might be determined first. If soil sample results indicate COC concentration exceeds its PRG, then the needed surface water sampling or air monitoring could be determined. In addition, soil data may indicate if a potential threat to ground water exists. The phased approach should be the most cost effective method of obtaining adequate data for complex sites.

5.2.1 Sampling Soil and Other Solids

This section describes sampling strategies and subsurface sampling considerations. The two primary soil sampling strategies used during an AML

investigation are authoritative and systematic random sampling (consult SW-846 (U.S. EPA, 1986a) and U.S. EPA Soil Screening Guidance EPA/540/R-95/128 for further sampling strategy information).

Authoritative sampling is intended to detect the highest concentrations of each contaminant and the approximate extent of contamination, and therefore is purposely biased. In this strategy, the investigator selects sampling locations using available information and professional judgement to identify potential "hot spots" (areas where the highest concentrations of contaminants are suspected).

Systematic random sampling is used to determine the location and extent of contamination at sites where the location and extent of contamination is not associated with obvious features (e.g., areas adjacent to or down-wind from mine wastes). In systematic random sampling, the first sample location point within the area of concern is randomly selected, but all subsequent sample points are established at a fixed space interval. An example of systematic random sampling is sampling a tailings impoundment along a transect in which the first sampling point on the transect is one meter from a randomly selected location on the impoundment and subsequent sampling points are located at two meter intervals along the transect.

Generally, discrete samples are preferred over composites. However, for large sites a combination of discrete and composite samples may be acceptable.

Subsurface samples should also be collected when possible to assess weathering effects. Weathering is a process by which minerals react with water and oxygen from the air, forming new compounds and releasing components to the water. The term "leaching" refers to removal of components by water; typically the outer 6-12 inches of mine waste piles are weathered and leached, but piles that have been exposed for several decades or more may be deeply weathered. The character and thickness of the weathered layer depends upon climate, temperature, particle size, mineralogy, permeability of the waste pile, age of the pile, contact with surface or ground water, and degree of disturbance by digging, grading, or other means (See Appendix B for further information on environmental impacts). Subsurface samples provide the most reliable indicator of long-term acid generating potential, and show the nature of material that will be exposed if mitigation measures require moving or grading the waste.

Regardless of the medium sampled (solid, water, gas, or biota), sample composition may vary depending on weather conditions at or prior to the time when the sample is collected. Together with leaching, certain secondary minerals may form on or near the surface of tailings or waste dumps during dry periods as a result of evaporation. Appendix D contains detailed information to aid in identifying and sampling several types of mine wastes. Appendix E provides augering and trenching guidance.

5.2.2 Field Evaluation and Sampling of Water

Contamination of ground and surface waters by metals is generally the most significant environmental hazard at mine waste sites. Sources of contaminated water include: adit or shaft drainage, seeps from dumps or tailings, run-off from waste rock or tailings piles, and leaching of metal salts from the surfaces of waste or tailing piles by surface water.

This section deals mainly with surface water; a detailed discussion of ground water monitoring and sampling methods is beyond the scope of the AML Handbook due to numerous complicated technical issues. If ground water contamination is suspected, a trained hydrologist experienced in mining environmental issues should be consulted. However, information relating to ground water can be collected during the background research phase of the investigation and can be included in the AML Preliminary Assessment Report (e.g., depth to ground water table, location of domestic wells). This information will be useful if ground water evaluation occurs as part of a more complete site characterization.

Metals are transported in water either as suspended or dissolved components. Migration of metals via suspension mainly occurs during significant storm events (or rapid snowmelt) where mine waste piles are susceptible to erosion. Filtration of water samples is generally done to isolate the dissolved components. Filters with a pore size of 0.45 micrometers are commonly used, and are the basis for some water quality regulations. However, it

should be recognized that the 0.45 micrometer pore size is an arbitrary cutoff, and colloidal particles will pass through the filter. The colloids are generally rich in iron and aluminum and may contain elevated concentrations of other metals.

Metals in waste piles and tailings may exist as relatively insoluble sulfides. However, the surfaces of many piles have weathered and the metal sulfides have been oxidized to sulfates, oxides, or carbonates. These oxidized metal salts can be readily dissolved and transported by surface water (e.g., rain and/or snowmelt).

Pyrite (FeS_2) is the most abundant sulfide mineral in many types of mineral deposits. Oxidation of other metal sulfide minerals is often enhanced by the presence of pyrite, because pyrite oxidizes readily and its oxidation products include sulfuric acid, which in turn attacks less reactive sulfides. Pyrite oxidation takes place wherever it is exposed to air in the presence of water as in the walls of mine openings, or in waste rock dumps and mill tailings. Although this process takes place naturally as pyrite-bearing bedrock is weathered, mining exposes more pyrite to air and water and therefore accelerates the acid generation process. When the sulfuric acid solution generated by oxidation of pyrite reacts with other metal sulfides it produces a metal-rich sulfate solution. Ground water migrating through waste rock dumps and tailings piles, and into mine workings can also provide the moisture needed for pyrite oxidation, and the medium needed for dissolution and transportation of metal salts.

As a result of the processes described above, many mine workings have associated drainage with low pH (acidic conditions) and elevated levels of dissolved metals. In the initial investigation, it is important to note the location and approximate flow rate of any drainage from mine workings, and of seeps or springs issuing from the vicinity of waste dumps or mill tailings. The best time of year to make observations regarding seepage is in the spring, soon after snowmelt in colder climates or during the late part of the wet season in others.

Sampling locations for screening purposes can be based on visual observation. When visual indicators are absent, any surface water that appears downslope from workings, dumps, or tailings should be checked. For large complex sites, which often present many sampling options, it may be necessary to seek advice from a hydrologist or geologist with experience in AML investigations. Because seasonal changes in precipitation affect water quality, especially in areas where soluble metal salts accumulate during dry periods, water quality cannot be characterized in a single sampling event. Appendix F contains more specific information on surface water observations and screening methods.

5.2.3 Air Samples

Air monitoring for dust should be considered to protect workers and any nearby residents during trenching in fine-grained mine waste containing, or suspected of containing, elevated levels of metals or asbestos. Monitoring of mercury vapors should be considered in areas of mercury production and possibly at gold mining sites where mercury was used extensively in mineral processing.

5.2.4 Background Samples

Background samples are collected to distinguish between site-related contamination and naturally occurring or non-mining anthropogenic contamination. Generally, contamination levels at a site should not be compared exclusively to regional background levels or estimates of average geochemical abundance. However, regional background information (e.g., County Soil Conservation Service surveys, USGS reports) can be helpful to understand surface soil types in the general vicinity of the AML site. Background samples should be collected for each medium being investigated, such as water, soil, rock, air, or biota. Background samples should be collected at or near the site, but away from areas likely to be influenced by the past site operations. Background samples should be collected from locations that are upgradient/ upwind/ upstream of the suspected contamination.

It is unlikely that a sufficient number of background samples will be collected during an AML preliminary assessment to be considered statistically valid. However, the information is useful in comparing ranges of background concentrations to on-site contamination. Generally, background samples should be collected from eight locations (professional judgement can increase or decrease this sample number depending on site size) to determine the range of contaminant concentrations that is not a

result of mining-related releases. If initial sampling reveals a high variability between samples, more samples should be collected to increase confidence that the results are representative of the source area. See Section 6.5.4.

Complications can arise where mineralized rocks are exposed at the surface, because they may contain amounts of metals many times greater than those in unmineralized rocks, which usually dominate geochemical background. If both mineralized and unmineralized rocks are collected to characterize background, the resulting ranges of values may be very large, and may overlap the values found in some mining wastes. In this situation, the best way to deal with the high variability in concentrations of metals is to separate the data for mineralized samples from that of unmineralized samples, and make independent estimates of metal concentrations for both. The range of values for the unmineralized samples can be considered as indicative of background. Mineralized rocks should be treated as another potential site hazard. Whether or not they are of concern depends upon which metals are enriched and their concentration levels. Mineralized zones can be further evaluated (e.g., whether significant amounts are present in mobile forms) during site characterization if the screening evaluation indicates there is a potential health threat.

Background samples should be analyzed for all potential COCs. With few exceptions, one may assume that background levels for man-made chemicals are zero. Rare exceptions may arise when an off-site source has contributed to on-site contamination, the site is affected by a regional contamination problem, or the chemicals (e.g. DDT) are pervasive in the environment in trace amounts.

5.3 WORKPLAN PREPARATION

5.3.1 Workplan Development

The plan of action for investigating the site should include a sampling plan and a site safety plan (SSP). The following points are to be addressed in the sampling plan:

1) Site background: site description and history relevant to sampling, which identifies past activities and areas where contaminated soil is likely. The workplan should also include other relevant site information such as topography, hydrology, climate conditions, and past sampling information. Field maps should show the site in relation to its surroundings and identify site-specific physical features, all sample locations, known or potential COC sources, surface water and general ground water flow directions, and site boundaries.

2) Sampling program: based on the sampling strategy, provide criteria for choosing locations, decide on number of samples, determine components to be analyzed, sample volume (for analytical work and archiving), and field screening methods. The details of any statistical sampling design used to select the specific locations should be explained.

3) Sampling methods: decide on and record standard operating procedures for collecting samples from all media. Identify equipment needed for sampling, and number and type of field quality control samples.

4) Analytical methods and detection limits: list the analyses to be performed on each sample or group of samples and the analytical methods with appropriate detection limits for each contaminant. The detection limit for a contaminant must be low enough to insure that it is detected at the level of concern established by U.S. EPA.

5) Sample documentation: develop a numbering system that uniquely identifies each sample and includes QA/QC samples but does not distinguish them from other samples. There should be a checklist of field documentation, including field logs, maps showing actual sampling locations, photographs, QC logs, and chain-of-custody forms and seals. The types of information to be entered in the various logs should be specified.

6) Sample containers and preservation: a table can be compiled to show types of containers and preservatives to be used for various matrices, and analyses. A description of, or reference to, precleaning method used for the containers should be noted.

7) Sampling packaging and shipment: develop and describe procedures for labeling, marking, packaging, and shipping samples to the analytical laboratory. Describe the laboratory's sample storage conditions.

8) A description of equipment decontamination procedures and disposal of materials should be provided.

5.3.2 Quality Assurance/ Quality Control

The workplan for the site should include QA/QC measures to be implemented as part of the sampling and analytical procedures. If field equipment is used, equipment calibration procedures should be noted. The purpose of these measures is to obtain data of known quality. The QA/QC measures are intended to monitor both field and laboratory procedures.

To check the precision and accuracy of field data, QA/QC samples will be collected for analysis. Field QA/QC samples include equipment blanks, duplicates, and co-located samples. Table 5.1 provides the minimum field QA/QC sample requirements for each medium.

In addition to samples listed in Table 5-1, QA/QC measures can be employed throughout the sample collection process to assure the quality of the results. When selecting equipment to collect, store, preserve, and transport the samples, consider the effects the devices may have on the integrity of the samples. Equipment must not react with, promote adsorption, leach analytes, or otherwise influence contaminant concentrations prior to analysis. Sample collection should also be performed in a manner that does not adversely affect the sample integrity. Samples are to be representative of existing site conditions, and influences due to the sampling and analysis procedures should be minimized. In order to evaluate any potential influences, persons conducting the sampling should document the manner in which the samples are handled from collection to final analysis.

QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

SAMPLE TYPE	RATIOS
Co-located replicates	5% OF TOTAL # OF SAMPLES
Duplicates	5% OF TOTAL # OF SAMPLES
*Water equipment blanks	1 PER FIELD SAMPLING EVENT (AS NEEDED)

TABLE 5 - 1

**A water equipment blank should be collected if the same piece of equipment is used for more than one water sample. A water blank will also verify the integrity of the sample container.*

CHAPTER SIX
SAMPLE ANALYSIS

6.1 INTRODUCTION

Chapter six briefly describes the three main classifications of analyses which may be necessary at an AML site: inorganic analysis, organic analysis, and prediction of acid-generating potential. In addition, this chapter includes a data evaluation section which will aid the AML investigator in determining data quality. The AML investigator has flexibility in determining which tests should be conducted. Note: A detailed discussion of specific inorganic and organic analyses is available in Test Methods for Evaluating Solid Wastes (SW-846): Physical /Chemical Methods (US EPA 1986a). A state certified laboratory should be used for all organic and inorganic sample analyses (Title 22, California Code of Regulations, Division 4, Chapter 19, and Division 4.5, Chapter 44).

6.2 INORGANIC ANALYSIS

The COCs at AML sites will most likely be heavy metals associated the hardrock mine wastes, and possibly mercury associated with mercury, hardrock gold, and placer gold recovery operations. This will usually be true regardless of the pH range (e.g., even at neutral conditions where AMD is not a concern). Conducting an initial multi-element scan on several representative samples to obtain a metal "profile" will aid in determining the most likely COC(s). Further metal analysis can be conducted on most or all of samples focusing on specific COCs. The most cost-effective approach (individual metal analysis versus a multi-element scan) can be evaluated once the most likely COCs are identified.

6.3 ORGANIC ANALYSIS

Organic chemicals may be present at some AML sites. For example, AML sites where electric generators were used may have polychlorinated biphenyls (PCBs) associated with leaking transformers, or spilled petroleum hydrocarbons (fuel and oil). Furthermore, some AML sites may contain organic chemicals as a result of illegal dumping of hazardous wastes, which may impregnate soil or appear in labeled or unlabeled drums, tanks, or in underground workings.

It is beyond the scope of this document to provide specific guidance for evaluation of organic chemicals. If organic chemicals are suspected at an AML site, refer to the DTSC's Preliminary Endangerment Assessment Guidance Manual, Section 2.4.2.1, page 2-10, for further information.

6.4 PREDICTING ACID GENERATION POTENTIAL

6.4.1 Paste pH and Rinse pH

An inexpensive and rapid method for determining the acid potential of mine wastes is the paste pH. A description of this method was provided by Sobek et al. (1978). Powdered soils, tailings, or rocks are mixed with deionized water at a soil/water ratio of 2:1, and the pH of the slurry is determined using either a standard pH meter and electrode or pH paper. One potential shortcoming of this method is that crushing samples increases their surface area and can expose reactive minerals (either acid-producers or acid-neutralizers) that were previously trapped inside larger particles and therefore much slower to react *in situ.*

An alternative and equally rapid procedure called rinse pH consists simply of mixing deionized water with an unpowdered sample and measuring pH. Measurements of paste pH are much more common that those of rinse pH. Either method can be used to get a qualitative measure of mine waste acid generation potential. pH measurements less that 5 indicate that the sample contained net acidity at the time of analysis. pH measurements less than 4 indicate that the material may be "acid-toxic" from the perspective of potential revegetation (Ritcey, 1989).

6.4.2 Acid-base Accounting

Several methods for predicting the potential of a material to generate AMD have been developed and tested. The most commonly used initial screening test is Acid-Base Accounting (ABA). A similar technique developed by the British Columbia AMD Task Force is also in common use and is preferred by some consultants. ABA yields a value expressed as kilograms calcium carbonate ($CaCO_3$) per metric ton of sample (kg/mt) or metric ton of $CaCO_3$ per 1,000 mt of sample (mt/1,000 mt).

Many analytical laboratories provide ABA analysis. This procedure should be requested by name just as any chemical analysis is requested. However, fewer laboratories offer ABA than provide chemical analysis. When choosing a laboratory for chemical analysis this should be a consideration. The AML investigator should discuss sample requirements for ABA analysis with the laboratory that will do the work to make sure that a proper sample is obtained. For ABA the laboratory determines a value for acidification potential (AP) and for neutralization potential (NP) of the sample. The value of ABA = NP - AP. Appendix G contains further information on methods used to evaluate acid generation potential.

6.5 EVALUATING DATA FOR QUALITY AND USABILITY IN SCREENING

An AML investigation usually requires collecting a variety of data for a number of different purposes. Data collected can range from visual field monitoring data for health and safety to analytical results for contaminant levels. Each sample may have been analyzed for a number of different chemicals, depending upon the reason for collecting the sample. The purpose of data evaluation is to determine which of the chemicals identified are likely to be site-related and to assess whether the reported concentrations for these chemicals are reliable enough to use in the AML preliminary assessment. Much of the following material was excerpted from "Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods" (SW846, Third Edition), U.S. EPA 1989a.

6.5.1 Evaluation of Analytical Methods

Not all of the data collected during the field investigation are appropriate for use in the screening evaluation. Analytical results that are not specific for a particular element or compound, or that are from insensitive analytical instruments (e.g., most portable field instruments) generally are not appropriate for quantitative risk assessment. These types of results, however, may be useful when considering sources of contamination, possible transport and fate of contaminants, or qualitative discussion of risk. In addition, the results of analyses unaccompanied by appropriate QA/QC procedures should be eliminated from quantitative use.

6.5.2 Evaluation of Detection Limits

Before eliminating chemicals because they are not detected, the following points should be considered:

- The detection limit for a chemical may be greater than the corresponding standards, criteria, or concentrations derived from toxicity reference values. If so, the chemical may be present at levels greater than the corresponding reference concentrations, which may result in undetected risk.

- The detection limit for some samples may be significantly higher than the limit normally stated for the analytical method, owing to matrix effects or interferences.

These two points and types and definitions of detection limits are discussed in detail in Chapter 5 of U.S. EPA (1989a).

6.5.3 Identification of Potential Chemicals of Concern

All chemicals should be considered a potential concern until eliminated via a screening evaluation discussed in Chapter 7 of this handbook.

6.5.4 Comparison of Site Data with Background

In some cases, a comparison of sample concentrations with background concentrations is useful for identifying the non-mining-related chemicals that are found at or near the site. If background risk is a concern, it should be calculated separately from site-related risk. It is common for areas of mining to have mineralized and hydrothermally altered rocks exposed at the surface. Mineralized areas tend to be localized and do not represent the general background of the area (see Section 5.2.4). A detailed discussion of background sample comparison is contained in Chapter 5 of U.S. EPA (1989a).

CHAPTER SEVEN
HUMAN HEALTH SCREENING EVALUATION

7.1 INTRODUCTION

The AML human health screening evaluation compares identified COCs with the U.S. EPA, Region 9, PRGs for residential land use. COCs can also be evaluated using the DTSC's Preliminary Endangerment Assessment Guidance Manual human health screening. This approach allows for a rapid evaluation of data to determine if a potential health threat exists. A residential land use is assumed because the AML screening is based on unrestricted land use. The AML screening evaluation is not an absolute estimate of risk or hazard at a specific site. The AML screening evaluation will determine whether further site characterization, risk assessment and remediation are necessary if unrestricted land use is the intended goal of the property. However, if alternative land use is desired (e.g., commercial use with a deed restriction) then modified cleanup levels can be developed as part of the cleanup plan.

Chapter 7 explains the screening evaluation assumptions and exposure factors, identification of COCs, and use of U.S. EPA PRGs. Detailed information on risk assessment is available in US EPA Risk Assessment Guidelines, Volume I, Human Health Evaluation Manual, Part A, 1989, and Cal/EPA DTSC Risk Assessment of Hazardous Waste Sites and Permitted Facilities, July, 1992.

7.2 SCREENING EVALUATION ASSUMPTIONS AND EXPOSURE FACTORS

There are several assumptions and exposure factors which are used when conducting a screening evaluation including; land use, exposure pathways, COCs, acute and chronic exposure characterization, and exposure point concentrations. These assumptions and factors are further described in this section.

7.2.1 Land Use

For the purposes of the human health screening evaluation, the land use of the AML site is assumed to be residential, regardless of the current use and zoning for the site. While this assumption is conservative, it is based on unrestricted land use and provides a common starting point for evaluation of AML sites. It is beyond the scope of this document to provide alternative human health screening evaluations because of the many possible land use scenarios. If other land use is intended, a modified human health screening evaluation by a certified toxicologist will be necessary. Regardless of the intended land use, many of the technical aspects outlined in this document will still apply (e.g., sampling techniques).

7.2.2 Exposure Pathways and Media of Exposure

It is assumed that the following exposure routes and media of exposure are applicable:

- Inhalation: airborne dust;
- Ingestion: surface water, groundwater (household use only), and incidental ingestion of soil;
- Dermal absorption: direct contact with soil, surface water, and groundwater (e.g., showering).

Other pathways of exposure are possible under a residential scenario, but for this screening evaluation, only these major pathways are considered. If food chain contamination is suspected or is plausible, then the risk analysis should not be restricted to the exposure pathways in this screening-level evaluation.

7.2.3 Chemical Groups

The most prevalent COCs associated with some abandoned mine sites are heavy metals (e.g., lead, cadmium, mercury), metalloids (e.g., arsenic), some minerals (e.g., asbestos), and processing chemicals (e.g., cyanide). In addition, there exists the possibility that some abandoned mine sites were used for the illegal dumping of hazardous wastes. If illegal dumping is suspected, contact the local environmental health department or the DTSC. Refer to the DTSC's PEA for a further description of chemical

groups and human health screening procedures and needed actions. If the AML site is suspected of containing chemicals associated with illegal drug manufacturing operations, leave the site immediately and contact local law enforcement and environmental health authorities, or contact a DTSC regional office for guidance.

7.2.4 Acute/Chronic Exposure

Human exposure occurs when people have direct contact with a COC. Generally, two types of exposure are considered, acute and chronic. Acute exposure is defined as short-term exposure to high concentrations of the COC (e.g., cyanide). Chronic exposure is defined as long-term exposure to low concentrations of the COC (e.g., arsenic is known to cause cancer in humans). In addition, some chemicals are known to cause birth defects (e.g., mercury).

7.2.5 Uncertainty

Numerous toxicological interactions are known among metals of concern. Some are antagonistic (e.g., zinc, copper, and calcium protect against cadmium and lead), while others are synergistic (i.e., toxic effects are cumulative). These effects can be concentration-species-dependent. It is beyond the scope of this screening to evaluate these effects. If an AML site fails the screening evaluation, a toxicologist can be consulted for a more detailed discussion of overall risk.

7.2.6 Exposure Point Concentrations to Identify Chemicals of Concern

Use the maximum contaminant value found from sampling as the exposure point concentration to identify potential COCs. In cases where there is adequate characterization, it may be appropriate to use the 95 percent upper confidence limit of the arithmetic mean as the exposure point concentration. The AML screening assumes the "worse case" scenario, however, not all potential exposure pathways are included (e.g., contaminant uptake by home-grown produce and subsequent ingestion).

7.3 U.S. EPA PRGs

The U.S. EPA, Region 9, Preliminary Remediation Goals (PRGs) combine current EPA toxicity values with "standard" exposure factors to estimate contaminant concentrations in environmental media (soil, air, and water) that are protective of humans, including sensitive groups, over a lifetime. Chemical concentrations above these levels would not automatically designate a site as "contaminated" or trigger a response action. However, exceeding a PRG suggests that further evaluation of the potential risks that may be posed by a site contaminant is appropriate. Further evaluation may include additional sampling, consideration of ambient background levels in the environment, or a reassessment of the assumptions on which the screening-level estimates were based.

PRG concentrations can be used to screen pollutants in the environmental media, trigger further investigation, and provide an initial cleanup goal if applicable. When considering PRGs as preliminary goals, residential concentrations should be used for maximum beneficial use of the property. Industrial concentrations are included in the U.S. EPA's PRG table as an alternative cleanup goal for soils. However, for the purposes of the AML screening evaluation these values are not appropriate to use. Use of the industrial PRGs may be appropriate during the remedial phase when further site characterization has been conducted and the intended land use is identified. The U.S. EPA, Region 9, PRG concentrations are based on exposure pathways for which generally accepted methods, models, and assumptions have been developed (i.e., ingestion, dermal contact, and inhalation) for specific land-use conditions. (Note: The PRGs do not consider impact to groundwater or ecological receptors).

PRGs are updated annually and can be obtained by contacting:

Ms. Lynn Trujillo
U.S. Environmental Protection Agency
Region 9
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-2419

PRGs are also available on the World Wide Web at: http://www.epa.gov/region09/waste/sfund/prg/index.html

CHAPTER EIGHT
ECOLOGICAL SCREENING ASSESSMENT

8.1 INTRODUCTION

Chapter eight outlines the requirements for conducting an ecological screening assessment. Chapter eight's ecological screening assessment is excerpted (with slight modifications) from the DTSC's "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part B: Scoping Assessment" July 1996; (DTSC, 1996b). In addition to the requirements of DTSC, (1996b) the AML ecological screening assessment relies on visual observations and professional judgement of those determining if environmental degradation has occurred. However, a lack of visual environmental damage indicators does not necessarily mean such damage is not occurring or has not occurred.

Further information on ecological assessment can be found in DTSC's "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview," July 1996, (DTSC, 1996a), and in the U.S. EPA's "Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual, Interim Final," March 1989 (U.S. EPA, 1989b).

8.2 ECOLOGICAL SCREENING ASSESSMENT

The initial screening assessment of potential ecological risk related to a hazardous substance release site is meant to identify potential ecological receptors, potential contaminants of concern and the potentially complete exposure pathways. Completion of a screening assessment relies on the professional judgment of the investigator to qualitatively evaluate the potential threat to non-human receptors posed by potential contaminants and site-specific activities.

It cannot be assumed that the human health screening evaluation provides an estimate of the threat to biota. Ecological receptors are frequently more sensitive to adverse contaminant-induced effects than humans. In addition, many terrestrial organisms may be exposed to higher concentrations of contaminants than humans. Burrowing animals, such as rodents or burrowing owls, would typically be exposed to higher concentrations of soil contaminants than humans.

The term "biota" generally refers to non-domesticated terrestrial and aquatic plants and animals, but may include domesticated species, such as livestock. The screening assessment uses a habitat approach as the basis for identifying the potentially complete exposure pathways between the areas of contamination and specific species or habitats which occupy, or potentially could occupy, the site. A list of the potentially exposed receptors and potentially complete exposure pathways in a screening assessment report is useful in deciding whether additional assessment is required or whether the site poses minimal threat to ecological receptors.

8.3 IDENTIFICATION OF POTENTIAL CHEMICALS OF CONCERN

It is important to recognize that the identification of contaminants of potential concern to ecological receptors may necessitate a separate identification process from any human health screening evaluation, since a chemical not generally considered a threat to human health may be a potential chemical of concern for biota. In contrast to aquatic organisms, individual exposure pathways for terrestrial organisms can be more easily evaluated. It is, therefore, difficult to offer similar media-specific comparisons for terrestrial organisms because toxicity can differ significantly depending on the route of exposure. The DTSC recommends that complete justification be provided in the text for inclusion or exclusion of potential contaminants of concern. Physical parameters such as water solubility, volatility and persistence should be specified in addition to the toxicity of potential degradation products and the potential for bioaccumulation.

The list of potential contaminants of concern may be developed based either on site-specific history of

use or laboratory testing of environmental media. The history of site-specific use is more typically the source of potential contaminants of concern in the scoping assessment phase of work. Where laboratory analytical results are available, the method detection limits should be compared to ecological effect concentrations or Applicable or Relevant and Appropriate Requirements (ARARs) to determine whether the laboratory detection limits were sufficiently low to allow selection of contaminants of ecological concern. For example, detection limits in water should be compared against Federal AWQC or California Water Quality Objectives (WQO) to ensure appropriate analytical methods were used. The DTSC recommends that a table, similar to the example in Table 9-1, be prepared listing the potential contaminants of concern, whether historical use or laboratory results were the basis for inclusion, the contaminated or potentially contaminated environmental media, and the potentially affected habitat. In listing potential contaminants of concern which are included based on chemical analysis, the DTSC recommends that the number of samples analyzed, the method detection limit, the minimum concentration, the maximum concentration, the mean concentration and the standard deviation for each contaminated medium be included in a tabular form to facilitate independent review.

8.3.1 Organic and Inorganic Background

The identification of chemicals of ecological concern is the point at which a potential responsible party (PRP) may choose to demonstrate that organic and inorganic contaminants are present at "background" concentrations and that the AML site therefore poses no greater risk than the surrounding unimpacted area (See sections 5.2.4 and 6.5.4). If organic chemicals of ecological concern are present or concentrations of inorganic elements are present above "background" concentrations the screening assessment proceeds to identify the potentially affected habitats or communities.

8.4 BIOLOGICAL CHARACTERIZATION

A biological characterization of the site, conducted by a qualified field biologist, is usually necessary to identify the biota actually or potentially occurring at the site. Site surveys should be scheduled to occur at various times throughout the day in order to maximize the potential for identification of potential ecological receptors. In order to facilitate the process, the DTSC recommends that advance notice of the date and time of the site survey be given to concerned regulatory agencies and natural resource trustees.

The biological characterization of the site should ultimately result in development of a conceptual site model which can direct investigation of potential ecological threats toward species and habitats most likely to demonstrate site-related effects. The DTSC recommends that the biological characterization be presented as described in Section 9.9 in a manner similar to the example in Table 9-2.

8.4.1 Identification of Habitats

In lieu of an extensive site-specific biological survey conducted over an extended period of time to physically identify species occupying each distinct habitat, the species expected to occupy each habitat can be identified using available electronic databases or publications prior to an actual site visit. For such an analysis, a qualified field biologist would first identify each distinct habitat occupying the site and the surrounding area within 1 mile (include identification of locations where contaminants may be transported). The site survey should allow identification and determination of the relative extent of site-specific habitats. Off-site habitats, and the associated receptors that may be affected by site-related contamination, are also important and warrant evaluation. Aquatic habitats should be evaluated in terms of both the water and sediment components. Terrestrial habitats such as forest, oak woodland, grasslands, Jepson prairie, vernal pools, riparian, lacustrine, palustrine, desert, sand dune, coastal chaparral, agricultural or maintained landscape such as golf courses warrant evaluation and characterization. Transition zone habitats such as freshwater wetlands, saltwater wetlands, brackish water wetlands, marine intertidal and mudflats of rivers, lakes or streams should be evaluated and characterized. Biological characterization of the site should also identify the species and types of communities potentially occurring due to their occurrence at nearby areas (i.e., within 1 mile). Identification of the location of all wildlife areas, preserves, reserves, sanctu-

aries, parks, natural areas, conservation areas, or other protected areas within 1 mile of the site is beneficial to the evaluation of ecological risk.

Note: AML sites with open adits and shafts can provide habitat for bats and other wildlife. Bat and wildlife habitat should be considered feasible unless biological characterization can prove otherwise.

8.4.2 Identification of Potential Receptors

Particular emphasis should be placed on identification of "special species" and their habitats which occur on or within a one-mile radius of the site. Special species include:

- California species of special concern;
- State and federally listed rare, threatened or endangered species; and
- Species which are proposed or recommended for state or federal listing.

The California Department of Fish and Game's (DFG) Natural Heritage Division should be contacted for the current special animal and special plant lists. The DFG's Natural Diversity Data Base (NDDB) can be a starting point for locating information about special species which have been found near the site, although the NDDB is not an all-inclusive listing. For more information on special plant and animal lists, and the NDDB, contact:

Information Services Coordinator
Information Services
Natural Heritage Division
California Dept. of Fish and Game
1416 9th St., 12th floor
Sacramento, CA 95814
(916) 324-3812 or (916) 327-5960

In addition to the rare, threatened or endangered species, the initial list of potential receptors includes those species which can be expected to occupy the habitats identified for the site based on the available literature. Examples of useful literature sources include Airola, (1988), Mayer and Laudenslayer, (1988), Zeiner et al. (1991). These references are available for purchase from Wildlife Habitat Relationship Coordinator, California Department of Fish and Game, (916) 657-3933. These references also provide summary information on food items, life history, and habitat requirements for many species found in California.

In the AML screening assessment report, the species noted to be present, or signs of activity, can be presented for comparison with the list of potential species based on the habitat evaluation in a manner similar to the example in Table 9-2.

8.5 IDENTIFICATION OF POTENTIALLY COMPLETE EXPOSURE PATHWAYS

Pathway assessment is conducted once potential species and habitats are identified. Pathway assessment identifies the potential for contact between biota and chemicals of concern in any medium and by any route. Media to be considered include soil, air, water, and biota. Of particular importance is consideration and evaluation of physical and chemical characteristics which influence environmental fate and transport. Persistent chemicals should receive special consideration. The DTSC recommends that potential off-site transport of contaminants, such as surface water transport in drainage channels, be evaluated.

Pathways may be direct, such as inhalation of air, or indirect, such as movement through the food web. Direct exposure routes to be considered include inhalation, ingestion, and dermal contact. Indirect exposure via consumption of food items also warrant evaluation, especially for those chemicals of concern with physical parameters which indicate a potential for persistence, bioaccumulation and toxicity. Generally, exposure via food web transfers should be evaluated for persistent, toxic compounds which have a log octanol-water partition coefficient (log K_{ow}) greater than 2.0. Persistent, extremely bioaccumulative compounds which have a log octanol-water partition coefficient (log K_{ow}) greater than 5.0 may require a greater degree of assessment be applied to bioaccumulation than to the pathways of direct exposure. In general, potential exposure pathways should be included when (U.S. EPA, 1989):

- There was or is a potential release to the environment, based on site-history or preliminary characterization data;

- Transport of the contaminant to a point of exposure is possible based on preliminary site characterization data or fate and transport modeling;

- A point of contact exists for the contaminant and potential receptors; or

- An exposure route, such as inhalation or ingestion, exists at the point of contact.

The DTSC recommends that pathways shall be considered complete unless there is scientific justification to demonstrate the chemical will not enter the medium or the receptor will not contact the medium, either directly or indirectly, now or in the future.

For completeness and to facilitate independent review, the DTSC recommends that a qualitative description of the magnitude, duration and frequency of exposure to the various biological receptors, representing multiple trophic levels, for each contaminant or area of contamination be included in a final report (see Section 9.9). A tabular summary of the exposure pathway analysis for each habitat type should be provided, identifying the most significant exposure pathways given the potential contaminants of concern and the potential ecological receptors. The exposure pathway table should be used to develop the conceptual site model. See the example in Table 9-3.

In the event that there are no contaminants of concern for ecological systems or the potential exposure pathways are incomplete, the identification of habitats and potential receptors may be used to evaluate any potential impact associated with remediation efforts based on the human health risk assessment. An estimate of potential damage to ecological systems may be a critical factor in selecting an appropriate remedial alternative.

PART THREE

SUGGESTED REPORT FORMAT

CHAPTER NINE
PREPARATION OF THE ABANDONED MINE LANDS PRELIMINARY ASSESSMENT REPORT

Chapter nine suggests a format for organizing the Abandoned Mine Land Preliminary Assessment Report (Report). The DTSC recommends that all AML investigations be documented. The Report serves to document the objectives, findings, conclusions, and recommendations of the AML investigation. The Report is formatted to provide comprehensive documentation, but can be tailored to meet the need of the investigator. If the Report is being developed as a PEA, and information is omitted because it is unknown or seems irrelevant to the AML site, the rationale for this omission should be included in the Report.

If during the background research and site inspection it is determined no further action for the AML site is required (see section 4.6.4), the DTSC recommends a document be prepared incorporating all site-specific information as well as the rationale for conclusions. This document does not need the level of information (e.g., human health or ecological screening) suggested for a full AML screening report.

9.1 EXECUTIVE SUMMARY

The executive summary is a complete summary of the AML site investigation. This section informs the reader of all major aspects of the AML site. Specifically, this section should include, but not be limited to, very brief descriptions of the following:

- purpose of investigation;
- site background and current status;
- physical and chemical hazards;
- pathways demonstrating potential human health or environmental threats;
- potentially exposed populations; and
- conclusions and recommendations.

9.2 INTRODUCTION

This section introduces the AML site and organization of the Report. The investigator should provide the reason for performing the AML investigation. The Report should include a statement of the assumptions used during the investigation (e.g., residential land use).

9.3 SITE DESCRIPTION

The AML site description should include information that identifies the physical setting of the site in relation to the surrounding area.

9.3.1 Site Identification

The following information should be included to clearly identify the AML site (table format is acceptable):

1) Site Name: Name and current land use.

2) Contact Person(s): Name of main contact person(s) and mailing address and phone number.

3) Site Address (if applicable): Street address or nearest cross streets, city, state, county, and zip code.

4) Former or alternate names for the current and historical operations on-site.

5) U.S. EPA Identification Number: If assigned.

6) CalSites Database Number: If assigned.

7) Assessor's Parcel Number and Maps: Parcel number(s) for the AML site and copy of the County Assessor's plat for the parcel(s) where the AML site is located.

8) Latitude, Longitude, Universal Transverse Mercator (UTM) coordinates, Township, Range, Section, Meridian, and Elevation: Corresponding to the site location.

9) Land Use and Zoning: Current land use and zoning and any proposed land use or zoning changes. Land use categories may include, but are not limited to: commercial, industrial, institutional, single family residence; multi-family residential; cultivated land; pasture or range land; wood or forest land; meadow; open grass areas, or landfill. In addition, public easements/right-of-way should be described.

9.3.2 Site Maps

A site location map and a site-specific map (AML diagram) should be prepared. The AML location map should show the general location of the site relative to its surrounding area (scale: 1:24,000 topographical map). The AML map should identify major highways, surface waters, land use, sensitive populations (residences, schools, hospitals, etc.), and critical habitats. The site specific map should include all significant site features (buildings, waste piles, impoundments, etc.), both current and historical, and should be drawn to a scale appropriate for the site size. The USGS quadrangle maps (1:24,000) on which the site is located should be identified. All maps should be oriented with north at the top of the page.

9.4 SITE HISTORY

9.4.1 Historical Operations

Provide a description of historical operations including the following information:

1) Type of operation (surface, underground, dredge, placer, etc.) including processing techniques and mine waste disposal practices.

2) Status of operation (past producer, explored prospect, unknown).

3) Commodities (gold, silver, copper, zinc, mercury, etc.).

4) Size of production (indicate the total amount of ore and metals produced to date if known).

5) Milling and processing methods (amalgamation, gravity, arrastre, stamp, jig plant, cyanidation, flotation, retort, vat leach, etc.).

6) Years of operation and workings history (steady or intermittent operation).

7) The site's past regulatory history with state and federal agencies.

8) Location of other mines within one mile of the AML site.

9.4.2 Current Site Status

Describe the site's current status including current regulatory status.

9.5 APPARENT PROBLEM

This section should summarize the available information regarding known or potential sources of contamination which constitute the primary reason for investigating the site. The summary should include documentation of type of mine, commodity, volume of mine wastes, identification of COCs, identification of primary human and environmental receptors of concern, and a description of potential exposure pathways. Detailed information related to the apparent problem should be described in subsequent sections of the Report.

9.6 ENVIRONMENTAL SETTING

During the background research, information should have been collected regarding the site's environmental characteristics. This information identifies the site environmental conditions that would influence the transport of contaminants, from the source of contamination through identified potential exposure pathways to the exposed individual or environmental receptor.

9.6.1 Factors Related To Soil Pathways

1) Describe the topography of the site and the surrounding areas.

2) Describe any evidence of environmental impacts from heavy metals or AMD (e.g., stained soil, stressed vegetation, dead wildlife, surface waters void of aquatic life).

3) Describe the predominant soil groups for the site. Use site-specific geologic boring logs when available or the U.S. Department of Agriculture Soil Maps. Identify the least and most permeable continuous layers of soil and the qualitative permeability of each layer.

4) Describe the surface slope characteristics of the site. Also, provide the slope of any intervening terrain between the site and the nearest downhill surface water body. State if the site is in a closed basin or is located adjacent to a surface water body. Provide topographic maps drawn to a scale suitable to illustrate pertinent features such as drainage areas, streams, etc.

5) Describe accessibility to the site in terms of both natural and man-made features or structures which currently restrict human access to the site.

6) Describe any measures which have been taken to contain or prevent off-site migration and/or direct contact with contaminated soil.

7) Provide the distance to and location of the nearest potentially affected residential or commercial areas (including schools, day-care centers, nursing homes, senior citizen communities, and hospitals) within one mile of the site.

9.6.2 Factors Related To Water Pathways

The AML investigation focuses on surface waters which are contaminated or have the potential to be contaminated. Geologic information gathered during background research can be helpful for a ground water investigation if ground water contamination is suspected and further characterization is required. The following hydrologic information should be provided.

1) Describe the hydrology beneath the site in terms of known ground water, depth to ground water, hydraulic conductivities, confining layers, discontinuities, ground water interconnections, and any other features of significance.

Data Sources: Sampling data; local water districts and utilities; county health departments; Department of Health Services; Public Water Supply Branch; Department of Water Resources; Regional Water Quality Control Board; USGS.

2) Identify the ground water which may have been contaminated by the site, or which is threatened to be contaminated as a result of migration of contamination from the site. Identify ground water which is interconnected with ground water that has been contaminated by a release from the site.

Data Sources: Sampling data; local water districts and utilities; county health departments; Department of Health Services; Public Water Supply Branch; Department of Water Resources; Regional Water Quality Control Board; USGS.

3) For ground water identified above, provide the following information for wells within a three-mile radius of the site:

   a) The use(s) of groundwater from the well which draws water (e.g., drinking water, irrigation, industrial process water, etc.).

   b) The distances to the nearest well and nearest drinking water well which draw from the ground water.

   c) The direction and velocity of ground water flow.

   d) The approximate number of service connections and population served by drinking water wells from the ground water.

Data Sources: Local water districts and utilities; County planning and health departments; Local irrigation districts; Department of Health Services, Public Water Supply Branch; Department of Water Resources; Regional Water Quality Control Board; USGS.

4) Describe the possible migration route(s) from the areas of contamination to nearby surface waters, marshlands, wetlands, or wildlife habitats in the event of surface water runoff or flooding.

Data Sources: Visual observation; aerial photographs; USGS maps.

5) Describe the locations and uses of surface waters, marshlands, wetlands, and wildlife habitats that may be potentially affected by migration of contaminants from the site. Also, provide the location and distance to the nearest surface water, marshlands, wetland, and wildlife habitat which may be affected by migration of the contaminants.

Data Sources: USGS maps; Department of Fish and Game; local planning department; Bureau of Reclamation; State Water Resources Control Board.

6) Describe any past or existing measures for preventing or mitigating surface water runoff from the site (e.g., berms, diversion systems, diking, runoff collection systems, surface impoundments, etc.).

Data Sources: Visual observation, Regional Water Quality Control Board files.

7) Identify the approximate population served (number of people drinking water) by each surface water intake within three (stream) miles downstream of the probable point of entry to a static body of water. Also identify the approximate number or acres of food/forage cropland irrigated by water from each intake and the approximate number of livestock or poultry which consume water from each intake.

Data Sources: U.S. Census Bureau; Local/regional planning and environmental health departments; Department of Health Services; Public Water Supply Branch; Local irrigation districts; Department of Water Resources.

8) Provide a topographical map to relate the AML site with the surrounding terrain and any surface water which may potentially accept runoff.

9.6.3 Factors Related To Air Pathways

Information for this section needs to be provided only if sampling data exist to document the release of contamination to the atmosphere or threat of release exists. The threat of a release exists if hazardous substances (including contaminated soil) on the site are subject to wind dispersal, evaporation, or dispersal from fire/explosion, or if dispersal of contaminated soil has been observed visually. If a release has been documented or a threatened release exists at the site, provide the following information.

1) Describe the known or potential source(s) and mechanism for the release or threat ened release.

Data Sources: Local environmental health departments, local air quality district.

2) Provide the daily prevailing wind direction and daily average velocity for the site.

Data Sources: Local air district; local weather station.

3) Describe local climatic factors (e.g., seasonal temperatures, seasonal precipitation, seasonal temperature inversions, seasonal wind patterns, and seasonal extreme events).

Data Sources: Local air quality districts; local weather stations.

4) Describe the timing of the release or threatened release (e.g., intermittent release during wind storms or All-Terrain-Vehicle activities).

Data Sources: local environmental health department; local air quality district.

5) Describe the possible dispersion route(s) from release or threatened release (e.g., wind dispersion).

Data Sources: Local air quality district

6) Provide the approximate population of residents and workers which may be affected by a release or threatened release of contaminants from the site.

Data Sources: U.S. Census Bureau; local planning data bases.

7) Provide the location and distance from the site to any of the following areas which may be impacted by a release or threatened release of contaminants from the site.

- commercial/industrial;
- national/state parks, forests, wildlife reserves, and residential areas;
- agricultural land;
- historic/landmark sites.

Data Sources: Local planning departments; Department of Food and Agriculture; Department of Water Resources; Department of Forestry; Department of Fish and Game.

8) If not previously indicated in other sections of the Report, provide the type, location, and distance from the site to the following sensitive environments:

- schools;
- day care centers;
- hospitals;
- nursing homes;
- retirement communities;
- regional and local park and playgrounds;
- national and state parks;
- coastal wetlands (within a two mile radius);
- fresh water wetlands (within a one mile radius);
- habitat for special species (within a one-mile radius); and
- any other sensitive populations.

Data Sources: Local planning and health departments; Department of Food and Agriculture; Department of Water Resources; Department of Forestry; Department of Fish and Game;.

9.7 SAMPLING ACTIVITIES AND ANALYTICAL RESULTS

In the three subsections that follow, the report should summarize the sampling activities performed, present the analytical data, and provide a discussion of the results.

9.7.1 Summary of Activities

The sampling plan provides a framework for field activities and allows flexibility for some decisions to be made in the field. This section should describe site description, the activities that were performed, document decisions made in the field, and identify any deviations from the sampling plan and their rationale. Also include information regarding the handling of analytical samples from the time of collection until final analysis. Provide a map showing locations of sample collection.

9.7.2 Presentation of Data

Use tables, charts, etc. to summarize the results of sample analysis for each medium. At a minimum, the information presented should include the chemical name, sample type, sample number or location, sample depth (if appropriate), detection limit, units, and date collected. Analysis results as reported from the lab, including QA/QC data should be provided in an appendix to the report.

9.7.3 Discussion of Results

Provide a summary of the conclusions reached upon evaluation of analytical data. Identify unexpected or conflicting results, unusable data, and field and/or laboratory interferences and provide potential rationale. This section should also identify secondary analyses performed to confirm original results that may have been questionable.

9.8 HUMAN HEALTH SCREENING EVALUATION

The introduction to the Human Health Screening Evaluation is to contain a brief summary of the information presented in the remainder of the section.

9.8.1 Physical Hazards

Provide a summary of physical hazards found on the AML site. This information can be presented in a table format if the physical hazards are numerous. The location of significant physical hazards should be noted on the site map.

9.8.2 Chemical Hazards

9.8.2.1 Exposure Pathways and Media of Concern

Use the Conceptual Site Model to show potential exposure pathways. If there are several distinct areas of contamination, the use of a separate Conceptual Site Model for each area is acceptable for clarity. If the exposure pathways are the same for each area, only one model is needed; however, a statement of that fact is required. Also, include a detailed description of each significant pathway and state if the release is actual or threatened (state if the release is continuous or intermittent, e.g., acid mine drainage during spring run-off). Provide a qualitative reason if a particular exposure is to be excluded from evaluation. The exposed population for each potential pathway should be described with this section.

9.8.2.2 Chemicals of Concern and Exposure Concentration

Data that identifies COCs and concentrations can be compiled into a table format. The table(s) should include the COC(s), the concentrations for each medium that were used as input for the screening evaluation (this should be displayed for each separate area of contamination). Every table is to have a descriptive title name and the name of the potentially contaminated area it represents if applicable. If the site has historic sampling data, significant results should be included in separate, chronological tables with each table clearly noting the sampling date. If there are large volumes of data, include only the significant findings in this section and reference the document(s) where specific data can be obtained. Provide the reason if a particular chemical is to be excluded from evaluation. All background data should be included in this section, with any suspected anomalies noted. A table can be used to compare metals concentrations found on site with background levels.

9.8.2.3 Identification of Applicable Preliminary Remedial Goals

In this section provide a table for the COCs and the most recent associated PRG(s). If a COC found at the site does not have a PRG, use the DTSC's PEA (DTSC, 1994), Section 2.5, regarding instructions on how to proceed. Section 5.4 of this manual contains information on obtaining the most recent PRG list from the U.S. EPA.

9.8.2.4 Risk Characterization Summary

The risk characterization summary should integrate the exposure assessment and PRG information. Significant findings and determinations are to be included in this section, such as any COC exceeding its PRG or Maximum Contaminant Level. Conclusions regarding the risk evaluation determinations are to be described in this section.

The goal of the AML screening evaluation is to ensure that no potential health hazard is overlooked; therefore, the screening evaluation is based on the conservative assumption of residential land use. Furthermore, the AML screening evaluation is often based on limited sampling information. This section of the report should indicate these facts to provide the reader with useful insight into the conservative nature of the evaluations.

9.9 ECOLOGICAL SCREENING ASSESSMENT

9.9.1 Introduction

This section outlines report contents for information collected during the ecological screening assessment. Section 9.9.2 is excerpted, with slight modifications, from the DTSC's "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part B: Scoping Assessment" July 1996, Section 5, (DTSC, 1996b).

9.9.2 Screening Assessment Reporting Requirements

It is recommended that a site-wide habitat map be included as part of the screening assessment. For comparison, we recommend that all major habitats be displayed on a map at least equivalent to a USGS 1°x2° map (1:250,000) or of greater resolution if necessary. Separate indication of the coverage of tree canopy, shrubs or dominant herbaceous plants may be appropriate. A site-wide map of similar dimension which indicates historical land-use patterns, particularly those land-uses which may have resulted in release of hazardous substances is also recommended. In addition, it may also prove beneficial to include an additional map showing current land use if it differs from historic land use. Location of waste rock piles, mill tailings, concentrates, unprocessed ore, surface impoundments, landfills, surface drainage, and significant physical hazards is especially important. Both the habitat coverage and the land use may be displayed on the same map if the degree of detail is not confusing. Additional larger scale maps of portions of the site may be warranted, as appropriate, to adequately portray habitat-specific information.

A qualitative statement should be provided which summarizes the findings of the screening assessment. If the conclusion is that the AML site, and areas actually or potentially impacted by the AML site, are not utilized by biota and do not contain wildlife habitats, or that there are no actually or potentially complete exposure pathways, this conclusion must be clearly stated and justified. If potential toxic chemicals have contaminated, or may reasonably be expected to contaminate media which may contact wildlife or wildlife habitats, either on-site, or off-site, directly or indirectly, the potential for exposure is considered to exist and further investigation and assessment may be warranted.

The DTSC recommends this section of the Report contain, at a minimum, the following materials or their functional equivalents:

A. Figures

a) A site-wide habitat map showing all major habitat types to at least a USGS 1°x2° map scale (1:250,000). A "qualitative" habitat map which outlines the general boundaries and extent of all major habitat types, with notation of features such as canopies, shrubs, and dominant herbs, will fulfill this requirement. A formal plant community field survey is generally not warranted for the screening evaluation.

b) A site-wide land use history map showing current and historical land use, such as waste rock piles, mill tailings, concentrates, unprocessed ore, surface impoundments, landfills, surface drainage, and significant physical hazards.

c) An overlay or combination of the site-wide habitat map and the site-wide land use map if significant to the findings of the screening assessment.

d) A subsite-specific habitat map if significant to the findings of the screening assessment. Alter the scale of the subsite-specific habitat map to suit each subsite, each habitat, and diversity of ecological receptors or habitats.

B. Tables

a) Summary table of potential COCs with descriptive statistics including minimum detected concentration, maximum detected concentration, mean, standard deviation, and 95th upper confidence limit (95th UCL) on the mean. Use one half the detection limit for non-detects when calculating the mean, standard deviation, and 95th UCL. The detail will vary from site to site and how much information is known during the time of the screening. See Table 9-1.

b) Current and historical land use information. This table may accompany and more fully explain the land use history map described in A (a) and (b).

c) Summary table of potential receptors including the following additional information using known species lists as a base: species name; season(s) in which it is expected to be found on the site; presence noted during the site visit (visual sighting (photograph), tracks (photograph), nest (photograph), call, scat, etc.); nocturnal or diurnal in habit, and Federal or California special species status. See Table 9-2.

d) Summary table of potentially complete exposure pathways. This table normally would include all habitats or ecological guilds including those, such as piscivorous birds or waterfowl, which may have significant exposure via consumption of aquatic food items. See Table 9-3.

9.10 COMMUNITY PROFILE

This section should be a summary of the community profile. The summary should highlight the assessment of the community, potential concerns the community may have, and how these concerns were determined. Also include any recommendations for future public participation activities. If a community profile was not prepared during the AML investigation, provide the rationale for its omission. See Appendix I for further information on public participation.

9.11 CONCLUSIONS

The conclusions of the Report need to address five main questions:

- If the site contains physical hazards, do they pose a significant threat to the public?
- Have past mining activities resulted in a release or threat of release of contaminants at the site?
- Has the site been used for illegal disposal of hazardous wastes or illegal drug operations?
- If a release has occurred or threatened release exists, does it pose a significant threat to public health or the environment? and
- Does the release pose an immediate potential hazard to public health or the environment which would require the implementation of an expedited response action?

In answering the above questions, the conclusions should be specific, concise, and supported by information presented in the body of the report. All conclusions presented in this section must be consistent with the data and analysis presented elsewhere in the Report.

If a release has not occurred or threatened release is not likely to occur, this section should include a statement to that effect and reference the information contained in the body of the report which supports the statement.

9.12 RECOMMENDATIONS

Based on the conclusions presented in the previous section, the investigator can make a recommendation(s) regarding the need for further action at the site. In its simplest form, the recommendation will either be "no further action" or "additional action required."

A "no further action" recommendation can be made in cases when the AML site is acceptable for unrestricted land use, there is no generation of acidic or metal-rich mine drainage and future acidic or metal-rich mine drainage is not likely, no hazardous wastes were disposed at the site, and the site has not resulted in environmental degradation. In addition, the "no further action" must include a statement indicating the absence of mine-related physical hazards. Any recommendation for "no further action" must be supported by information provided in the human health and ecological screening assessment sections of the report.

At sites with significant contamination and/or physical hazards, a recommendation for further action to investigate, mitigate, or remediate the site must be made. This recommendation should not simply state that "further action is required". The recommendation should identify additional investigation, mitigation, and/or remediation needs and strategies to address the problems at the AML site.

Example Table 9-1. Potential chemicals of concern.

Chemical	Medium	Site History	Analysis	Number of Detects and Samples	Limit of Detection	Minimum	Maximum	Standard Deviation	95th UCL
Beryllium	Soil	X	X	0/5	100 ug/kg	ND	ND	ND	
DDT	Soil	X	X	3/5	100 ug/kg	1 mg/kg	66 mg/kg	28.7	36.1 mg/kg
Mercury	Sediment		X	4/5	10 ug/kg	200 ug/kg	900 ug/kg	370.4	744.6 ug/kg
Beryllium	Water		X	3/5	0.5 ug/kg	1 ug/1	100 ug/1	44.2	54.4 mg/kg

Example Table 9-2. Site habitat summary and potential ecological receptors.

Habitat Type	Hectares (% SITE)	Expected Species	Observed Species	Relative Occurrence	Rare, Threatened Or Endangered
Chaparral	(<<1 %)			Uncommon	No
Oak Woodland	10 (50%)	Scrub jay	am X pm X	Common	No
Oak Woodland	10 (50%)	Deer mouse	am X pm	Common	No
Stream	1 (5%)	Rainbow trout	am X pm X	Common	No
Oak/Willow Riparian	9 (45%)	Least bell's vireo	am X pm	Rare	Yes

Example Table 9-3. Assessment of potentially complete exposure pathways listing all pathways evaluated, those potentially complete and those apparently incomplete.

Habitat Type	Potential Receptor Group	Potential Contaminants	Contaminated Media	Direct Exposure Pathway	Food Web Exposure	Complete Exposure Pathway
Oak woodland	Burrowing Mammals	Arsenic	Soil	Soil ingestion		Yes
Oak woodland	Burrowing Mammals	Arsenic	Soil	Ingestion of prey	Soil invertebrates and plant seeds to mouse	Yes
Oak woodland	Burrowing Mammals	Arsenic	Soil	Particulate inhalation		Yes
Oak woodland	Burrowing Mammals	Arsenic	Soil	Dermal absorption		Yes
Stream	Fish (secondary consumers)	Copper	Sediment	Ingestion of prey	Stream invertebrates to fish	Yes
Stream	Benthic	Mercury	Sediment	Sediment ingestion		Yes

In addition to the recommendation above for long-term actions, this section must include recommendations for expedited response actions necessary to mitigate any immediate potential hazards to public health or the environment. These actions can take a number of forms, including but not limited to: sealing adits, restricting site access, removing or covering highly contaminated soils, re-routing site drainage, revegetation of exposed soils, and abating physical hazards. However, some of these actions can have potentially detrimental effects on the environment and should be carefully evaluated (e.g., sealing adits which serve as bat habitat). When determining if expedited response actions are required, consider the following:

- Does the site have unrestricted access?
- Are there explosives remaining on the site?
- Is AMD or metal-rich water contained in surface impoundments?
- Does surface water draining from the site have a pH less than 5.0?
- Are ground conditions stable (e.g., presence of eroding highwalls, sink holes, or breached tailings dams)?
- Are there unlabeled, unsealed or leaking drums?
- Does the site contain old transformers (they may contain polychlorinated biphenyls (PCBs)) or fuel tanks? Are they leaking?
- Does the toxicity of the hazardous substances at the site pose an immediate public health or environmental endangerment?
- What is the most immediate exposure threat facing nearby population?
- How many people live or work around the site and what is the distance of that population from the site?
- Is there a confirmed instance in which chemical or physical hazards have caused injury, illness, or death to humans, domestic or wild animals, or plants?
- Can it reasonably be inferred from the geology and hydrology of the site and the surrounding area and the nature of the contaminants that there is the potential for off-site migration?
- Is there evidence of off-site migration of contaminants?
- Is there a potential for the contamination to become airborne?
- Is AMD or metal-rich water impacting the beneficial uses of surface water which is used for a public drinking water or domestic animal or irrigation supply?
- Can a reasonable inference be made that taking an immediate action could significantly reduce continued or potential off-site migration from the site through air emissions via dust or surface water runoff?
- Does action need to be taken to reduce or eliminate the potential for physical hazards (e.g., sealing adits or shafts, razing dilapidated structures)?

REFERENCES

Airola, Daniel A., 1988, "Guide to the California Wildlife Habitat Relationship System." California Department of Fish and Game. Sacramento, March 1988.

California Department of Conservation, 1985, Division of Mines and Geology. "Foothill Counties Mining Handbook," October 1985.

Clark, W.B., 1963, "Gold Districts of California." California Department of Conservation, Division of Mines and Geology. Bulletin 193.

California Environmental Protection Agency, 1993, "Our Lands, New Strategies for Protecting the West, Blueprints for Action," June 4, 1993, pp 85-96.

California Environmental Protection Agency, Department of Toxic Substances Control, 1994, "Preliminary Endangerment Assessment Guidance Manual," January 1994.

California Environmental Protection Agency, Department of Toxic Substances Control, 1996a, "Guidance for Ecological Risk Asssessment at Hazardous Waste Sites and Permitted Facilities, Part A: Overview," July 1996.

California Environmental Protection Agency, Department of Toxic Substances Control, 1996b, "Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Part B: Scoping Assessment," July 1996.

Hood, M., et.al., 1988, "Mine Waste Study, Final Report," University of California at Berkeley, July 1, 1988.

Hutchison, I.P.G., Ellison, R.D., 1992, "Mine Waste Management." Chapters 4 and 5. Lewis Publishers, Inc., Chelsea, Michigan, 123 pp.

Mayer, K.E., and Laudenslayer, W.F., 1988, "A Guide to Wildlife Habitats of California." California Department of Forestry and Fire Protection. Sacramento, 166 pp.

Moore, J.N., and Luoma, S.N., 1990, "Hazardous Wastes from Large-Scale Metal Extraction." Environmental Science and Technology, Vol. 24, No. 9, pp. 1278–1285.

Morin, K.A., and Hutt, N.M., 1997, Environmental Geochemistry of Minesite Drainage: "Practical Theory and Case Studies." MDAG Publishing, Vancouver, British Columbia, Canada, 333 pp.

Ritcey, G.M., 1989, "Tailings Management: Problems and solutions in the mining industry." Elsevier, New York, 970 pp.

Sobek, A.A., Schuller, W.A., Freeman, J.R., and Smith, R.M., 1978, "Field and Laboratory Methods Applicable to Overburdens and Minesoils." Report EPA-600/2-78-054, U.S. National Technical Information Report PB-280 495, 403 pp.

Williams, B.C., Lambeth, R.H., Stewart, B.M., 1989, Determining Heavy Metal Leaching and Transport From Abandoned Mine Wastes," Society of Mining Engineers Annual Meeting, Las Vegas, Nevada.

U.S. Department of the Interior, Office of Inspector General, 1991, "Audit Report: NonCoal Reclamation, Abandoned Mine Land Reclamation Program, Office of Surface Mining Reclamation and Enforcement," Report No. 91-I-1248. September 1991.

U.S. Department of the Interior, Bureau of Mines, 1994, "Abandoned Mine Land Inventory and Hazard Evaluation Handbook" draft, May 1994.

U.S. Environmental Protection Agency, 1985, "Report to Congress: Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining and Oil Shale," EPA/530-SW-85-033, December 1985.

U.S. Environmental Protection Agency, 1986, "Sampling Plan." Chapter 9. In Test Methods of Evaluating Solid Waste, Physical/Chemical Methods (SW-846), Third Edition. Office of Solid Waste and Emergency Response, Washington, D.C., September 1986.

U.S. Environmental Protection Agency, 1987, "Data Quality Objectives for Remedial Response Activities." OSWER Directive 9335.075. Washington, D.C.

U.S. Environmental Protection Agency. 1988b. "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA." Office of Emergency and Remedial Response. Washington, D.C., EPA-540/G-89/004, October 1988.

U.S. Environmental Protection Agency. 1989a. "Human Health Evaluation Manual (Part A)." Volume I. In Risk Assessment Guidance for Superfund. Office of Emergency and Remedial Response. Washington, D.C., EPA-540/1-89/043, December 1989.

U.S. Environmental Protection Agency. 1989b. "Environmental Evaluation Manual." Volume II. Risk Assessment Guidance for Superfund. Interim Final, Office of Emergency and Remedial Response. EPA-540/1-89/001, March 1989.

U.S. Environmental Protection Agency, 1991a, "Compendium of ERT Surface Water and Sediment Sampling Procedures." OSWER Directive 9360.4-03. Washington, D.C., EPA-540/P-91/005.

U.S. Environmental Protection Agency, 1991b, "Compendium of ERT Soil Sampling and Surface Geophysics Procedures." OSWER Directive 9360.4-02. Washington, D.C., EPA-540/P-91/006.

U.S. Environmental Protection Agency, 1996, Seminar Publication: "Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites." Office of Research and Development. Washington, D.C., EPA-625/R/95/007.

Western Governors' Association Mine Waste Task Force, 1991. "Inactive and Abandoned NonCoal Mines." August 1991, Vol. I.

Zeiner, D.C., Laudenslayer, W.F., and Mayer, K.E., 1988, "California's Wildlife, Volume 1, Amphibians and Reptiles." California Department of Fish and Game. Sacramento, May 2, 1988, 272 pp.

LIST OF ACRONYMS

ABA -Acid-Base Accounting
AML -Abandoned Mine Land(s)
AMD -Acid Mine Drainage
ANFO -Ammonium Nitrate with Fuel Oil
AP -Acidification Potential
ARAR -Applicable or Relevant and Appropriate Requirement
ARD -Acid Rock Drainage
AWQC -Ambient Water Quality Criteria
BLM -(U.S.) Bureau of Land Management
Cal/EPA -California Environmental Protection Agency
CEQA -California Environmental Quality Act
CERCLA -Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS -Comprehensive Environmental Response, Compensation and Liability Information System
COC -Chemical (or contaminant) of Concern
DFG -California Department of Fish and Game
DMEA -Defense Minerals Exploration Administration
DMG -Division of Mines and Geology, California Department of Conservation
DOC -California Department of Conservation
DTSC -California Department of Toxic Substances Control
DWR -California Department of Water Resources
GIS -Geographic Information System
HERD -Human and Ecological Risk Division, Office of Scientific Affairs, Department of Toxic Substances Control
HWIS -Hazardous Waste Information System
IRIS2 -Integrated Risk Information System
MAS/MILS -Mineral Availability System/Mineral Industry Location System
MCL -Maximum Contaminant Level
MCLG -Maximum Contaminant Level Goal
MRDS -Mineral Resource Data System
MSHA -(U.S.) Mine Safety and Health Administration
NCP -National Contingency Plan
NPL -National Priorities List
NDDB -Natural Diversity Data Base
NP -Neutralization Potential
OME -Office of Minerals Exploration
ORCA -On-line Recordation Case Access
OSHA -(U.S.)Occupational Safety and Health Administration
PA -Preliminary Assessment
PEA -Preliminary Endangerment Assessment
PCBs -Polychlorinated Biphenyls
PRG -Preliminary Remediation Goal
PRP -Potentially Responsible Party
QA/QC -Quality Assurance/Quality Control
RCRA -Resources Conservation and Recovery Act
RI/FS -Remedial Investigation/Feasibility Study
RWQCB -California Regional Water Quality Control Board
SI -Site Inspection
SMCL -Secondary Maximum Contaminant Level
SSP -Site Safety Plan
SWRCB -State Water Resources Control Board
TDS -Total Dissolved Solids
UCL -Upper Confidence Limit
UTM -Universal Transverse Mercator
USBM -United States Bureau of Mines
U.S. EPA -United States Environmental Protection Agency
USFS -United States Forest Service
USGS -United States Geological Survey
WQO -Water Quality Objectives

GLOSSARY

Abandoned mine: Excavations, either open, caved, or sealed, that are deserted or in which further mining is not currently intended (in this document abandoned or inactive mines are not distinguished).

Acid mine drainage: Contaminated water from a mine or mine waste pile, which contains sulfuric acid, mainly due to the oxidation of pyrite (also referred to as AMD).

Acid rock drainage: A more general term for acid mine drainage that includes naturally occurring acidic waters (also referred to as ARD).

Activator: A reagent that facilitates flotation of selected mineral species in a flotation cell.

Adit: A horizontal or nearly horizontal passage driven in rock from the surface for the workings or dewatering of the mine.

Amalgamation: The process by which mercury is alloyed with some other metal to produce an amalgam. This process was used at one time for the extraction of gold and silver from pulverized and placer ores.

Ambient Water Quality Criteria: These criteria are published by U.S. EPA under the Clean Water Act to protect human health and welfare and freshwater and marine aquatic life. These criteria are found in: 1) Quality Criteria for Water, 1986, the "Gold Book"; 2) the Ambient Water Quality Criteria volumes (1980, 1984, 1986, 1987, and 1989); 3) Quality Criteria for Water, 1976, the "Red Book"; and 4) Water Quality Criteria, 1972, the "Blue Book."

AMD: Acid Mine Drainage.

AML: Abandoned Mine Lands.

ARARs: Applicable or relevant and appropriate requirements. ARARs are generally promulgated, enforceable requirements and determined on a site specific basis. There are three types of ARARs; chemical specific (e.g., drinking water standard for arsenic), location specific (e.g., site located on a floodplain), and action specific (e.g., RCRA subtitle D requirements).

Arrastre, arrastra: A circular rock-lined pit in which broken ore is pulverized by stones attached to a pillar and dragged around the pit. The arrastre was in common use in the western and southwest United States in the 18th and 19th centuries.

Arsenopyrite: An iron-arsenic sulfide mineral, FeAsS.

Background: Concentrations of inorganic elements unimpacted, and thus not elevated by anthropogenic activities.

Ball mill: A rotating horizontal cylinder in which nonmetallic materials are ground using various types of grinding media such as quartz pebbles, porcelain balls, or steel balls.

Barren solution: In hydrometallurgy, a leaching solution that has been chemically stripped of metal values. Typically, the barren solution is recharged with leaching agent and recycled.

Beneficiation: The processing of ores for the purpose of (1) regulating the size of a desired product, (2) removing unwanted constituents, and (3) improving the quality, purity, or assay grade of a desired product.

Bioaccessibility: The ability of a substance to dissolve in the body's gastrointestinal tract.

Bioavailability: The ability of a substance to be absorbed by the body.

Blasting caps: An enclosed metal shell containing a charge of detonating compound which is ignited by electric current or the spark of a fuse. Used for detonating high-yield explosives.

Carbonate rocks: Rocks composed primarily of carbonate minerals, usually limestone or dolomite. Carbonate minerals are mineral compounds characterized by a fundamental anionic structure of CO_3^{-2}. Calcite ($CaCO_3$) and dolomite [$(CaMg(CO_3)_2$] are examples of carbonate minerals.

Chilean mill; edge runner: A mill having vertical rollers running in a circular enclosure with a stone or iron base or die. There are two classes: 1) those in which the rollers gyrate around a central axis, rolling upon the die as they go (the true Chilean Mill), and 2) those in which the enclosure or pan revolves, and the rollers, placed on a fixed axis, are in turn revolved by the pan.

COC: Chemical of concern or contaminant of concern.

Collar: The term applied to the timbering or concrete around the mouth or top of a shaft. The junction of a mine shaft with the surface.

Collector (flotation): A reagent that adsorbs on the surface of mineral particles in flotation, making them hydrophobic. These hydrophobic particles attach to gas bubbles, and report to the froth, which is skimmed off.

Comminution: To reduce solids to minute particles by crushing and grinding to liberate metals.

Concentrate: 1)[verb] To separate metal or ore from the associated gangue or barren rock, 2) [noun] Enriched ore after removal of waste in a benefication mill (mineral concentrate).

Country rock: General term applied to the rock surrounding and penetrated by mineralized veins.

Crusher: A machine for crushing rock or other materials. Among the various types of crushers are the ball mill, gyratory crusher, Hadsel mill, jaw crusher, rod mill, rolls, stamp mill, and tube mill.

Cyanide: A salt or ester of hydrocyanic acid. In solution, cyanide is used to dissolve gold and silver from unwanted material for later recovery.

Cyclone: A device for classification by centrifugal means of fine particles suspended in water (or air), whereby the coarser grains collect and are discharged at the apex of the vessel, while finer particles are eliminated with the bulk of the water at the discharge orifice.

Depressant (flotation): A reagent that causes selected mineral species to remain in suspension in a flotation cell.

Drift: A horizontal passage underground.

Dynamite: An industrial explosive which is detonated by blasting caps. The principal explosive ingredient is nitroglycerin or specially sensitized ammonium nitrate.

Environment: All the physical, biological, and chemical conditions and influences surrounding and affecting the development and functioning of an organism or group of organisms.

Exposure: Contact of an organism with a chemical or physical agent. An exposure is quantified as the amount of the agent available at the exchange boundaries of the organism (e.g.,skin, lungs, gut) and available for absorption.

Exposure Pathway: The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of inter-media transfer) also is included.

Exposure Point: A location of potential contact between an organism and a chemical or physical agent.

Exposure Route: The way a chemical or physical agent comes in contact with an organism (i.e., by ingestion, inhalation, dermal contact).

Flotation: The method of mineral separation (using a flotation cell) in which a froth created in water by a variety of reagents floats some finely crushed minerals, whereas other minerals remain in suspension.

Gangue: Valueless rock or mineral aggregates in an ore; that part of an ore that is not economically desirable but cannot be avoided in mining.

Geochemistry: The study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water, and the atmosphere, and the study of the circulation of the elements in nature on the basis of the properties of their atoms and ions.

Glory hole: A large open hole typically associated with a mined-out or widened shaft.

Gravity mill: A process in which dense metals or minerals are separated from waste by the action of agitation and gravity on materials suspended in a liquid, usually water.

Hard-rock mining: A technique of mining used when mineralized rock occurs deep beneath the Earth's surface. To reach the ore body, remove ore and waste, and provide ventilation, miners must excavate either a vertical or inclined shaft, a horizontal tunnel called an adit, or a gently inclined tunnel called a decline. Within the ore deposit, horizontal passages called drifts (parallel to the vein or ore body) and crosscuts (across the vein or ore body) are developed on several levels to access stopes (openings in the ore body).

Headframe: The vertical steel or timber frame at the top of a shaft which supports the hoist system that is used to lower workers and equipment and remove ore from the shaft.

Heap leaching: A recovery process in which prepared ore is stacked in heaps on impervious pads and a lixiviant percolated through the heap to dissolve selected metals, most commonly gold.

Heavy metal: Principally the metals zinc, copper, cobalt, and lead. Usually the term is used to include one or more of the following metals; bismuth, cadmium, chromium, gold, indium, iron, manganese, mercury, molybdenum, nickel, palladium, platinum, silver, thallium, tin, and vanadium.

Hoist: 1) A drum on which wire rope is wound in the engine house, as the cage or skip is raised in the hoisting shaft. 2) An engine with a drum used for winding up a load from a shaft.

Hydrometallurgy: The treatment of ores, concentrates, and other metal-bearing materials by wet processes, usually involving the solution of some component, and its subsequent recovery from the solution.

Inactive mine: See Abandoned mine.

Inclined shaft or incline: A non-vertical shaft, usually along the dip of a vein.

Intermittent stream: A stream or stretch of stream that flows at only certain times of the year when it receives water from springs, snow melt, or storm runoff.

Jig (mineral jig): A machine in which the feed is stratified in water by means of a pulsating motion and from which the stratified products are separately removed, the pulsating motion usually being obtained by alternate upward and downward currents of water.

Leaching: 1) The removal in solution of the more soluble minerals by percolating waters, 2) Extracting a soluble metallic compound from an ore by selectively dissolving it using a suitable lixiviant, such as water, sulfuric acid, hydrochloric acid, cyanide, etc.

Maximum Contaminant Levels (MCLs): Drinking water standards adopted by both the California Department of Health Services (DHS), Office of Drinking Water in Title 22 of the California Code of Regulation, Division 4, Chapter 15, "Domestic Water Quality and Monitoring," and by the U.S. Environmental Protection Agency (U.S. EPA) under the Safe Drinking Water Act. DHS's drinking water standards are required to be at least as stringent as those adopted by the U.S. EPA. Some are more stringent.

Maximum Contaminant Level Goals (MCLGs): MCLGs are promulgated by U.S. EPA under the National Primary Drinking Water Regulations as the first step in establishing MCLs. By law, MCLGs must be set at levels which represent no adverse health risks. They are set at "zero" for known and probable human carcinogens.

Metalloids: Elements with properties that lie between those of metals and nonmetals, such as arsenic and selenium.

Mesh: The number of openings per unit area of a screen (sieve).

Micrometer: Measure of length equal to one-millionth of a meter, or one-thousandth of a millimeter. A human hair is approximately 100 micrometers in diameter.

Mill: A mineral treatment plant in which crushing, grinding, and further processing of ore is conducted to produce a product.

Milling: The physical processing of ore to produce a product.

Mill tailings: The refuse material resulting from the washing, concentration, or treatment of milled ore. Material can be coarse gravel to sand-size particles to silt-like "flour." Particles tend to be more uniform in size and are typically deposited in one or a series of piles. Tailings can contain unwanted heavy metals and sulfide minerals.

Mine: An excavation for the extraction of ore or other economic minerals.

Mineral: A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.

Mineral deposit: A mass of naturally occurring mineral material, such as metal ore or nonmetallic minerals, usually (but not always) of economic value.

Mine waste: Solid waste from mining operations, including waste rock, tailings, and slag.

Mining district: An area containing multiple mines for a particular mineral commodity.

Open-pit mining/opencut mining: A form of operation designed to extract minerals that lie near the surface. The mining of metalliferous ores by surface-mining methods is commonly designated as "open-pit mining" as distinguished from "strip mining" of coal and the "quarrying" of other nonmetal materials such as limestone, building stone, etc.

Ore: A mineral, or mineral aggregate, containing precious or useful metals or metalloids, which occur in such quantity, grade, and chemical combination as to make extraction commercially profitable.

Ore deposit: A general term applied to rocks containing minerals of economic value in such amount that they can be profitably recovered.

Overburden: Barren rock material, either loose or consolidated, overlying a mineral deposit, which must be removed prior to mining.

Oxidation: Loss of electrons; a reaction involving the transfer of electrons from one species to another. An example of rapid oxidation is fire and slow oxidation is rust. Pyrite oxidation in the presence of water generates acidic solutions.

Perennial stream: A stream or stretch of a stream that flows continuously throughout the year.

pH: The degree of acidity or basicity of a solution or substance expressed as a negative logarithm of the hydrogen ion activity (concentration). A pH value of 7 is neutral. pH values less than 5 are considered moderately acidic, and less than 3 are very acidic.

Pit: Surface excavation of relatively large dimensions from which ore and waste has been extracted.

Placer: A surficial mineral deposit formed by mechanical concentration of mineral particles from weathered debris, the process usually involving water.

Portal: The surface entrance to a drift, tunnel, or adit.

Pregnant solution: In hydrometallurgy, metal-laden solution resulting from a leaching process.

Pyrite: Iron disulfide, FeS_2.

QA/QC: Quality assurance/quality control.

Raise: A vertical or inclined mine working driven upward from a level to connect with the level above, or to explore the ground for a limited distance above the level.

Receptor: An organism (e.g., human, biota) which is or has the potential to be exposed to a chemical or physical agent.

Secondary Maximum Contaminant Level (SMCL): These levels are derived from human welfare considerations (e.g., taste, odor, laundry staining) in the same manner as the primary MCLs.

Slag: Solid waste material from smelting activity, consisting mostly of silicate minerals and glass. Some slags contain elevated concentrations of heavy metals and metalloids in forms that are leachable.

Slimes: Material of extremely fine particles encountered in the treatment of ore. Primary slimes are extremely fine particles derived from ore, associated rock, or clay. They are usually found in waste rock/tailings dumps and in mineral deposits that have been exposed to climatic action. Secondary slimes are finely ground minerals from the ore.

Sluice box: A long inclined trough for washing or separating ores.

Slurry: Fine solid particles suspended in a liquid, typically water, of a consistency that allows flow by gravity or pumping.

Smelting: Any metallurgical operation in which metal is separated by fusion from those impurities with which it may be chemically combined or physically mixed, such as ores.

Special species: Rare, threatened or endangered species (California or federal), or recommended or candidate species for California or federal listing, or California species of special concern.

Species (chemical): Form that an element takes in aqueous solution, such as individual metal ion, ion pair, or aqueous complex. Certain metal species (e.g., methylated mercury compounds) are known to be more toxic that others to human and aquatic life.

Stamp battery: A machine in which rock is crushed by descending pestles (used particularly in gold milling).

Stamp mill: An apparatus (also the building containing the apparatus) in which rock is crushed by a stamp battery.

Stope: An underground excavation from which ore has been removed.

Subsidence: A sinking of a part of the earth's surface. Can be caused by the collapse of underlying underground openings or underground workings.

Sulfate: The most oxidized form of sulfur (SO_4^{-2}). Sulfates can combine with metals to form soluble salts, however, some sulfate salts are relatively insoluble (e.g., gypsum and barite).

Sulfide: A group of minerals in which metallic ions are combined with reduced forms of sulfur.

Surface mining: The mining in surface excavations, including placer mining, mining in open pits, mining and removing ore from open cuts by hand or with mechanical excavating and transportation equipment, and the removal of overburden to uncover the ore.

Tailings: See "Mill Tailings."

Tailings pond: A pond with a constraining wall or dam to which mill effluents are run.

Waste rock: The barren rock from a mine. It also applies to the part of the ore deposit that is too low in grade to be of economic value at the time of mining.

Water Quality Objectives: Indicates the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area.

Wildlife: All non-domesticated plants and animals including aquatic plants and animals.

Wildlife habitat: The place where an animal or plant normally lives, often characterized by a dominant plant form or physical characteristic.

Winze: A vertical or inclined passageway, or excavation, connecting two levels in a mine, differing from a raise only in construction. A winze is driven downward and a raise is excavated upward.

APPENDIX A

APPENDIX A
CHARACTERISTICS AND DISTRIBUTION OF CALIFORNIA MINERAL DEPOSITS, AND THEIR ENVIRONMENTAL IMPACTS

INTRODUCTION

California has been a major contributor to minerals production in the United States since the days of the Gold Rush. California, with 4.4 percent of the land area of the U.S., accounted for 8 percent of the country's mineral production by dollar value in 1996. The state produces 25 or more types of industrial minerals and a half dozen metals from more than 900 mines, ranking third nationally in non-fuel mineral production. Another half-dozen metals have been produced in significant quantities in the past, and depleted, inactive, or abandoned mines number in the tens of thousands (fig. A1).

California's rich mineral endowment is a consequence of its complex and extremely varied geology. The first section of this appendix provides an overview of geologic environments in California and the earth movements that have shaped the landscape, and is followed by a description of the physiographic provinces of the state (fig. A2) and the types of mineral deposits found in each province, including metallic ores and industrial minerals.

The last section contains descriptions of important mineral deposit types found in California in terms of their geographic distribution, size range, and mineralogy, and gives some historical perspectives on discovery, development, mining methods, and processing technologies.

THE GEOLOGIC FRAMEWORK OF CALIFORNIA

Much of the state comprises island-arc and oceanic crust terranes that were accreted to the ancient North American continent, mainly in Mesozoic time (about 100-250 million years ago). Boundaries of these terranes are usually regional fault zones that dip inland, suggesting that the leading edge of the continent over-rode them. Emplacement of enormous masses of granite followed these accretion events, also in Mesozoic time. Subsequently, subduction of oceanic plates beneath California in Cenozoic time (since about 30 million years ago) has produced widespread volcanism.

Presently the Pacific plate is impinging upon California, moving from south to north, bounded by the San Andreas fault. The leading edge of the Pacific plate is at the Mendocino triple junction. North of this junction, which continues to move northward, subduction and related volcanism continue, forming the volcanoes of the Cascade Range. South of the junction, the subduction regime is replaced by a strike-slip regime, and volcanism ceases within a few million years after the triple junction passes.

East of the Sierra Nevada and east of the Cascade Range, the crust is being pulled apart in an east-west direction, resulting in the alternating north-trending fault-bounded basins and ranges of the Great Basin. This extensional regime extends into the Modoc Plateau, to the north, and into the Mojave desert and lower Colorado River basin to the south. Extension began several tens of millions of years ago, but much of it has occurred in the last 20 million years. Concurrently the Sierra Nevada block, bounded on the east by major north-trending faults, has tilted progressively to the west as its east side rose. During the same period, the San Andreas and associated strike-slip faults extended northward through the Coast Ranges, and complex patterns of subsidence and uplift produced a patchwork of short-lived marine and continental basins.

PHYSIOGRAPHIC PROVINCES OF CALIFORNIA AND THEIR MINERAL DEPOSITS

I. Sierra Nevada

The Sierra Nevada mountain range is a west-tilted block dominated by granitic rocks. A composite batholith composed mainly of granodiorite occupies the eastern and southern parts of the range. The west-central and northwestern parts of the range expose accreted belts of pre-batholithic metamorphic rocks derived from marine-sedimentary and island-arc-volcanic rocks. Major north-to-northwest-trending faults bound these belts, and serpenti-

nite bodies commonly occur along the fault zones. Isolated granitic masses are scattered through the metamorphic rocks, particularly in the northern Sierra.

Most of the historic gold production of California has come from the Sierra Nevada Province. The gold is found in or around quartz veins in the metamorphic rocks or occasionally in granitic bodies near their contacts with metamorphic rocks. Many districts are localized along the major faults within the metamorphic rocks, most notably the districts of the Mother Lode belt. Goldbearing veins of this type, which are found also in Alaska, the southeastern U.S., and other parts of the world, particularly Canada and Australia, have been given various names including "metamorphic gold," "orogenic gold," and "greenstone-hosted gold." In a recent U.S. Geological Survey classification they are called "low-sulfide gold-quartz veins" because metal sulfide minerals are relatively minor. Gold released from the veins by erosion accumulated in channels of the rivers that presently drain the Sierra, and also in ancient river channels established when the Sierra Nevada block began to rise and tilt westward. Almost half the gold recovered from the province came from auriferous river gravels and sands, which are known as placer deposits.

Several other types of deposits occur in the Sierra Nevada Province. A belt of metamorphosed volcanic rocks at the west edge of the province contains copper-zinc deposits that tend to be relatively small and rich. Since they contain abundant metal sulfide minerals and are thought to be formed by submarine volcanic activity, they are known as "volcanogenic massive sulfide" deposits. These deposits were significant sources of copper beginning in the late 19th century and continuing through World War II.

Tungsten deposits are also important in the Sierra Nevada Province. Where carbonate rocks (limestone or marble) are intruded by granitic rocks, heat and fluids from the cooling granite may alter the carbonate and precipitate metallic and silicate minerals, forming deposits known as "skarns." Tungsten-bearing skarns and veins, as well as molybdenum-bearing veins, are scattered throughout the province, and are particularly abundant in pendants of metamorphic rocks within the granitic bodies of the southern and eastern Sierra.

Small chromite deposits are associated with the serpentinite bodies in the Foothills and northern Sierra. They have been mined sporadically, mainly during World Wars I and II.

Chert beds found in slate units of the Sierra are locally manganiferous, resulting in numerous manganese prospects, but few have produced and none are large.

In the foothills limestone and marble are quarried for cement, and granite, slate, and other rock types are quarried for building stone. Small quarries providing crushed rock for construction are widespread.

II. Klamath Mountains

The Klamath Mountains, like the western and northern Sierra Nevada, are composed of metamorphic belts separated by major fault zones, ultramafic bodies partly altered to serpentinite, and scattered granitic intrusions. Like the Sierra Nevada, low-sulfide gold-quartz veins and placer gold deposits are numerous. Several of the metamorphic belts host important volcanogenic massive sulfide deposits, and the ultramafic rocks contain chromite deposits. An array of industrial minerals similar to that in the Sierra Nevada Province is obtained in the Klamath Mountains Province. In spite of the many similarities between the two provinces, there are some differences. For example, skarn deposits are scarce and small in the Klamath Province. On the other hand, the Klamaths contain some mercury deposits, which are rare in the Sierra.

III. Cascade Range, and IV. Modoc Plateau

The Cascade Range is mainly a gently-dipping sequence of volcanic and volcaniclastic rocks of mid-Tertiary to Recent age, less than about 40 million years old, produced by periodic volcanism related to subduction of the Juan de Fuca tectonic plate beneath the North American plate. Rocks in the part of the range within California are mostly less than about 25 million years old. Modern volcanoes that form the High Cascades, including Mt. Shasta and Lassen Peak in California, are built on this older volcanic sequence.

Broad shield volcanoes no more than a few million years old form much of the Modoc Plateau. The chemistry of Modoc lavas shows affinities both to Cascade volcanic rocks to the west and volcanic rocks of the Great Basin to the east.

Metallic mineral occurrences are nearly absent in the Cascades, and are few in the Modoc Plateau. They include precious metals, mercury, and uranium deposited at shallow depths in hot-springs systems associated with the volcanism. The volcanic rocks yield some useful industrial minerals, including cinders, pumice, and building stone.

V. Great Basin (Basin and Range)

The Basin and Range Province is a large area in the interior western U.S. characterized by alternating elongate basins and mountain ranges. The northern part of the Basin and Range, which covers most of Nevada, western Utah, and adjacent parts of Idaho, Oregon, and California, has interior drainage and is consequently called the Great Basin. The Great Basin is being pulled apart in an east-west to northeast-southwest direction, causing the terrane to break into north- to northwest-trending blocks, some of which subside to form basins. The basins, which are as much as several kilometers deep, are filled with debris eroded from the adjacent ranges.

In the northeast corner of California (Modoc and Lassen Counties), thick volcanic sequences of Tertiary age are exposed in the relatively uplifted blocks that form the ranges. In the central part (Mono County), metamorphic and granitic rocks similar to those of the Sierra Nevada province are exposed. In the Death Valley region (Inyo County), carbonate and clastic sedimentary sequences deposited on the continental shelf 300 to more than 600 million years ago are exposed.

Gold-silver deposits associated with ancient geothermal systems are scattered throughout the Great Basin. These deposits include both nearsurface hot-spring and deeper epithermal vein types, as well as other types of gold deposits in pre-Tertiary rocks. Tungsten skarn and vein deposits and iron skarn deposits are found in the central and southern parts. The carbonate rocks of the Death Valley region host lead-silver-zinc deposits, including several relatively large districts. The carbonates also host some asbestos and talc deposits formed where mafic sills have intruded and altered magnesian carbonates.

Chemical constituents dissolved from bedrock by surface water, ground water and geothermal waters are transported to the basins and are concentrated there by evaporation, producing important industrial mineral deposits including borates, trona (sodium carbonate), and other salts. Clay, diatomite, pumice, perlite, and sulfur occur in volcanic rocks and basinal sedimentary rocks.

VI. Coast Ranges and VII. Transverse Ranges

The central and northern parts of the Coast Ranges, northeast of the San Andreas fault, are dominated by the Franciscan assemblage, a sheared mixture of blocks of various marine sedimentary rocks and sea-floor basalt. It is bounded on the east side by a major east-dipping fault called the Coast Range thrust, which separates it from a thick sandstone unit called the Great Valley sequence. Some remnants of underlying sea-floor crust are preserved locally at the base of the Great Valley sequence. The Franciscan assemblage, of middle to late Mesozoic age (about 100-150 million years old), probably represents a subduction complex. The coeval Great Valley sequence, which is not disrupted, was probably formed some distance away from the Franciscan.

South of the San Andreas fault, the Coast Ranges and Transverse Ranges are dominated by the Salinian block, a belt of highly metamorphosed carbonate and clastic sedimentary rocks intruded by granitic plutons. If the Salinian block is restored to its original position by removing the 200 km or more of right-lateral strike-slip displacement on the San Andreas fault, it should match rocks across the fault in the Mojave Desert. Lithologies of the Salinian and Mojave blocks cannot be correlated, however, possibly because the Salinian block is more deeply eroded.

Franciscan-type rocks reappear on the oceanward side of the Salinian block, separated from it by the Nacimiento fault. In the southern Coast Ranges and western Transverse Ranges, sedimentary rocks of Tertiary and Quaternary age (about 1-50 million years old), which were deposited in a series of complex basins, overlap both the Salinian and Franciscan rocks on the south, and Tertiary sedimentary rocks of the San Joaquin Valley are uplifted and exposed on the east side of the central and southern Coast Ranges.

Small volcanic fields dot the Coast Ranges. Volcanism in each field lasted for several million years, and the fields become progressively younger from south to north. The youngest and northernmost of these, the Clear Lake field, is still active, with recent volcanic rocks and high heat-flow which is responsible for the Geysers geothermal area. This volcanism follows in the wake of the triple junction as it moves north, because as the growing San Andreas fault encroaches on the sinking Juan de Fuca plate, a gap forms in the lower crust, allowing hot mantle material to well up, melting the crust and triggering volcanism.

Throughout the Coast Ranges, ultramafic rocks and serpentine found along the major thrust faults and subsidiary faults host mercury deposits, including some that were highly productive. These are called "silica-carbonate" mercury deposits, referring to characteristic alteration of the host serpentine. Fluids that produced this alteration and deposited the mercury were probably derived from metamorphism of Franciscan and Great Valley sequence rocks at depth, and the mercury may have a sedimentary source. In addition, geothermal systems associated with the volcanic fields deposited both hot-spring gold-silver and hot-spring mercury deposits.

As is true elsewhere in the state, small chromite and small to moderate-sized asbestos deposits are associated with ultramafic rocks. Serpentinite derived from ultramafic rocks contains magnesite deposits. The Franciscan assemblage includes cherts with associated small manganese deposits, a few limestone bodies that are quarried for cement, an isolated massive sulfide deposit associated with oceanic basalt, and a single low-sulfide gold-quartz district.

The Salinian block is nearly devoid of metallic mineral occurrences, but granitic rocks and marble are quarried.

Coal has been mined from Tertiary sedimentary rocks in the east central part of the Coast Ranges. The sedimentary rocks also contain diatomite and gypsum deposits, and phosphate resources.

VIII. Great Valley

The Great Valley sequence continues eastward under the west side of the Great Valley, and the metamorphic belts and granitic rocks of the the Sierra Nevada continue westward under the east side. The relations of these basement units beneath the center of the valley are complex and not yet well understood. Younger sedimentary fill of Tertiary age is an important source of petroleum and natural gas. Of much less importance, these rocks are a source of industrial minerals, especially clays.

The present-day rivers draining the mountainous regions on all sides of the Great Valley continue to fill the valley with sediment. Along the northeast edge of the Great Valley, adjacent to the gold-rich region of the Sierra Nevada, are a series of major placer gold fields. The gravels that contain placer gold are deposited at the edge of the valley by every river that drains the Sierra, from Butte Creek in the northern part of the range to the Merced River in the central part. Many of these gravel fields supported large-scale gold dredging operations after introduction of the bucket-line dredge to California near the turn of the 20th century. The dredge fields now support sand-and-gravel operations that continue to produce byproduct gold.

IX. Peninsular Ranges, and X. Colorado Desert

The Peninsular Ranges are dominated by the Southern California batholith. Like the Sierra Nevada batholith, it consists mainly of granitic intrusive rocks of Mesozoic age. Wallrocks of the batholith, exposed mainly along its western margin, are roughly similar to some of the metavolcanic belts of the northwestern Sierra. Some of the types of deposits seen in the Sierra occur here, including low-sulfide gold-quartz veins, tungsten skarns, tungsten veins, and molybdenum veins, but unlike the Sierra, there are no major historic producers. The most notable deposits are pegmatites, which are masses of coarsely crystalline minerals that form late in the cooling history of the granites. They have been mined for lithium minerals, industrial minerals such as sheet mica, and gemstones.

The Southern California batholith and its wall rocks are covered on the west by Tertiary sedimentary rocks, and on the east by Tertiary and Quaternary sediments that fill the Salton Trough, part of the lower Colorado River desert region. The Tertiary rocks exposed on the west side of the Salton Trough host several hot-spring gold deposits presently being developed. The sediments of the Salton Trough contain a substantial geothermal brine reservoir that is a significant metal resource.

XI. Mojave Desert

The Mojave Desert is a block lying between the right-lateral San Andreas fault on the south and the left-lateral Garlock fault on the north. As part of the greater Basin and Range Province, it is characterized by alternating basins and ranges. Unlike the main part of the province, however, which encompasses Nevada and western Utah, the ranges have relatively low relief and often show no elongation or alignment, and the extensive basins coalesce around the ranges. In the western part of the Mojave the older rocks exposed in the ranges are metasedimentary and metavolcanic rocks of Paleozoic and Mesozoic age like those that form pendants in the Sierra Nevada batholith, whereas in the eastern Mojave they are mainly late Precambrian and Paleozoic shelf carbonates and clastics like those of the southern Sierra and southern Great Basin. Granitic plutons intrude these rocks throughout the Mojave. There are numerous volcanic fields of Tertiary age, and a few of Quaternary to Holocene (Recent) age.

Interplay between east-west extension and strike-slip motion along the San Andreas and Garlock faults has produced complex fault patterns. In the eastern Mojave, where extreme extension has occurred, large blocks representing pieces of Tertiary basin sections have moved considerable distances on low-angle detachment faults.

The mineral deposits of the Mojave block are as varied as its geology. They include epithermal and hot-springs gold-silver deposits, lead-silver-zinc carbonate replacement deposits, polymetallic vein deposits, tungsten skarn deposits, iron skarn deposits, and an important rare earth (lanthanide) deposit associated with alkaline intrusive rocks. They also include deposits of types possibly unique to the southwestern U.S., including gold ore bodies and polymetallic deposits associated with detachment faults.

With its proximity to the population centers of southern California, the Mojave Desert is exploited extensively for construction materials including limestone, building stone, aggregate, and gypsum. In addition, the basins are exploited for a variety of evaporite and brine minerals (borates, trona, potash, and salt). The Tertiary volcanic and sedimentary sections yield perlite and clay.

CALIFORNIA DEPOSITS WITH IMPORTANT ENVIRONMENTAL IMPACTS

Introduction

This section describes the mineral deposit types that have the most important known and potential environmental impacts in California. Deposit types are grouped by dominant commodities. Important mineralogical characteristics, and the size range for each deposit type are summarized in table A1. The geographic distribution of each deposit type, which was discussed in the section on physiographic provinces, is also summarized in the table. The text gives comments on geologic occurrence of each group of deposit types, and summarizes highlights of discovery and development, and technological, economic, and political changes that affected exploitation.

Gold deposits

Placer mining in its various forms, particularly dredging and hydraulic mining, has significant impacts on the landscape because large volumes of fine sediment washed from auriferous gravels are carried downstream and redeposited. Most placer tailings, however, do not contain reactive minerals and therefore do not generate acid or release toxic metals. Consequently this discussion is limited to lode deposits (see fig. A3).

Limited mining of placer deposits and a few shallow gold lodes occurred in southern California as early as 1775, but lode mining did not begin in earnest until 1849, the second year of the gold rush. Most of the major districts in the Sierra Nevada and Klamath Mountains were discovered by 1852, and lode mining was widespread by the late 1860s. Discovery and development of gold lodes in the Great Basin and Mojave Desert Provinces lagged behind those on the west slope of the Sierra and in the Klamath Mountains, occurring mainly between the 1870s and World War I. In recent years gold mining in the Sierra Nevada and Klamath Mountains has involved developing new ore bodies, extensions, or low-grade disseminated ores in established historical mining districts. In the Great Basin and Mojave Desert, in contrast, several discoveries have been made in areas with little or no previous production.

One major deposit, the McLaughlin mine, was developed in the northern Coast Ranges in a former mercury-mining district.

Between 1850 and 1866, the major production period resulting from the gold rush, lode mines accounted for less than 10 percent of gold production in California. Since 1884, however, production of gold from lodes has exceeded production from placers in most years. During the Depression gold production increased, rising sharply when gold was revalued from $20.67 to $35 per troy ounce in 1933-1935. This resurgence, during which lode gold accounted for 50-60 percent of production, was cut off late in 1942 by War Production Board Limitation Order L-208, which shut down gold mining. Although L-208 was lifted in 1945, gold mining did not revive again until the price of gold was decontrolled and began to rise substantially in the 1970s. Recent production is almost entirely from lodes, in most cases exploited by open-pit mining methods.

Many improvements in mining and processing methods have occurred during the 150-year history of lode mining in California. These technological changes, along with changes in economic conditions, affected mining and ore treatment practices, which in turn have implications for characteristics of mining wastes.

All hard-rock ore must be crushed, and often ground to fine powder, to free gold particles or sulfide mineral particles that contain the gold. The arrastres that were commonly employed for crushing and pulverizing ore in the 1850's were quickly replaced with stamp mills, and some of the earliest mines were equipped with stamp mills at the outset. Improved crushing and grinding devices, such as gyratory crushers and ball mills, were introduced beginning in the 1890s, but stamp mills continued in common use through the 1930s. Widespread availability of electrical power was an important factor in adoption of more efficient equipment around the turn of the century, and also was necessary for expanding stamp mills to large sizes.

The most common recovery method was plate amalgamation, which was used in conjunction with stamp mills. Pulverized ore from the stamp batteries was washed over silver-plated copper sheets coated with mercury. Gold was recovered from the amalgam by retorting to remove the mercury. Gravity separation of free gold and sulfide minerals using jigs or shaker tables was soon added, along with barrel amalgamation. Efficient gravity separators of many designs, capable of handling larger volumes of material, were developed beginning in the 1890s. Cyanidation (leaching with sodium cyanide solution) was introduced in California in 1896, after which many mills installed circuits employing both amalgamation and cyanidation. Although froth flotation methods were developed early in the 20th century, flotation was not generally employed in gold mills until the 1930s. In recent years the use of mercury has been suspended owing to environmental concerns, and improvements in cyanide leaching methods.

It was not usually economic for individual mines to install and operate the equipment necessary to recover gold from sulfide concentrates, so concentrates were shipped to smelters. The American Smelting and Refining Company Smelter at Selby, near Benicia, California, now closed, processed concentrates and ores from many California gold mines. Mines in the eastern and southern parts of the state, however, also utilized smelters in Arizona and Utah. Some larger and better equipped mines processed ores or concentrates from other mines, usually but not always within the same mining district.

A factor that may affect the volume of various mining wastes at individual properties is the practice of back-filling mine workings. At many mines some waste rock was disposed of occasionally in worked-out stopes to avoid having to haul it to the surface, and at some larger and more recent operations, systematic disposal of waste rock underground was part of the mining plan. Mill tailings, particularly the relatively coarse sands, may also be returned underground through slurry pipelines, again as part of a systematic mining plan such as cut-and-fill stoping. Half or more of the material milled may be disposed of in this way.

The Caminetti Act of 1893 (Anti-debris Act), although aimed primarily at keeping placer-mining debris out of waterways, apparently had some affect on mill tailings disposal practices at lode mines. Before that time little attention was paid to control of mill tailings. Since mills required water they were built near streams, and tailings were discharged in or near the same streams, to be washed away immediately or during periods of high run-off. After 1893 tailings at the larger mines were impounded behind dams or dikes, and in recent decades tailings control has been required at all mines. Tailings piles or

impoundments at some abandoned or inactive sites, however, have been eroded in recent years, and tailings have washed into local streams.

Gold mining increased again in California beginning in the early 1980's as a result of the gold price increases in the 1970s. Many current operations, especially those in the Mojave Desert, utilize heap-leaching methods, in which crushed ore is piled on impermeable pads and leached for periods of weeks to months with cyanide solution delivered through sprinkler systems. It is particularly suitable for sulfide-free oxidized ores, which can be profitably treated at very low ore grades.

Base metal and silver deposits

Ore deposits exploited mainly for base metals (copper, lead, and zinc) or silver are widespread in California, but various parts of the state have different deposit types with different combinations of these commodities.

Base metal deposits in the Sierra Nevada foothills and the Klamath Mountains are mainly of the volcanogenic massive sulfide (VMS) type (fig. A4). These deposits comprise masses of sulfide minerals that were deposited on the sea floor by submarine hot-springs systems. They are usually relatively small, but their ores are very rich. Most volcanic rock units contain no VMS deposits at all, but those that formed when conditions were favorable for preservation of sulfidic sea-floor muds usually contain numerous deposits. VMS deposits account for most of California's historical copper production. Important byproducts include zinc, silver, and gold. Occasionally sulfur (for sulfuric acid) and iron are produced from the abundant pyrite in VMS ores.

The most important base-metal deposits in southeastern California, both in the Basin and Range and Mojave Desert Provinces, are lead-silver-zinc ore bodies in carbonate rocks. The most productive ore bodies are irregular masses of sulfides that replace limestone or marble close to major faults, and consequently they are referred to as polymetallic replacement deposits. Ore bodies may have other forms, however, including pipes and veins. These deposits also tend to be relatively small and high grade, and contain galena, sphalerite, pyrite, chalcopyrite, and sulfosalts (complex minerals that contain various base metals, silver, arsenic, antimony, and sulfur). In some deposits base metals, mainly lead, are most valuable, but in many deposits silver is the main commodity. In most but not all districts granitic intrusive rocks are exposed. Ore-forming fluids probably circulated around these intrusions as they cooled.

Polymetallic veins found in various types of host rocks are scattered throughout the state but are most common in the Mojave Desert Province and east of the crest of the Sierras. They are near the margins of intrusive bodies, both in the granitic rocks and the surrounding wall rocks. Either precious metals or base metals may be most valuable. Those most valuable for gold are included on the gold deposits map (fig. A3). If the most valuable metal is not gold, it is usually copper or silver; all deposits with a major commodity other than gold are included on fig. A4.

Exploration following the Marshall gold discovery at Coloma in 1848 resulted in discovery of many of the VMS deposits, especially in the Foothills belt, where production started in 1862. The Foothills belt is a short distance west of the Mother Lode belt and parallel to it, because the deposits are hosted by metavolcanic rocks that follow the regional northwest trend of geologic units in the western and northern Sierra. The early production was from surface-enriched copper-zinc ores with good gold and silver values, but these were depleted by the 1870s. From the 1880s until the 1920s various deposits were mined intermittently, yielding a fairly steady overall production that peaked in 1917. There was a revival of production during World War II.

The most important VMS deposits in the state, accounting for about half of California's copper production, are those of the West Shasta and East Shasta districts, northwest and northeast of Redding, respectively. These districts began production in the mid-1890s and expanded rapidly to dominate California copper production through World War I, after which they declined just as rapidly, with the last significant production in World War II.

Although many VMS deposits have considerable zinc, none was recovered until 1906, when it became economically worthwhile to recover zinc. Even after 1906, attempts to separate sphalerite from copper sulfides and other sulfide minerals were generally unsuccessful, forcing the mines to produce bulk polymetallic concentrates. Smelting of mixed-metal

concentrates is generally more difficult and costly than single-metal concentrates, which probably discouraged mining of zinc-rich ores and attempts to fully recover zinc. Methods of differential flotation for efficiently separating zinc from copper were developed in the 1920s, and applied by the California mining industry beginning in the early 1930s. Thus zinc did not become a major product of VMS deposits until relatively late in the history of exploitation of these deposits.

The largest lead-silver-zinc replacement and vein deposits of the Great Basin and Mojave Desert Provinces were discovered in the 1860s and 1870s. Discoveries of smaller deposits, and some silver-dominated deposits of other types continued in the Mojave Desert until World War I. Owing to increased demand for lead and improved processing methods, many lead-silver-zinc mines had their heyday in the 1940s and 1950s.

Since most individual base metal deposits are relatively small, it is seldom economic to construct a smelter for a single mine or even a mining district. Concentrates from California copper-zinc deposits were generally shipped out of state for smelting. Lead-silver concentrates were shipped out of state or treated at the former Selby smelter near Benicia, California. Smelting was done on site at only a few mines.

Mercury deposits

California has accounted for the majority of U.S. mercury production. The deposits are located primarily in the Coast Ranges, which constitute one of the most productive mercury provinces in the world (fig. A5). Mercury was recognized in the Coast Ranges in the 1840s, and successfully extracted at New Almaden in Santa Clara County beginning in about 1846, but significant development did not occur until the gold rush produced a local demand for mercury. Production grew, albeit with ups and downs, to reach a peak in 1877. Much of the early production came from the New Almaden deposit, but many other significant deposits were developed from the 1850s through the mid-1870s. The New Idria mine in San Benito County dominated production from 1895 until the 1930s. Mercury production remained notoriously cyclical through the 1960s, owing to large price swings, shortages, and periods of overproduction. After World War I new uses for mercury developed and industrial demand became more important relative to that for gold mining. Since 1970 production has generally declined, owing to reduced demand and low prices, and mercury is now produced only as a byproduct from some gold mines.

The mercury deposits of the Coast Ranges, even the larger ones, are characterized by small, irregular, and unpredictable ore bodies, so individual mines tend to have complex histories of development employing various mining strategies. Not uncommonly, persistent exploration has yielded new ore bodies in mines thought to have been depleted.

Ore processing is more predictable. Since mercury minerals are easily decomposed at relatively low temperatures, mercury metal is generally recovered on site, even at the smallest mines. The basic process is to roast the ore to a high enough temperature to decompose the mercury minerals (most commonly cinnabar) and volatilize the mercury, then collect the metal in a condensing system.

Before World War I retorts and Scott furnaces were used exclusively. Retorts consist of cylindrical or D-shaped iron pipes mounted singly or in sets over a fire box, all enclosed in masonry. The condensing apparatus is essentially cast-iron pipe that discharges into a water tank. Since the retort is sealed except for the outlet to the condensing system, lime is added to combine with the sulfur released as cinnabar decomposes. Retorting is a batch process; the retort tubes must be loaded with crushed ore, usually by hand, sealed, heated, cooled, opened, discharged, and reloaded. D-tube retorts were particularly popular; the tubes are mounted flat side down, so that the flat surface facilitates hand loading and unloading. The Scott furnaces used at some California mines had stacked multiple hearths, and were also operated in a batch mode.

Beginning in 1918, larger mines installed continuous-feed furnaces, which have higher capacity and are more efficient than retorts. The most common furnace was the rotary kiln, a steel tube lined with fire brick, mounted with a slight slope. Hot air from a burner is blown into the low end of the tube while ore is continuously fed in at the top, working its way down as the tube is rotated. Burnt ore is discharged at the bottom while combustion gases and mercury vapor are drawn from the top into a condensing system. Less commonly used was the Herreshoff vertical multiple-hearth furnace, in which ore passes downward successively over stacked circular

hearths. Horizontal arms mounted on a vertical shaft at the center rotate over the hearths, pushing the ore toward openings where it falls to the hearth below. Heating ore to drive off the mercury is referred to as "burning," and burnt ores from both retorts and furnaces are referred to as "calcines."

Although by the 1960s more than 90 percent of mercury produced in the United States was recovered using furnaces, retorts have remained in use, especially at smaller mines with higher-grade ore, because they are comparatively inexpensive to construct and are suitable for intermittent operation.

Various mechanized methods have been employed for beneficiating mercury ores before roasting, including size classification by screening, gravity separation by jigging or tabling, and flotation. They are not cost-effective for most ores, however, and the majority of mines have not used them. The most common beneficiation method is probably hand sorting. Leaching methods exist but are seldom used, because they are more costly than the traditional distillation methods.

Other deposit types

The above discussion covers the types of ore deposits that contain sulfide minerals and are common in California, and therefore have potential environmental impacts, but problem deposits may not be limited to these types. Other deposit types less common in the state, or whose main ore minerals are not sulfides, may in some cases contain enough sulfides, or have been developed in such a manner as to be of concern. Several deposit types that could have environmental impacts are included in Table A1. For some deposit types whose characteristics are difficult to predict, particularly with regard to variables related to acid-generating potential, and for deposits lacking detailed published descriptions, field examinations are essential.

BIBLIOGRAPHIC SOURCES FOR APPENDIX A

Albers, J.P., 1981, A lithologic-tectonic framework for the metallogenic provinces of California: Economic Geology, v. 76, no. 4, p. 765–790.

Albers, J.P., and Fraticelli, L.A., 1984, Preliminary mineral resource assessment map of California: U.S. Geological Survey Mineral Investigations Resource Map MR-88, scale 1:1,000,000.

Clark, W.B., 1970, Gold districts of California: California Division of Mines and Geology Bulletin 193, 186 p.

Cox, D.P., and Singer, D.A., editors, 1986, Mineral deposit models: U.S. Geological Survey Bulletin 1693, 379 p.

DuBray, E.A., editor, 1995, Preliminary compilation of descriptive geo-environmental mineral deposit models: U.S. Geological Survey Open-File Report 95-831, 272 p.

Jennings, C.W., compiler, 1977, Geologic map of California: California Division of Mines and Geology, California Geologic Data Map Series, scale 1:750,000.

Kohler-Antablin, Susan, 1997, California's non-fuel mineral production—1996: California Geology, v. 50, no. 4, p. 116–118.

Peele, Robert, editor, 1918, Mining Engineer's Handbook (First Edition): John Wiley & Sons, Inc., New York, 2375 p.

Tooker, E.W., and Beeby, D.J., compiler-editors, 1990, Industrial minerals in California—economic importance, present availability, and future development: U.S. Geological Survey Bulletin 1958, 127 p.

Wright, L.A., editor, 1957, Mineral commodities of California—geologic occurrence, economic development and utilization of the state's mineral resources: California Division of Mines Bulletin 176, 736 p.

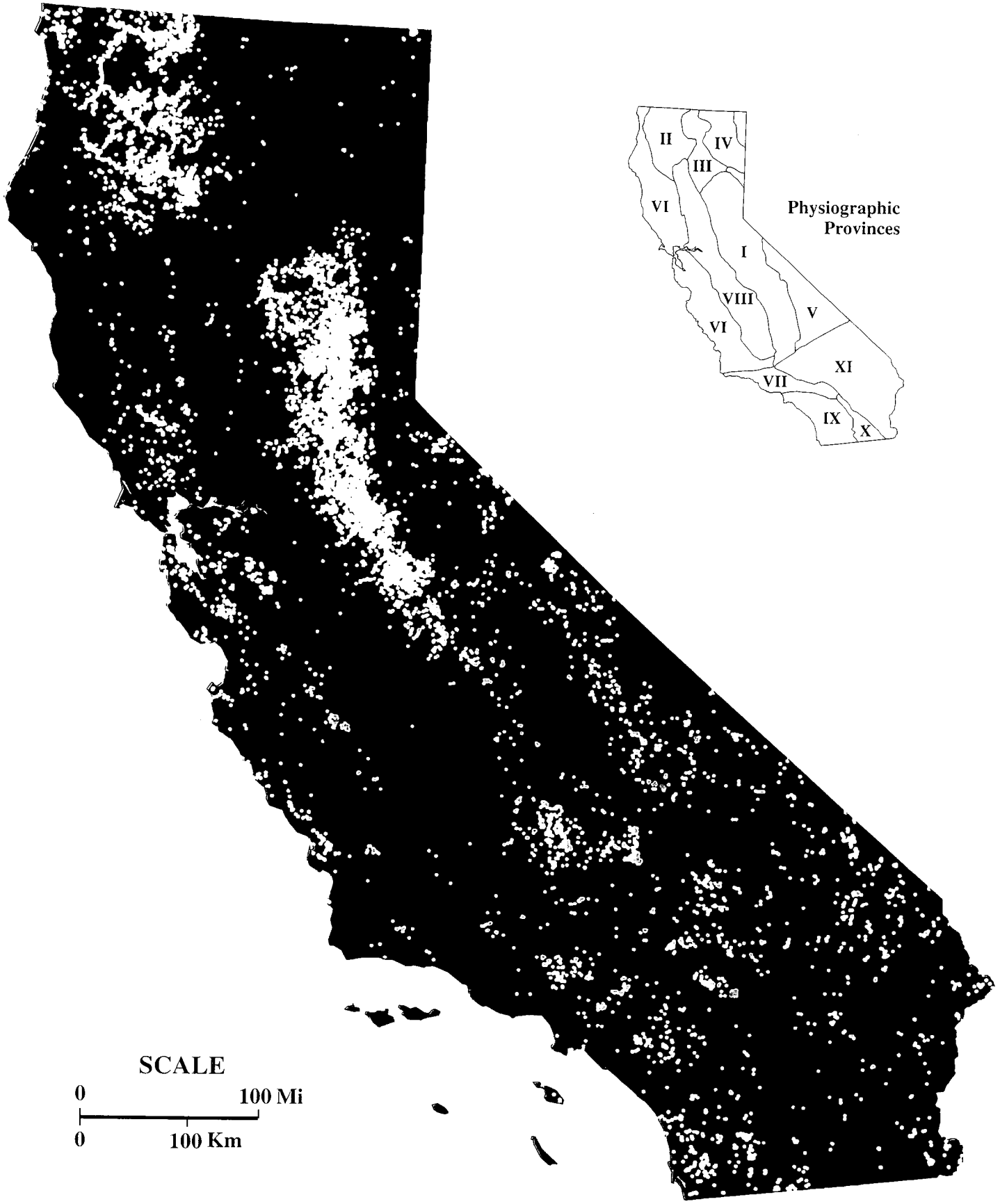


Figure A1. Map of California showing locations of past and present mines with recorded mineral production, including metallic commodities, industrial minerals, and some construction commodities. Fuel minerals are not included. Data primarily from U.S. Geological Survey, Mineral Resource Data System (MRDS) database, supplemented with selected data from Mineral Industry Location System (MILS) database (formerly maintained by U.S. Bureau of Mines, now maintained by U.S. Geological Survey). Data set depicted does not include all small and intermittent producers, and is known to be incomplete with respect to sand and gravel, aggregate, and stone.

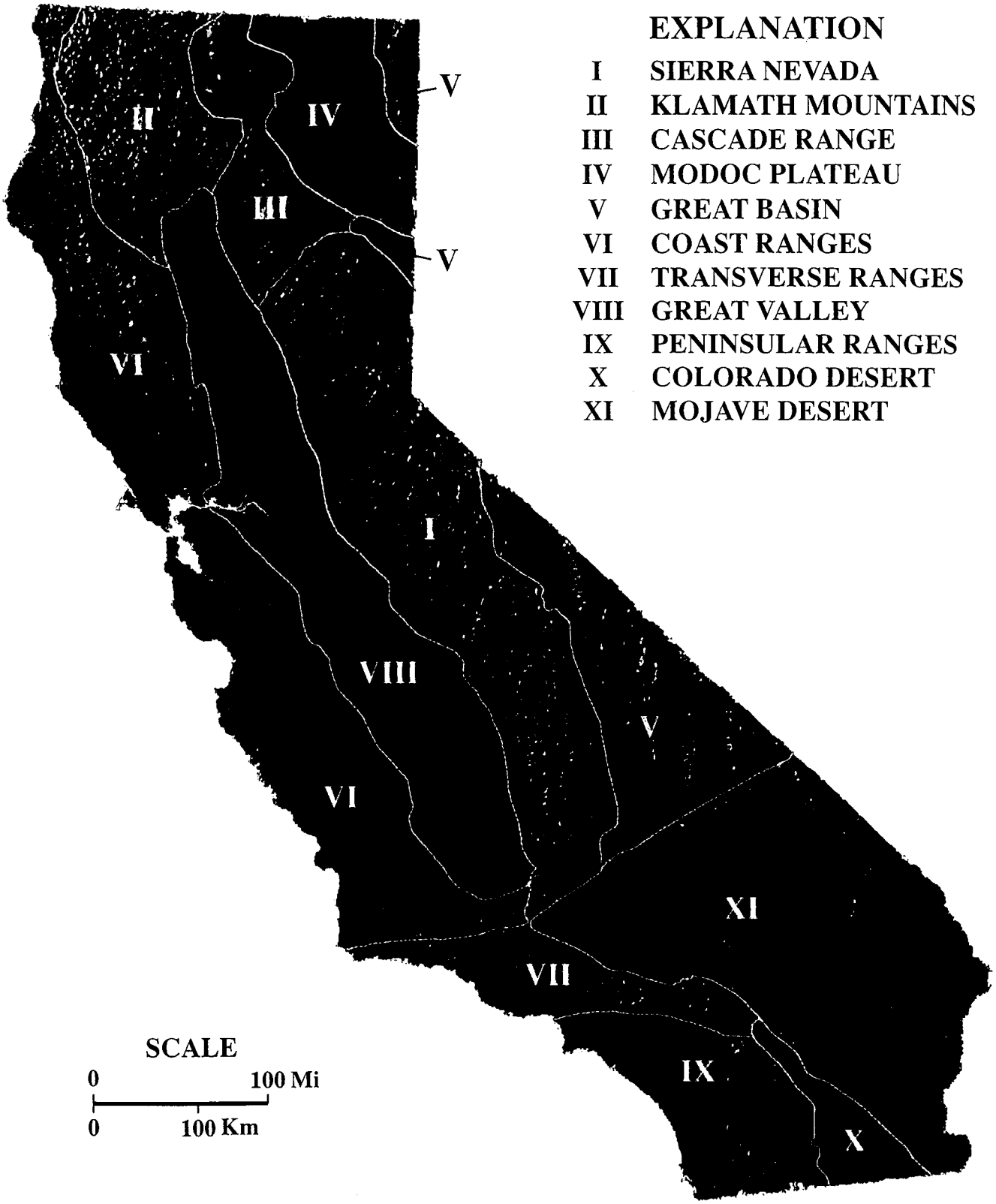


Figure A2. Physiographic provinces of California. Provinces include: I, Sierra Nevada; II, Klamath Mountains; III, Cascade Range; IV, Modoc Plateau; V, Great Basin (Basin and Range); VI, Coast Ranges; VII, Transverse Ranges; VIII, Great Valley; IX, Peninsular Ranges; X, Colorado Desert; XI, Mojave Desert. Base from Thelin, G.P., and Pike, R.J. 1991, Landforms of the conterminous United States—a digital shaded-relief portrayal: U.S. Geological Survey Miscellaneous Investigations Series Map I-2206, scale 1:2,500,000.

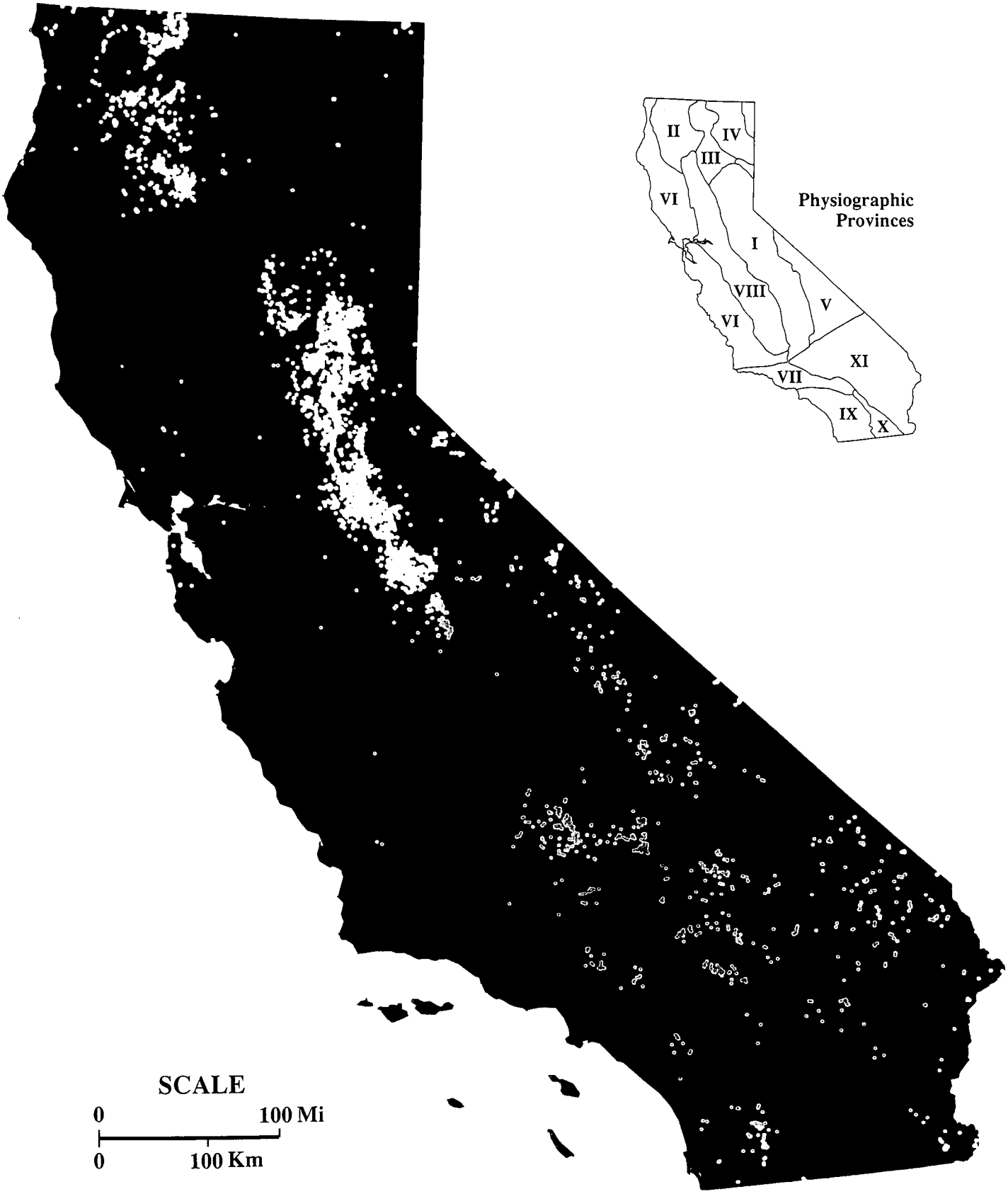


Figure A3. Map of California showing locations of lode gold mines with recorded production. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database.

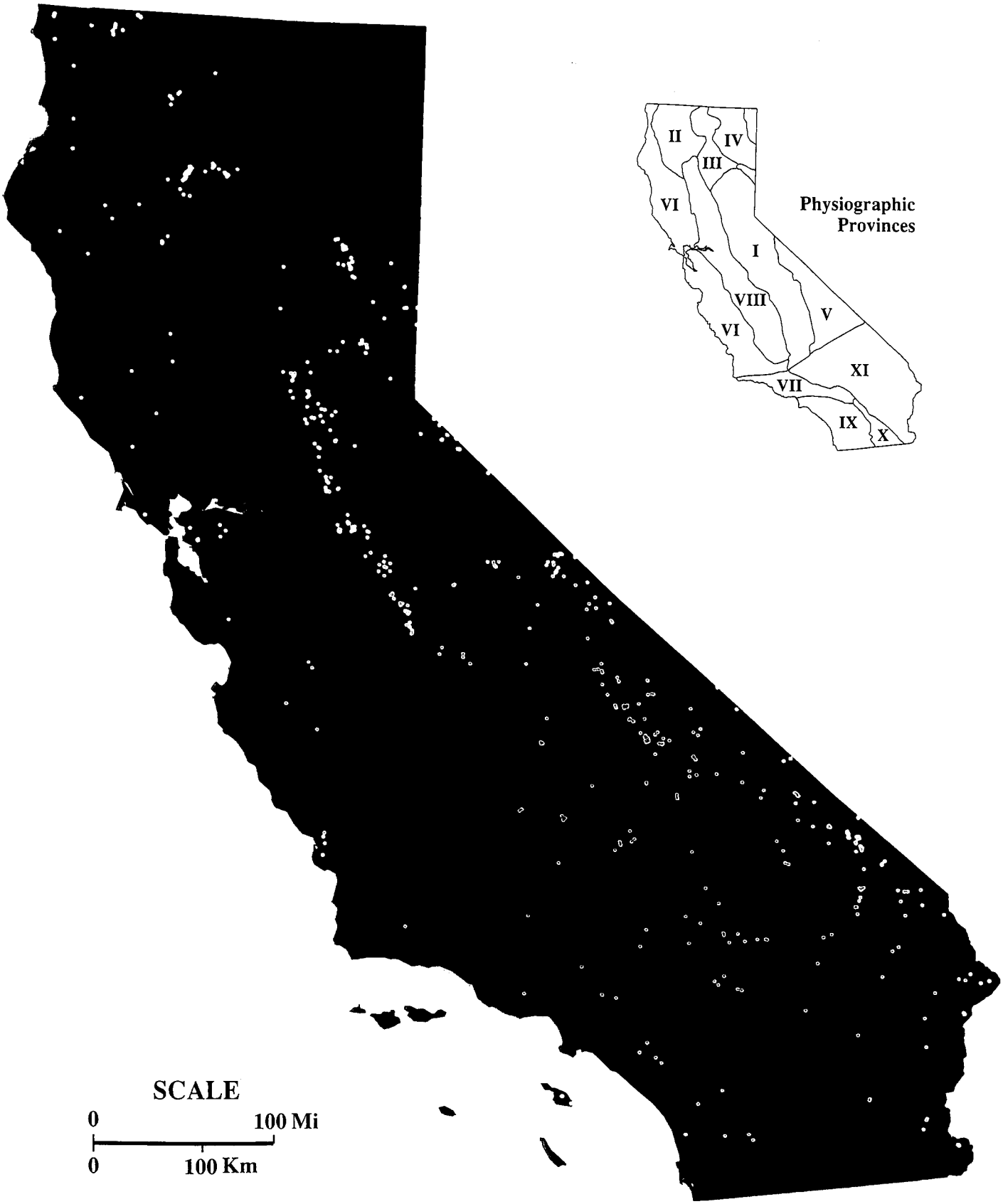


Figure A4. Map of California showing locations of mines that produced base metals (primarily copper, lead, or zinc), with or without silver. Either base metals or silver may account for the majority of production value. Many mines shown here produced gold as a byproduct; mines in which gold value predominates, however, are shown on Figure A3. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database.

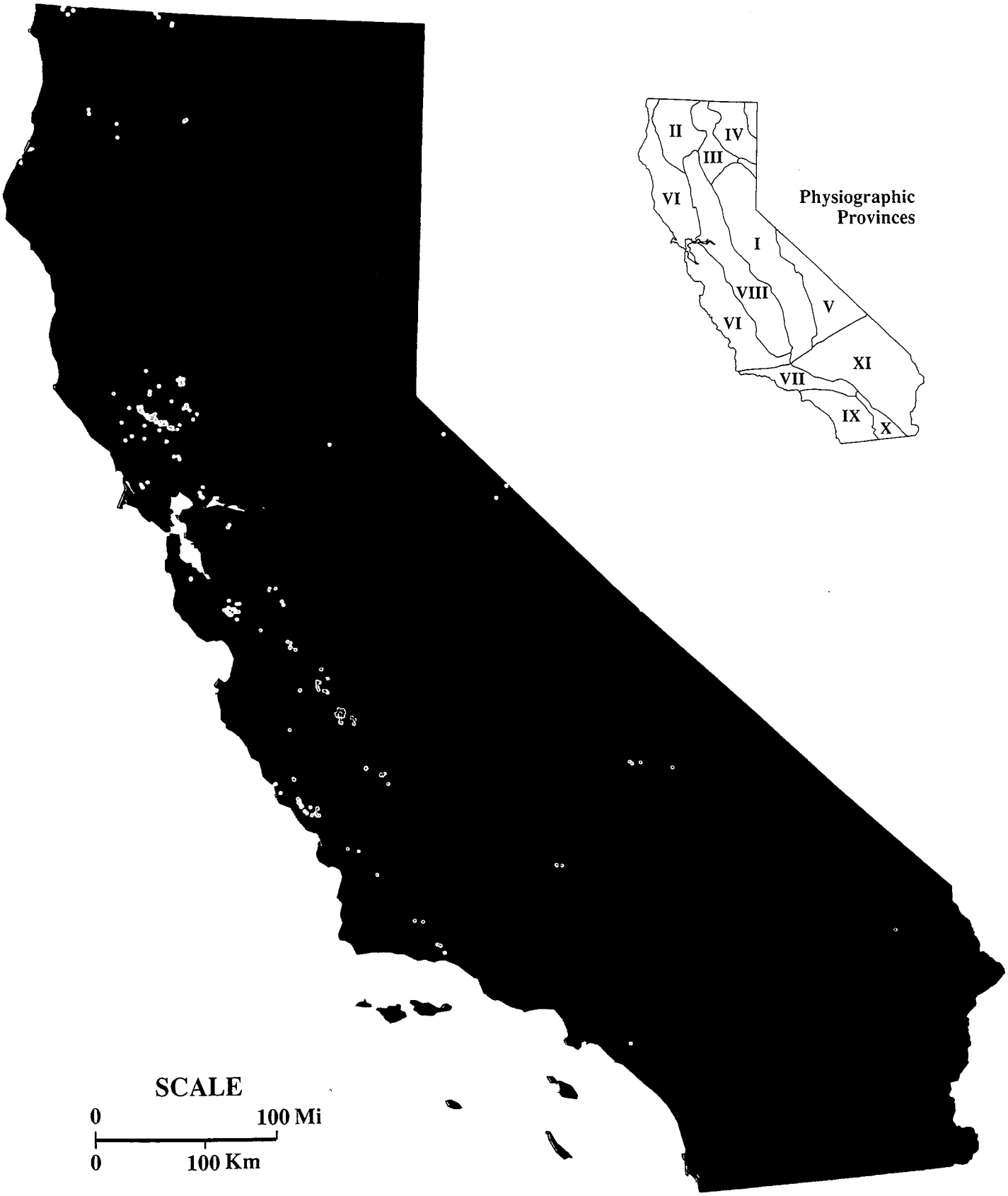


Figure A5. Map of California showing locations of mines that produced mainly mercury. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database. Data set depicted is known to be incomplete with respect to small producers.

Table A1. Characteristics of mineral deposits with significant environmental impacts

Deposit Type (USGS Model)	GEOGRAPHIC DISTRIBUTION (Province No.)	COMMON SULFIDE MINERALS	PERCENT SULFIDES IN ORES	BUFFERING MINERALS ASSOCIATED WITH ORES	DEPOSIT SIZE RANGE (million short tons)[1]		
Base Metals and Silver					90th	50th	10th
Volcanogenic massive sulfide	I, II, VI	Pyrite, sphalerite, chalcopyrite, pyrrhotite, galena	5-90+	None	0.13	1.7	20
Polymetallic vein	I, II, V, VI, VII, IX, XI	Pyrite, sphalerite, chalcopyrite, galena, arsenopyrite, sulfosalts[2], argentite	10-50+	Calcite, dolomite, ankerite, siderite, rhodochrosite	0.0013	0.014	0.14[3]
Polymetallic replacement	V, XI	Pyrite, galena, sphalerite, chalcopyrite, argentite, marcasite, many sulfosalts[2]	10-50+	Calcite, dolomite, siderite, rhodochrosite	0.26	2.0	15
Skarn (copper)	I, V, XI	Chalcopyrite, pyrite, bornite, pyrrhotite	10-50+	Calcite, dolomite	0.33	0.62	10
Skarn (zinc-lead)	V, XI	Sphalerite, galena, pyrrhotite, pyrite, chalcopyrite, bornite, arsenopyrite	10-50+	Calcite, dolomite, rhodochrosite	0.18	1.5	13
Gold and Silver							
Low-sulfide gold-quartz veins	I, II,VI, VII, IX, XI	Pyrite, arsenopyrite, stibnite, sphalerite, chalcopyrite, galena, pyrrhotite	1-10	Dolomite, ankerite, magnesite, siderite, calcite	0.001	0.033	1.00
Epithermal veins	IV, V, XI	Pyrite, argentite, silver sulfosalts[2], galena, sphalerite, chalcopyrite, marcasite, arsenopyrite	<1-5	Calcite, rhodochrosite	0.072	0.85	10

Table A-1 – continued

Quartz-alunite gold	V, XI	Pyrite, sulfosalts[2], chalcocite, covellite, chalcopyrite, marcasite, sphalerite, galena	2-30	None	0.24	1.8	12
Hot spring	IV, V, VI, XI	Pyrite, stibnite, realgar	<1-10	None	1.4	10.2	73
Polymetallic veins	I, II, V, VII, IX, XI	Pyrite, sphalerite, chalcopyrite, galena, arsenopyrite, sulfosalts[2], argentite	5-20	None	0.014	0.084	0.47[3]
Mercury							
Silica-carbonate	VI	Cinnabar, pyrite, marcasite, stibnite, chalcopyrite, sphalerite	2-10	Magnesite, dolomite, calcite, serpentine	0.0014	0.031	0.66
Hot spring	IV, V, VI	Cinnabar, marcasite, pyrite	<1-5	None	.00002	0.01	0.51
Tungsten							
Vein	I, V, XI	Pyrite, molybdenite, bismuthinite, pyrrhotite, arsenopyrite, bornite, chalcopyrite[3]	<1-10	None	0.05	0.62	7.7
Skarn	I, V, XI	Pyrite, pyrrhotite, molybdenite, chalcopyrite, sphalerite, bornite, arsenopyrite, bismuthinite[4]	<1-10	Calcite, dolomite	0.04	0.9	20
Iron							
Skarn	I, V, XI	Chalcopyrite, pyrite, pyrrhotite, sphalerite, arsenopyrite[5]	1-20	Calcite, magnesite, epidote	0.36	7.9	176

1. The first column below gives the deposit size at the 90th percentile; 90 percent of deposits in a tonnage model are larger than this number (see Cox and Singer, 1986, for tonnage models). The second colunm is the median deposit size; half the deposits in the tonnage model are larger than this, and half are smaller. The third column gives the 10th percentile deposit size; only 10 percent of deposits in the model exceed this number.
2. Sulfosalts are complex minerals that contain various base metals, silver, arsenic, antimony, and sulfur.
3. Sizes and grades of polymetallic veins vary considerably from region to region. These figures, which are for deposits in Idaho and northeastern Oregon, are given to provide an approximate indication of size. Models for California polymetallic deposits are not presently available.
4. The valuable mineral, scheelite, is not a sulfide.
5. The valuable mineral, magnetite, is not a sulfide.

APPENDIX B

APPENDIX B
HOW MINERAL DEPOSITS INTERACT WITH THE ENVIRONMENT

INTRODUCTION

The purpose of this section is to summarize how ores react and change when exposed to water and air, either naturally or through mining and processing. How ore minerals release metals into the environment and how the metals subsequently behave explains how ore-related chemical hazards develop at mine sites and outside the immediate mined area. Contaminated drainage may flow into a stream or river and affect water quality for a considerable distance downstream.

Physical hazards, which are often associated with pits, quarries, and underground mine workings, are not treated here.

MINERALS ASSOCIATED WITH ORE DEPOSITS

In the case of metallic deposits, the minerals that contain the valuable metals are usually sulfides (metals combined with sulfur) or sulfosalts (metals combined with sulfur and one or more metalloids such as arsenic, antimony, or selenium). Oxides are second in importance as sources of metals, and silicates, carbonates, and other types of compounds are seldom important metallic ore minerals. Industrial and agricultural minerals, however, include silicates, carbonates, halides, sulfates, phosphates, borates, and other compounds. A list of formulas for minerals mentioned in this report is given in Table B1.

Gangue minerals are non-valuable minerals closely associated with the valuable ore constituents. They generally include silicates, carbonates, or sulfates. They may form veins that carry the ore minerals, or represent minerals that replaced host rocks as a result of reaction with the fluid that deposited the ore minerals. The thermal waters that deposit many types of metallic ore deposits can cause dramatic changes in the mineralogy of host rocks, creating bodies of rock referred to as "hydrothermal alteration zones," which may be many times larger than the economically-defined ore zones. Unaltered host rocks may include almost any common rock type. Most common rocks are composed of silicates or carbonates, with minor amounts of oxides and other compounds.

SURFACE PROCESSES: EFFECTS OF WEATHERING

Weathering is a general term for reactions of minerals with air and water. One of the most important types of reaction is oxidation, in which minerals react and combine with oxygen in the air. Most minerals react with oxygen and water because they formed at elevated temperatures and pressures, and are therefore unstable under surface conditions.

Most sulfide minerals react with oxygen and water, and some common sulfides, especially those containing iron and copper, generate sulfuric acid in the process. Pyrite, the most common sulfide mineral, reacts with oxygen and water to form ferrous iron and sulfuric acid in solution. The acid thus produced will attack the more resistant sulfides of other metals, as well as dissolve silicate and carbonate gangue and wall-rock minerals. The amounts of pyrite and other iron-rich sulfide minerals such as marcasite, pyrrhotite, and chalcopyrite are critical in producing acid drainage, which tends to carry high concentrations of base metals such as copper, zinc, cadmium, and nickel, metalloids such as arsenic and antimony, and heavy metals such as lead, mercury, bismuth, and tellurium.

Since weathering of pyrite or similar iron-bearing sulfides is required to produce acid, the rates of oxidation reactions for these minerals are critical in producing significant environmental effects. The reactions involved in the oxidation process proceed rapidly except for oxidation of ferrous iron, which is regarded as the rate-determining step. Aseptic laboratory experiments indicate that years to decades would be required to oxidize a significant proportion of sulfide, even if it is present in small particles that provide large surface area for reaction. Observations of natural systems, however, consistently indicate much faster reaction rates. The reason for this is that some common strains of bacteria

that are present in almost all environments increase the reaction rate by many orders of magnitude. Pyrite-bearing ore and waste piles begin to generate significant amounts of acid within a few months to a few years, and acid generation may continue for many decades.

Carbonate minerals, which may be present in gangue or host rocks, react with acid water and tend to neutralize it. Calcium carbonate minerals (calcite, aragonite) react most readily, dissolving in weakly acidic rainwater to produce a bicarbonate solution. Iron and magnesium carbonates (dolomite, ankerite, magnesite, and siderite) are less reactive, and the iron-rich carbonate siderite can even produce acid under some conditions.

The aluminosilicate minerals that are abundant in many kinds of host rocks react weakly with acid, and react very slowly with normal surface waters, mainly by hydrolysis (reactions involving H^+ and OH^-, the components of water) rather than oxidation. The most reactive aluminosilicate materials are volcanic glass and iron- and magnesium-bearing silicates such as olivine and serpentine. Feldspars such as albite and orthoclase, the most abundant class of minerals in the Earth's crust, hydrolyze quite slowly, and quartz, also very abundant, dissolves at an almost imperceptible rate.

SECONDARY MINERALS

Erosion of the land surface is generally slow; catastrophic events that accelerate mechanical and chemical erosion processes are uncommon. Thus exposures of unstable minerals are usually limited, and considerable time is available for reactions to take place. Consequently products of natural weathering tend to be dominated by relatively stable secondary minerals such as goethite, hematite, azurite, malachite, barite, scorodite, and kaolinite.

In contrast, sulfide-bearing minerals may be extensively exposed in mine wastes and mill tailings because fragmental material has a large surface area relative to natural outcrops. In many cases the time elapsed since mining and processing has not been sufficient to allow stable minerals to form. Consequently, secondary minerals formed from mine wastes may be dominated by soluble salts, mostly sulfates, with important implications for mobility and pathways of metals. Soluble minerals include melanterite, copiapite, and rhomboclase (iron), halotrichite-pickeringite (iron, magnesium, and aluminum), epsomite (magnesium), gypsum (calcium), chalcanthite and brochantite (copper), goslarite (zinc), and cerussite (lead). These soluble efflorescent salts precipitate from metal- and sulfate-rich drainage waters as they evaporate during dry times of the year, typically coating the walls of mine workings, the surfaces of dumps and mill tailings piles, or the channels of intermittent streams that drain mine workings or wastes. With return of rainy conditions or spring snowmelt, referred to as "first-flush" events, these salts dissolve readily, adding metals to the water.

The cycle of precipitation and dissolution of soluble metal sulfates, which requires alternating wet and dry conditions, has some important implications. First, transport of metals and sulfur is intermittent, and most transport occurs during the first significant rain storm or snowmelt event after a dry period. Second, the first water to redissolve sulfates, or more important, water that has undergone evaporation, can be highly reactive owing to its elevated concentrations of sulfate and ferric iron, and in itself can promote sulfide mineral oxidation and other weathering processes.

EFFECTS OF MINING AND ORE PROCESSING

Historically, available technology has limited mining methods. Advances that permitted excavation at substantial depths began in Europe in the 16th century. Technological hurdles facing underground mining have included developing efficient, durable, and eventually mechanized drills, safe and effective explosives, high-pressure mechanized pumps for dewatering, and strong cable for hoisting. Key developments such as air drills and steel cable did not come until the late 19th century, which is relatively late in the 450-year history of modern mining. Since the Industrial Revolution, declining energy and capital equipment costs have made mining feasible under a growing range of conditions. With the advent of large-scale bulk mining, many surface and underground mining methods are in use today; nevertheless, the methods used to exploit a given deposit depend mainly upon the geologic and geotechnical characteristics of the ore body and its host rocks.

Mine openings facilitate access of air and water to reactive ore and gangue minerals. In addition, underground mines may gather groundwater, in some cases from a relatively large volume of rock, and focus discharge at mine openings. Water often collects in open pits after mining operations cease. Mine pit lake waters usually show effects of reaction with ores and their host rocks because the pit walls present large exposure areas, and they are usually fractured from blasting. Concentration by evaporation is an important process affecting water quality in both surface and underground mine workings as well as in mine waste environments.

Waste rock is rock removed from mine openings or stripped off to expose the ore body (referred to as "overburden") and not processed. The character of such material varies greatly. It may include unmineralized rock composed of minerals that weather slowly, but commonly it includes low-grade mineralized rock that contains sulfide minerals, and rarely it includes relatively high-grade material, with or without abundant sulfides. Miners often sorted promising-looking low-grade ore or refractory high-grade ore into separate piles, hoping that changes in economics or technology would allow later processing. Mineralized rock, however, can also be mixed with unmineralized rock in waste-rock piles.

Like mining, mineral processing has a long history. Smelting to recover copper and tin defined the Bronze Age, and the use of mercury to recover gold goes back at least to that time. Use of chemical processes originated with alchemy in the Middle Ages. As with mining technology, some major mineral processing developments have occurred largely within the past century, including cyanidation for gold ores and flotation for concentrating sulfide minerals.

Mineral processing includes two main phases. The first is milling, in which the ore is ground to a grain size fine enough to liberate the valuable minerals from gangue minerals, and is then treated by physical methods (gravity or magnetic separation, or flotation) to recover metal directly (as is the case with gold) or to recover a concentrate of the metal-bearing minerals (usually sulfides). Wastes from this process are known as mill tailings, which are usually silt- to fine-sand sized (less than about 0.25 millimeters or 0.01 inch). They may be highly reactive owing to the very large exposed surface area of mineral grains, degrading the quality of surface and ground waters. The fine grain size and large surface area may also result in increased bioavailability of metals in mill tailings.

The second step in mineral processing involves recovering metals from the metallic mineral concentrates. Historically this has been done by smelting, which is heating the ore or mineral concentrate, mixed with a fluxing agent, to a high temperature under oxidizing conditions. The principal waste product from smelting is slag, a glassy material that resembles lava. Slag commonly contains elevated metal concentrations, and its environmental behavior varies greatly. Another waste material from smelting is flue dust, which can have extremely high concentrations of heavy metals such as lead and metalloids such as arsenic.

Usually the most economical scheme for processing sulfide ores has been to produce concentrates by milling on site, and to ship these concentrates to a custom smelter for further processing. At a few mines, however, smelting was done on site, and mining wastes include slag piles. In the case of mercury, recovery is usually achieved on site by crushing and roasting the ore and distilling the mercury, with no need for pre-concentration, because mercury compounds are easily decomposed by heating and metallic mercury is highly volatile. This practice produces calcines, yet another type of waste that may contain partly oxidized sulfides as well as residual mercury.

The mineral processing techniques applied at a given site depend upon many factors including mineralogic character of the ore, period of production, financing and capital cost of equipment, operating factors, operator experience, and availability of processing facilities elsewhere in the area.

EFFECTS OF CLIMATE

Climate has an important influence on the environmental behavior of mineral deposits, although climate effects are secondary to the controls on metal mobility related to deposit mineralogy and geology. California climates cover a wide range, from arid to temperate humid, and include subalpine and alpine zones. A large part of the state is semiarid.

Precipitation and temperature determine surface water flows, groundwater levels, mineral-water reaction rates, and indirectly, the abundance of organic material. In humid and semiarid climates sulfide oxidation and metal leaching are more rapid than in arid climates, but water tables tend to be shallower in wetter climates, impeding oxidation. Watertable depths may be highly variable in response to local conditions in semiarid and arid areas. The depth of weathering-related oxidation tends to be greater in drier climates, but is also highly variable.

The wetting-drying cycle that leads to episodic transport of metals is typically more pronounced in semiarid climates than in humid climates. Evaporative processes are important throughout much of the humid region and all of the semiarid region of California, because rainfall is generally concentrated during the winter and early spring seasons, even where annual precipitation totals exceed one meter. Wetting-drying cycles may be even more extreme in arid areas, such as the Mojave Desert, where metal cycling still occurs because infrequent but intense storm events account for much of the rainfall. Overall oxidation rates, however, are likely to be lowest in the desert regions.

Weathering rates are lower in cold climates, but only a small area within California is cold enough to preserve unweathered sulfide minerals at the surface. However, freeze-concentration of acid water, leading to increased metal contents, probably occurs in sub-alpine and alpine environments, which cover substantial areas in the high-mountain regions of the state. Snowmelt typically is more acidic than other surface water, which can affect metal cycling in mountainous areas.

The nature of downstream impacts is affected by climate. Under wet conditions, acid and metal-rich waters are affected by dilution, causing precipitation of iron and aluminum hydroxides and subsequent absorption of metals by these precipitates. Under dry conditions, downstream metal transport and precipitation may depend upon reactions with detritus or mineral crusts in streambeds.

BIBLIOGRAPHIC SOURCES FOR APPENDIX B

Cox, D.P., and Singer, D.A., editors, 1986, Mineral deposit models: U.S. Geological Survey Bulletin 1693, 379 p.

DuBray, E.A., editor, 1995, Preliminary compilation of descriptive geo-environmental mineral deposit models: U.S. Geological Survey Open-File Report 95-831, 272 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3rd. edition): U.S. Geological Survey Water-Supply Paper 2254, 264 p.

Jambor, J.L., and Blowes, D.W., editors, 1994, Environmental geochemistry of sulfide mine wastes: Mineralogical Association of Canada, Short Course Handbook, 438 p.

Plumlee, G.S., and Logsdon, M.J., editors, 1997, The environmental geochemistry of mineral deposits—Part A: Processes, techniques, and health issues: Society of Economic Geologists, Review in Economic Geology, Volume 7A, in press.

Singer, P.C., and Stumm, Werner, 1970, Acid mine drainage—the rate-determining step: Science, v. 167, p. 1121–1123.

Smith, K.S., Plumlee, G.S., and Ficklin, W.H., 1994, Predicting water contamination from metal mines and mining wastes: U.S. Geological Survey Open-File Report 94-264, 112 p.

TABLE B1. Minerals associated with ore deposits.

1. ORE MINERALS

a) SULFIDES	FORMULA
Pyrite	FeS_2
Marcasite	FeS_2
Pyrrhotite	$Fe_{(1-x)}S$
Chalcopyrite	$CuFeS_2$
Bornite	Cu_5FeS_4
Chalcocite	Cu_2S
Covellite	CuS
Gersdorffite	$NiAsS$
Arsenopyrite	$FeAsS$
Arsenian pyrite	$Fe(S,As)_2$
Loellingite	$FeAs_2$
Orpiment	As_2S_3
Realgar	AsS
Cinnabar	HgS
Metacinnabar	HgS
Sphalerite	$(Zn,Fe,Cd,Hg)S$
Greenockite	CdS
Stibnite	Sb_2S_3
Galena	PbS
Millerite	NiS

b) SULFOSALTS	FORMULA
Tennantite-tetrahedrite	$(Cu,Ag,Fe,Zn)_{12}\ (As,Sb)_4\ S_{13}$
Enargite	Cu_3AsS_4
Luzonite-famatinite	$Cu_3\ (As,Sb)S_4$
Proustite-pyrargyrite	$Ag_3(As,Sb)S_4$

c)NATIVE ELEMENTS	FORMULA
Electrum	(Au,Ag)
Gold	Au
Silver	Ag
Copper	Cu
Quicksilver (native mercury)	Hg

d) OTHER	FORMULA
Niccolite	$NiAs$
Magnetite	Fe_3O_4
Calaverite	$AuTe_2$
Hessite	Ag_2Te
Petzite	Ag_3AuTe_2

Table B 1 continued

2. GANGUE MINERALS

a) CARBONATES	FORMULA
Calcite	$CaCO_3$
Aragonite	$CaCO_3$
Dolomite	$CaMg(CO_3)_2$
Ankerite	$Ca(Fe,Mg)(CO_3)_2$
Siderite	$FeCO_3$
Rhodochrosite	$MnCO_3$

b) SILICATES	FORMULA
Quartz	SiO_2
Albite	$NaAlSi_3O_8$
Orthoclase	$KAlSi_3O_8$
Anorthite (plagioclase)	$Ca_2Al_2Si_2O_8$
Kaolinite	$Al_2Si_2O_5(OH)_4$
Muscovite	$KAl_2\ AlSi_3O_{10}(OH)_2$
Mariposite (Cr-phengite)	$K(Al,Cr)_{1.5}(Mg,Fe)_{0.5}Al_{0.5}Si_{3.5}O_{10}(OH)_2$

c) SULFATES	FORMULA
Barite	$BaSO_4$
Gypsum	$CaSO_4{\cdot}2H_2O$
Anhydrite	$CaSO_4$

Table B 1 continued

3. WEATHERING MINERALS

a) OXIDES/HYDROXIDES	FORMULA
Hematite	Fe_2O_3
Goethite	$FeO(OH)$
Ferrihydrite	$Fe_2O_3 \cdot 2FeOOH \cdot 2.6H_2O$
Cuprite	Cu_2O
Tenorite	CuO
Gibbsite	$Al(OH)_3$
Boehmite, diaspore	$AlO(OH)$
Bunsenite	NiO
Theophrastite	$Ni(OH)_2$

b) SULFATES	FORMULA
Antlerite	$Cu_3(SO_4)(OH)_4$
Brochantite	$Cu_4(SO_4)(OH)_6$
Gypsum	$CaSO_4 \cdot 2H_2O$
Melanterite	$Fe^{II}SO_4 \cdot 7H_2O$
Rozenite	$Fe^{II}SO_4 \cdot 4H_2O$
Szomolnokite	$Fe^{II}SO_4 \cdot H_2O$
Halotrichite	$Fe^{II}Al_2(SO_4)_4 \cdot 22H_2O$
Coquimbite	$Fe^{III}_2(SO_4)_3 \cdot 9H_2O$
Copiapite	$Fe^{II}Fe^{III}_4(SO_4)_6(OH)_2 \cdot 20H_2O$
Ferricopiapite	$Fe^{III}_5(SO_4)_6O(OH) \cdot 20H_2O$
Schwertmannite	$Fe^{III}_8O_8(OH)_6SO_4$
Rhomboclase	$Fe^{III}(H_3O)(SO_4)_2 \cdot 3H_2O$
Jarosite	$KFe^{III}_3(SO_4)_2(OH)_6$
Alunite	$KAl_3(SO_4)_2(OH)_6$
Jurbanite	$Al(SO_4)(OH) \cdot 5H_2O$
Anglesite	$PbSO_4$
Goslarite	$ZnSO_4 \cdot 7H_2O$

c) ARSENATES & ANTIMONATES	FORMULA
Scorodite	$Fe^{III}AsO_4 \cdot 2H_2O$
Mansfieldite	$AlAsO_4 \cdot 2H_2O$
Pharmacosiderite	$KFe^{III}_4(AsO_4)_3(OH)_4 \cdot 6\text{-}7H_2O$
Beudantite	$PbFe^{III}_3(AsO_4)(SO_4)(OH)_6$
Stibiconite	$Sb_3O_6(OH)$
Bindheimite	$Pb_2Sb_2O_6(O,OH)$

d) HALIDES	FORMULA
Calomel	$HgCl$
Chlorargyrite	$AgCl$
Atacamite, paratacamite	$Cu_4Cl_2(OH)_6$

e) CARBONATES	FORMULA
Azurite	$Cu_3(CO_3)_2(OH)_2$
Malachite	$Cu_2(CO_3)(OH)_2$
Cerussite	$PbCO_3$
Smithsonite	$ZnCO_3$

APPENDIX C

APPENDIX C
TYPICAL MINERAL PROCESSING METHODS

Ore from hardrock mining, with few exceptions, must be "beneficiated" prior to further processing. Beneficiation, commonly referred to as "milling," is the processing of ores for the purpose of regulating the size of the desired product; removing unwanted constituents; and improving the quality, purity, or assay grade of a desired product.

Ore processing methods may be as simple as washing, screening, and drying, as in the case of sand and gravel, or highly complex as in multi-product flotation of copper, lead, zinc, silver, and gold ores. This appendix will briefly describe four typical processing methods: gravity milling, amalgamation, two-product flotation, and heap and vat leaching.

GRAVITY MILLING

Gravity mills often are used to separate heavy minerals such as garnet, ilmenite, and scheelite, or heavy metals such as gold from waste rock. Depending on the nature of the ore, the process may or may not include a flotation circuit.

The following description and flowsheet of a typical gravity mill are repeated from Camm 1991, p. 24b (see Figure C-1):

Mined ore is initially crushed by a jaw crusher. The discharge is sent to a double-deck screen where the 3/4 inch fraction discharges onto a conveyor belt and is fed to a cone crusher. The minus 3/4 inch fraction from the jaw and cone crusher is conveyed to vibrating screens. Oversize from the screens is returned to the cone crusher and the undersize is slurried and fed to the jig.

Tails from the jig go to the rod mill where grinding occurs in closed circuit with a cyclone classifier. Overflow from the cyclone is pumped to a spiral classifier. Size fractions from the classifier are sent to a series of tables to produce a high-grade concentrate, a middling product, and tailings. The middlings are combined and recycled though the rod mill.

Table concentrates are sent to a flotation cell where any sulfides present are floated off. Underflow from the float cell is combined with the concentrates from the jig and then thickened and dried. Tailings are thickened and sent to the tailings pond.

AMALGAMATION

The amalgamation gold recovery method has been used throughout the world for hundreds, perhaps thousands, of years. In the United States it was commonly used from colonial times until the 1960s and was widely used in conjunction with sluice operations or associated with stamp mills or other methods of liberating free gold from the host rock.

Gold (and other metals), when brought into contact with metallic mercury, will "amalgamate", i.e., the liquid mercury will bind with the surface gold to form a mercury-coated particle which has surface properties similar to those of pure mercury. The amalgamated particles will coalesce or cling together much as drops of pure mercury will collect into a single puddle. When mercury has amalgamated as much as possible, the result is a gray plastic mass or "amalgam". When heated in a retort, the mercury is distilled off leaving behind metallic gold (called sponge gold).

Large amalgamation operations commonly used amalgamation plates for recovering gold. Copper plates heavily coated with mercury (copper also amalgamates with mercury) were commonly used. Placer material or crushed gold ore is washed over the plate(s) as a thin pulp. The heavy gold particles fall to the bottom and are amalgamated by the mercury. When the mercury is saturated with gold, it is scraped off and new mercury applied to the plates. The amalgam is squeezed through canvas or chamois to remove excess mercury prior to retorting. Mercury vapor from the retort is condensed and reused. Amalgamation of high-grade ore or concentrates often was accomplished by agitation with mercury in a revolving barrel (barrel amalgamation).

Smaller operations and individual miners often placed liquid mercury directly into sluices or gold pans. When the mercury was saturated, it often was heated in the pan over an open fire, thereby discharging mercury vapor directly into the atmosphere. Eventually the mercury vapor condensed to a liquid and fell onto vegetation, the ground, or into surface waters. In many instances, metallic mercury was, by accident or inefficient operating procedures, spilled on the ground or washed into streams or other surface waters.

It could be argued that mercury contamination, because of its toxicity, persistence, and historical wide-spread use, presents the greatest chemical hazard world-wide when considering mineral process-related contamination.

Indications of possible amalgamation operations include, but are not limited to; wooden or metal troughs up to several meters in length ("long toms"- the troughs may or may not have cleats or "riffles" at regular intervals normal to the longitudinal axis), large copper trays attached to sluices or troughs, the presence of mercury flasks, liquid mercury in adjacent streams or other surface waters, stamp mills, Chilean mills, or arrastres.

FLOTATION

Flotation is a method of mineral separation in which a number of reagents (frothers, activators, depressants, collectors, and conditioners) modify the surface properties of finely crushed minerals such that one or more type of mineral adheres to gas bubbles and floats while the remainder stay in the aqueous suspension in an enclosed flotation cell. The process is particularly suitable for base metal sulfides.

The following description of a two-product flotation mill and associated flowsheet is repeated from Camm 1991, p. 22 (see Figure C-2):

Ore is initially crushed and sized in a series of crushers and vibrating screens to approximately minus 1.6 cm (5/8 in). Crushed ore is then ground in rod mills and passed through cyclones. The oversize is ground in ball mills then pumped back to the cyclones to achieve a minus 200 mesh flotation feed. Cyclones' undersize is sent to the first product rougher flotation cells. These rougher concentrates pass to cleaner cells where they are further concentrated. Tails from the cleaner cells and middlings from the rougher cells are recirculated through the first flotation circuit. Concentrates from the cleaner cells are thickened and dried prior to stockpiling for shipment.

Tails from the first product rougher cells flow to the second flotation circuit. Rougher concentrates are further treated in the second cleaner cells. As with the first product circuit, tails from the cleaner cells and middlings from the rougher cells are recirculated through the second product flotation circuit. Tails from the rougher cells are sent to the tailings pond and the concentrates are thickened, dried, and stockpiled for shipment.

Indications of a possible flotation mill include, but are not limited to the presence of flotation cells; conditioning tanks; and barrels, bins, or other containers whose markings may indicate their use for transport or storage of reagents associated with flotation operations. Common reagents used in flotation include, but are not limited to; xanthate, pine oil, sodium cyanide (NaCN), lime (calcium oxide-CaO), alum, and alcohol frothers.

HEAP AND VAT LEACHING

Heap and vat leach processes use a chemical property of cyanide, acid or other lixiviant to dissolve metals from ore. Metals contained in the cyanide solution are subsequently adsorbed on activated charcoal, stripped from the charcoal by a hot caustic solution, electroplated on steel wool cathodes, then smelted to produce a dore product (gold and silver).

Cyanide leaching processes were employed in Nevada and southern California in the early 1900s primarily to recover silver; modern leaching practices are essentially improved variations on the older methods. Today, the most widely applied leach process is the heap leach method which is generally used for lower grade oxidized gold ores. In instances where a mine has both oxide (generally lower grade) and sulfide ores (generally higher in grade), two or more processes may be used. The low-grade ore is typically processed by heap leaching, the higher grade ore by carbon-in-leach (CIL), carbon-in-pulp (CIP), or other methods. Depending on ore characteristics, cyanidation may be used by itself or in combination with other processes such as

gravity and flotation. With hard-to-process ores, including sulfide ores, other processes such as oxidation, chlorination, and autoclaving may be used in conjunction with cyanide leaching.

Run-of-mine ore is generally crushed and screened, then hauled by truck to leach pads where bulldozers are commonly used to level and contour the pile. A cyanide solution is sprayed on the ore and percolated through the heap, dissolving metal values in passing. The metal-laden solution (pregnant solution) is routed through a series of pipes or lined ditches to a pregnant solution pond. From the pond the solution is pumped or flows by gravity to the recovery plant

In the recovery plant the pregnant solution is passed through a series of tanks containing activated charcoal which adsorbs the gold. Alternatively, in the Merrill-Crowe process, metal values are precipitated from the solution using zinc dust.

When the charcoal becomes saturated, it is treated with a hot caustic solution to dissolve the gold which is then electroplated onto steel wool cathodes. The cathodes are smelted to recover gold and other metallic constituents in bullion form, referred to as "dore".

A flowsheet for a typical heap leach operation is presented in Figure C-3.

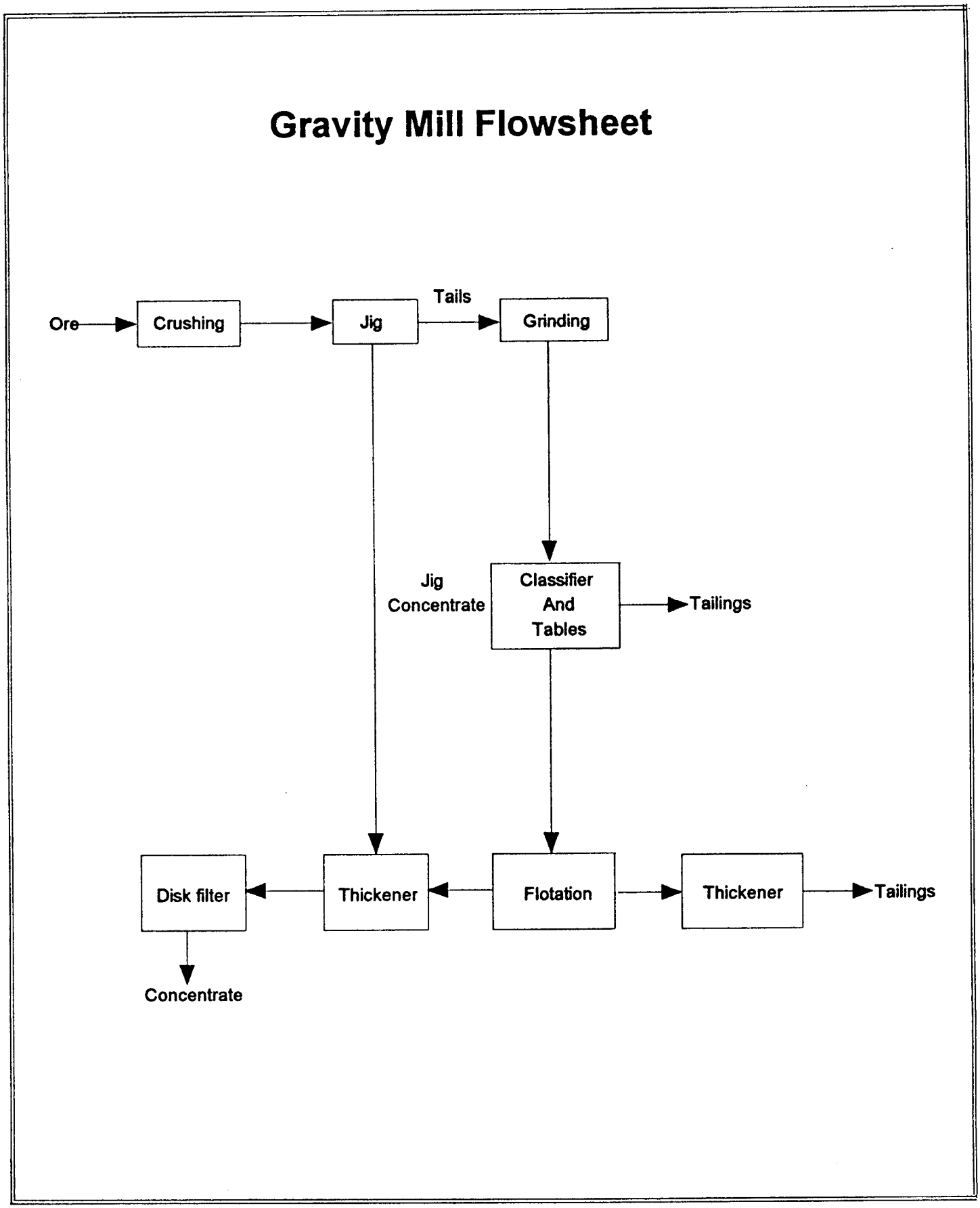

Gravity Mill Flowsheet
Ore
Crushing
Jig
Tails
Grinding
Jig
Concentrate
Classifier
And
Tables
Tailings
Disk filter
Thickener
Flotation
Thickener
Tailings
Concentrate

Figure C-1

Typical Flotation Mill Flowsheet, Two-Product

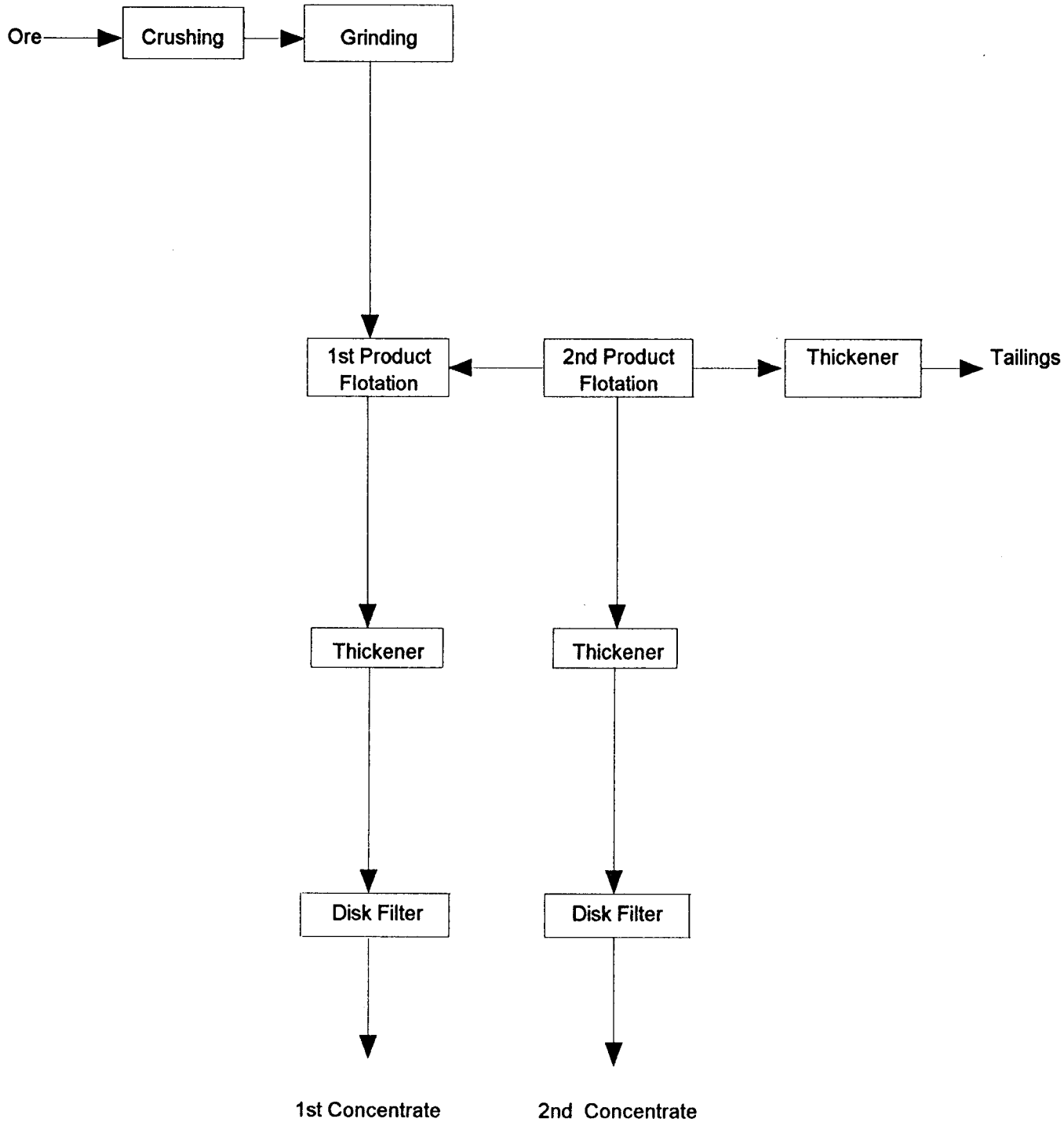


Figure C-2

VAT OR HEAP LEACH FLOWSHEET FOR GOLD

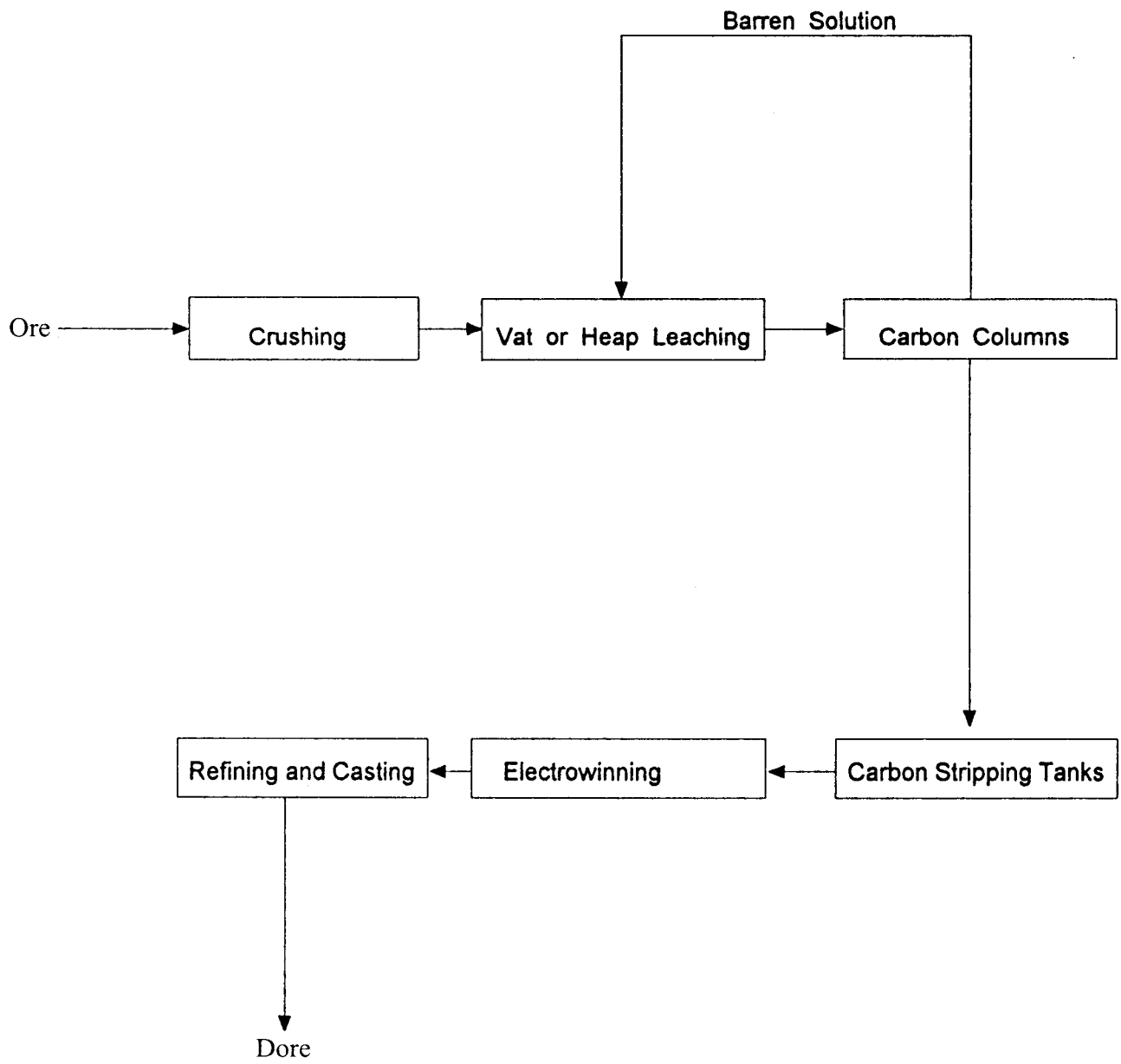


Figure C-3

APPENDIX D

APPENDIX D
SPECIFIC MINE WASTE DESCRIPTION AND SAMPLING STRATEGY

This appendix provides recommendations for sampling different types of mine wastes. In most cases the goal of the sampling effort is to identify COCs and acid generating potential. Generally, the sampling strategy developed for COCs and acid generation potential is the same (Appendix B describes the environmental effects on mine waste and will aid in understanding the dynamic nature of mine wastes).

MINE WASTE DUMPS

Waste dumps generally consist of country rock, gangue, low-grade rock, or non-mineralized rock that has been separated from the ore after blasting and hauled to the dump. The dump material ranges in size from large boulders to fine sand and is typically unsorted. The homogeneity of the waste rock depends on the geology of the deposit. In some cases, the waste rock may be all of one kind; in other cases, the waste may consist of several rock types. In addition to variations in lithology (rock type), most rocks in mineralized areas commonly have undergone varying degrees of hydrothermal alteration, which leads to significant additional heterogeneity in terms of chemical, physical, and mineralogical characteristics of waste rock. Whether the waste consists of a single rock type or several, it is usually dumped together in one pile. If one type of rock contained low-grade ore, it may have been segregated into a separate dump (stockpile) so that it could be processed at a later date. Many waste piles also served as garbage dumps and are repositories for tin cans, car parts, cables, rails, wooden ties, blasting caps, chemicals, and other discarded and potentially hazardous items.

The location of waste dump samples depends largely on the ease of obtaining a sample. Commonly, the material on the top of the dumps is compacted and overgrown. This is especially true where the waste contains abundant fine-grained material. Samples can usually be collected at, or slightly below the crest of the dump, however, if the angle of the slope is near the natural angle of repose, walking on the face can be dangerous. Another acceptable sample location is at the toe of the dump, however, the material here tends to be predominantly the larger size fractions.

Representative sampling of a waste dump during initial site investigation is nearly impossible without heavy equipment. The size and nature of most mine waste dumps allows for only near-surface sampling, unless time and equipment are available to cut a channel through the dump. However, subsurface samples should be collected if possible (using a shovel or auger, however, an auger usually cannot be used because of the large range in material size). Changes with depth are expected, as a weathering profile will generally develop and deepen with time. There is a considerable difference for many COCs between their behavior in oxidized and unoxidized zones.

If the waste material consists of several different rock types that have been segregated into separate dumps, then each dump should be sampled separately. If possible, both the oxidized and unoxidized material of each rock type should be sampled separately.

MILL TAILINGS

"Mill tailings" refer to the solid portion of the slurry waste product discharged by an ore concentrating mill. Prior to 1910, most ore was processed by a gravity separation method called jigging, which produced tailings ranging in size from 3 millimeters (mm) to 10 mm (coarse sand to fine pebbles). After 1910, flotation became the most common processing method, and the size range of the tailings decreased to fine sand to medium silt. The tailings material produced by vat leaching of gold ore is about the same size range as that produced by flotation milling. Tailings from mills that operated from the early 1900s to the 1930s or 40s may contain both jig and flotation tails. Refer to Appendix C for discussion of gravity, flotation, and other types of mineral processing.

Mill tailings may be classified as controlled or uncontrolled. Controlled tailings were deposited behind protective embankments or discharged into a pond or basin specially designed to keep the tailings out of streams. Uncontrolled tailings were dumped directly into a stream or gully, and no effort was made to restrict them. Even if the site is known to have a mill, tailings may not be present because they were deposited directly into a stream, washed away, and subsequently deposited downstream at some distance from the site. If this is suspected, it may be necessary to extend the investigation downstream of the suspected discharge point.

Mill tailings piles commonly range in size from less than 1 acre to 50 acres, and have a thickness ranging from less than 3 feet to 45 feet, depending on the size of the milling operation and the length of time the mill operated. Often a mill continued to operate as a custom mill long after closure of the mine that it was originally built to serve. If this is the case, ore from many different sites may have been processed at the mill. Mill tailings can be distinguished from waste rock by their fine-grained texture, the presence of a layering caused by differential settling of material, color (commonly orange, red-brown, gray), relatively flat surface, and topographic setting (bottom of gullies, along stream banks, behind man-made embankments).

Because of the nature of tailings deposition, only three-dimensional sampling can be considered representative of the material present. Samples collected from the near surface of a tailings pile are not representative of the entire pile because the surface material was the last material processed, and the surface material is likely to be at least partially oxidized. If a tailings pile has several levels, each level represents a different time period and must be sampled separately. During the site investigation, time must be taken to try to obtain at least one series of samples through a vertical profile of the tailings. A few discrete samples at depth would give a better picture of the composition of the tailings than would several surface samples, or a vertical composite.

The best methods for sampling tailings piles are hand auger sampling and/or trenching. Augering can be done by hand to a depth of at least six feet in moderately compacted tailings. The equipment is light enough to be transported by foot to a site. Shallow trenching requires only a shovel and pick. If the tailings are confined to a completely enclosed impoundment, augering would be the method of choice because digging a vertical trench or pit would be very time consuming, labor intensive, and depending on the thickness of the tailings, perhaps dangerous. If tailings deposition was uncontrolled, or if the impoundment has been breached by a stream resulting in exposure of a vertical section through the material, then a trench can be dug though the exposed wall and channel samples collected.

STOCKPILES

Stockpiles are dumps of selected ore-grade or sub-ore-grade material that the mine operators did not send to the mill. Random samples of this material should be collected, but care should be exercised not to bias the sample by collecting only the highest grade material. The goal is to collect enough samples to represent the distribution of material within the pile. Properly collected samples may give an indication of the character of the ore mined. It is possible that the stockpiled material was hauled from some other property.

CONCENTRATES

Concentrates are the valuable fraction of the ore that is left after the worthless material has been removed during processing in the mill. They are usually very fine-grained, dark, and heavy. Normally they would be found in the mill, or in the area where the mill once stood. This material potentially contains some of the highest heavy metal concentrations and other COCs found at abandoned mine sites.

STREAM AND LAKE/POND SEDIMENTS

Sediment sampling for the purposes of a screening evaluation can be difficult due to the dynamic nature of most deposition (e.g., storm event versus continual deposition). When a known release of mine wastes has occurred, sediment sampling can be a mechanism to trace the mine wastes back to the source. However, when no such event has occurred, sampling of sediments should be confined to areas where sediment is most likely to be deposited (lentic waters, eddies, etc.).

A comprehensive sediment profile is beyond the scope of a screening evaluation, but should be conducted if historical information indicates that a release(s) has occurred and the material released contains high levels of COCs. Sediment samples should also be collected if AMD is suspected. Samples should be collected in surface water with a range of water pH values (this will possibly identify the location of metal precipitation). A comprehensive sediment profile should be conducted by an experienced professional.

APPENDIX E

APPENDIX E
AUGERING AND TRENCHING

This appendix provides general guidance for augering and trenching. Professional judgement should be used to modify procedures based on site-specific conditions (e.g., ease of site access).

BRIEF DESCRIPTION OF HAND AUGER SAMPLING OF TAILINGS

1) Scrape away any organic material from the sampling location. Collect the top one inch of the sampling point as your surface sample.

2) Because the hollow bits are about one foot long, withdraw the auger after one foot of penetration and remove the sample by scraping out the material with a spatula or by gently hammering the outside of the bit with a wooden stick or hammer. The samples should be spread out sequentially on a plastic sheet as they are collected.

3) Be sure to clean the bit between each sample to minimize cross contamination of the samples. After the sample is scraped out of the auger bit, a stiff bristle or wire brush should clean out the residue. If the material is wet, the bit may have to be washed as well as brushed. If a stream is nearby, water can be carried to the sample sites in buckets. Take care to minimize the amount of surface material that is knocked into the hole, both during removal and insertion of the auger assembly.

4) Measure the depth of the hole before reinserting auger and continue to collect samples in the same manner. Add extensions until the bottom of the tailings is reached, or until all the extensions are used. Collect a sample of the native soil below the tailings pile if possible. If a point is reached where the auger handle cannot be turned without excessive torque, or if the auger assembly becomes very difficult to remove from the hole because of caving around the stem and bit, the hole should be abandoned, rather than break or stick the auger in the hole.

5) After the hole is completed, examine and log the sequence of samples and determine how to collect representative discrete samples. Material that is clearly different should be sampled. When logging the hole, note the following: grain size and texture, color and color changes, degree of compactness (loosely, moderately, highly), thickness of each different layer, obvious changes in mineralogy or type of material, and depth to bottom of hole or point where sampling stopped.

6) Fill all auger holes upon completion of sampling. Ideally, granular bentonite clay is the preferable filler (usually bentonite is used to prevent migration or cross contamination); however, in remote areas, scraping tailings material into the holes would be adequate in most situations.

BRIEF DESCRIPTION OF TRENCH AND CHANNEL SAMPLING OF TAILINGS

Please note that all trenching operations should fully comply with the requirements of OSHA and Cal-OSHA.

1) If possible, select a section of the tailings that shows a complete top to bottom profile. If the tailings pile has several levels, more than one trench may be necessary.

2) If the sides of the tailings pile are sloping, begin at the top of the pile, back far enough from the edge to permit digging a staircase-like trench from top to bottom. The material excavated should be cast to the side, rather than downslope, to avoid moving it more than once. The trench should proceed downslope in a step-wise fashion with the distance between steps not exceeding 2-3 feet, and the face should remain vertical. The channel should be wide enough so that a person can maneuver comfortably.

3) If the face is near vertical and the thickness exceeds five feet, then only back-hoe operations should be used for trenching. In this case, auger sampling would be preferable.

4) Once the trench is constructed, a detailed graphic log should be made of the stratigraphy of the exposed tailings, and sampling intervals selected. The different zones are much more apparent in trenches where they can be examined in place, than they are in material that has been collected by an auger. The same characteristics should be noted as were listed in step five in the section on auger sampling. Trenching permits more exact determination of the boundaries between layers and allows viewing of an entire vertical section through the tailings.

5) Once a trench has been dug, a small trowel is a convenient tool for collecting the samples. It should be thoroughly cleaned with a stiff brush between samples.

APPENDIX F

APPENDIX F
SURFACE WATER EVALUATION

It is difficult, if not impossible, to characterize the condition of surface water via any one sampling event. Surface water chemistry can change due to numerous factors including precipitation, temperature, groundwater influence, biological influence, drainage pattern as it relates to natural mineralized areas, drainage pattern as it relates to mine wastes, adit discharge, and other factors. A complete evaluation of surface water conditions should be conducted by trained hydrologists and/or limnologists. A single water sampling event offers a snapshot of water conditions at the time of sampling. In addition to water samples, the AML investigator may be able to determine if contaminated water exists using visual indicators.

During the initial site visit, the investigator can usually identify certain visual mine waste characteristics indicating acid or contaminated water. These characteristics can indicate that environmental damage is occurring. Indicators of AMD are:

- Long filamentous algae in the water of streams and drainages indicates possible contaminated waters;
- Equisetum or "horsetail", an indicator of poor soil conditions, is often observed growing at the mouth of adits with acid drainage;
- Red, orange, or yellow staining or "ochre" deposits in or adjacent to streams or drainages (including adit drainage) usually indicate deposition of iron oxides and hydroxides from acid water. Absence of this "yellow boy" is not an indication of clean water. At pH of two or less, these compounds may not precipitate;
- White, yellowish, green, or bluish salt deposits adjacent to drainages or on waste piles indicate upward or outward transportation and deposition of metal salts from ground water;
- Blue-green malachite or azurite staining on bone or woody material often comes from copper in solution depositing on these substrates;
- Dead or dying plants in or adjacent to drainages can indicate contamination from intermittent surface drainage or shallow ground water; and
- A natural stream will usually have a variety of aquatic invertebrate species living on and under rocks. A complete lack of these life forms or the existence of only one type often indicates stress which can be caused by metals contamination of the water.

The only reliable method for determining whether drainage water is contaminated is a thorough sampling and analysis of mine waters. This type of sampling is not usually within the scope of an initial site screening, but may be necessary in order to obtain a realistic view of the potential environmental hazard represented at any particular site.

Contaminant levels can vary with time over orders of magnitude at any particular location. Representative sampling of water must include several sampling events. The procedure for proper sampling, preservation, analysis, and data interpretation is complicated and should be conducted with the consultation of a trained hydrologist or limnologist.

If high sediment loading is observed (cloudy or turbid water), water samples should be collected and analyzed for total metals (water samples analyzed without being filtered) and soluble metals (water samples analyzed after being filtered). The best time to observe high sediment loading is during, or soon after, significant storm events. Deep erosion channels in mine wastes and mine wastes co-mingled in stream sediments are also evidence that sediment loading is occurring.

There are a few simple tests available to indicate whether a particular water **may** pose an environmental hazard including pH and Total Dissolved Solids. However, these analysis should not be used in lieu of complete laboratory analysis.

pH: Measurement of the water's pH using either a meter or proper pH paper can be useful for indicating whether the water is presently acidic (neutral or basic). pH is an indicator of the hydrogen ion concentration (the acidity) of the water. It ranges from 0 to 14, with 0 being extremely acidic and 14 being extremely basic, and 7 being neutral. Most natural surface water has a pH between 6.5 and 8.5. However, a neutral water does not indicate lack of contamination; water can be neutralized by natural processes after the metals have been dissolved and transported. pH probes with direct digital readout are readily available, inexpensive, and relatively easy to use. Some need calibration with standard solutions before each use while others do not. Regardless of the type of pH probe, standard solutions should be checked both before and after measurements of unknown pH as part of QA/QC procedures. pH paper dipped in the water will display a color relating to the pH; this color is compared to a chart and an estimate of pH is read. pH paper can be obtained in several pH ranges. A variety are often needed. pH measurements with pH paper are generally less reliable than those made with a calibrated pH probe and electronic meter.

Total Dissolved Solids: A measurement of the total dissolved solids (TDS) in the water can serve as another indicator of possible contamination. TDS, as the name implies, is a measure of the total amount of all constituents dissolved in the water and is typically expressed in milligrams of solids per liter of water (mg/L). Acid drainage or metals-contaminated water usually has a high TDS. A field method for measuring TDS directly is not readily available, but measurement of specific conductance of the water provides an indication of TDS (or "conductivity"). Direct digital readout conductivity meters are available and inexpensive and usually need no calibration. The meter usually reads in microsiemens per centimeter. To obtain estimates of TDS in mg/L the conductivity values must be multiplied by a conversion factor.

Natural "fresh" water, uncontaminated by metals, usually has a TDS from near zero up to 1,000 milligrams per liter (mg/L) Brackish water may have a TDS as high as 10,000 mg/L. Contaminated mine drainage water commonly contains from several hundred to several thousand milligrams per liter TDS.

Because of the large range of possible values, TDS is not a stand-alone indicator of water contamination. Specific conductance must be used along with other indicators. Note that adit drainage water with a TDS value of several hundred mg/L may not be contaminated. These measurements should be combined with field observations and chemical analyses. For example, if drainage issuing from an adit or waste dump has a TDS of 800 mg/L and a pH of 6.0, and the substrate is coated with orange iron oxide, it is a fair guess that the water could be contaminated. If this same water shows no iron oxides, but contains a large amount of long filamentous algae and all nearby waters contain this same long filamentous algae, then nothing conclusive can be noted and further investigation may be needed.

APPENDIX G

APPENDIX G
EVALUATION OF ACID GENERATING POTENTIAL

This appendix describes how acid mine drainage is formed and describes several common methods for predicting the acid generating potential. References for this appendix are provided at the end of the text if further information on acid generating potential is required.

ACID GENERATING POTENTIAL

Many mine waste materials contain sulfide minerals which can, when exposed to air and moisture, generate sulfuric acid (H_2SO_4) solutions known as acid rock drainage. The reaction between pyrite (iron disulfide), oxygen, and water is the primary acid producer. Another important reaction is the oxidation of dissolved ferrous iron, which produces dissolved ferric iron, which can oxidize pyrite and other sulfide minerals. The rate of these reactions can be accelerated significantly by the presence of iron- and sulfur-oxidizing bacteria, such as Thiobacillus ferrooxidans. Acid waters themselves can be harmful to aquatic biota and other users. Deposition of iron-oxide and oxyhydroxide sludges associated with acid waters can fill or restrict flow in streams and cover the stream substrate used by aquatic animals and plants.

As sulfide-bearing mine wastes oxidize, the acid produced can dissolve base metal sulfide minerals and release the metals to solution. The dissolved metals can then be transported by water to the surrounding environment. However, some mine waste materials will never generate AMD because the host rock contains sufficient acid-neutralizing agents to prevent deposition of iron-oxide or the acid reaction with metal sulfide minerals.

STATIC TESTS: ACID-BASE ACCOUNTING

Static tests of acid generating potential are done at a single point in time, in contrast to kinetic tests, which involve several repetitive analysis. Results of static tests are often used to predict the future evolution of drainage chemistry, but these predictions should be considered highly uncertain. The best use of static testing is as a screening tool, to identify samples having uncertain acid generation potential and requiring further testing, such as by kinetic methods. Discussion of kinetic testing is beyond the scope of this document. For additional information, see discussions by Ritcey (1989) and Morin and Hutt (1997).

Several methods of static testing are used. The most common is Acid-Base Accounting (ABA). Method EPA 600 ABA is documented by Sobek et al. (1978). Several other static methods have also been used, as described by Ritcey (1989) and Morin and Hutt (1997). A common feature of the static testing approach is that a measure of acid-generation potential is derived from the sulfur (or sulfide) content of the mine waste, and then a second test is done to provide a measure of the acid-neutralization potential. In the ABA method of Sobek et al. (1978), total sulfur is used to estimate acid potential (AP). The neutralizing potential (NP) is obtained by adding a known amount of hydrochloric acid (HCl) and titrating with a standardized base (NaOH solution) to pH 7. Net Neutralizing Potential (NNP) is defined as the difference between NP and AP (NNP=NP-AP). Thus, NNP values less than 0 are taken to indicate that waste is likely to eventually produce acidic drainage. NNP values between 0 and 20 tons $CaCO_3$ per 1000 tons of waste indicate an uncertain future, and NNP values of greater than 20 tons $CaCO_3$ per 1000 tons of waste are generally interpreted to indicate sufficient neutralizing capacity to remain alkaline or near-neutral indefinitely (Morin and Hutt, 1997).

There are numerous other ways by which data from static tests are described, including Net Potential Ratios (NPR), which assess the ratio of NP/AP. NPR values less than 1.0 generally indicate eventual acidic drainage. NPR values between 1.0 and 2.0 are in the uncertain range, and NPR values greater than 2.0 may indicate long-term alkaline or near-neutral behavior. There is apparently no consensus concerning the values of NPR and their interpretation. These data should be used as qualitative guides only.

Because of the numerous variations of static tests that have been used and the various ways in which that data are reported, one must be very cautious in interpreting results in previous reports and in comparing results from one type of test with another. Morin and Hutt (1997) provide a detailed discussion of the various kinds of static tests and their interpretation in several case studies.

SAMPLING FOR ACID GENERATING POTENTIAL

Sampling of mine waste materials for ABA is similar to that for chemical analysis. The sample for ABA can be the same size and can be taken in the same manner as those for chemical analysis. Refer to Chapter 5 and Appendices D and E for specific details. Care must be taken to keep the sample representative of the material present, particularly if only one sample is taken from any single dump or pile. One extra piece of pyrite-bearing rock or limestone in a sample could significantly affect the ABA value. Rocks and minerals in the uppermost 1-2 feet of material in a waste or tailings pile are often fully or partially oxidized. Pyrite may have been weathered to an iron oxide or sulfate and no longer have acid producing potential. ABA samples should therefore be taken deep enough within the pile to obtain non-weathered material. Some piles, exposed to sufficient moisture and air, may be oxidized through most of their depth. In this case, a weathered sample may be representative.

If the pile does not appear to be uniform (e.g., if there is a particular area of "rust" staining) each obviously different material should be sampled separately. Taking a composite sample containing all material types, even if taken in representative amounts, will not give realistic ABA numbers.

REFERENCES

Morin, K.A., and Hutt, N.M., 1997, Environmental Geochemistry of Minesite Drainage: "Practical Theory and Case Studies." MDAG Publishing, Vancouver, British Columbia, Canada, 333 pp.

Ritcey, G.M., 1989, "Tailings Management: Problems and solutions in the mining industry." Elsevier, New York, 970 pp.

Sobek, A.A., Schuller, W.A., Freeman, J.R., and Smith, R.M., 1978, "Field and Laboratory Methods Applicable to Overburdens and Minesoils." Report EPA-600/2-78-054, U.S. National Technical Information Report PB-280 495, 403 pp.

APPENDIX H

APPENDIX H
HEALTH AND SAFETY

Conducting a thorough historical background investigation will give the AML investigator insight into the potential hazards associated with a particular AML site. Some types of AML sites, such as sand and gravel operations, pose little to no chemical threats to human health, however, physical hazards may be present. Base metal AML sites have the potential to pose human health threats and the levels of heavy metals may exceed federal and state hazardous waste criteria. The property owner should insure that individuals accessing the AML site have the proper health and safety training.

The Code of Federal Regulations (CFR) and the California Code of Regulations (CCR) describe requirements for health and safety at hazardous waste sites. Specifically, 29 CFR 1910.120 and 8 CCR 5192 require that:

- Personnel receive 40 hours of classroom training and 24 hours of supervised field training concerning the hazards that may be encountered at hazardous waste sites (AML sites potentially contain concentrations of heavy metals that exceed California's hazardous waste criteria);
- Personnel participate in a medical monitoring program;
- A Site Safety Plan (SSP) must be prepared prior to personnel entering a hazardous waste site; and
- Personnel review the SSP for specific hazards concerning the site prior to initiating work.

The objective of the SSP is to ensure protection of the investigative team as well as the general public during the sampling activities. This training, while recommended, may not be necessary in all cases for all workers.

In addition to the above requirements, other useful training includes:

- First aid;
- Adult cardio-pulmonary resuscitation (CPR);
- Wild animal safety, habits, methods of avoiding encounters;
- Outdoor survival, basics of how to stay healthy while working outdoors and, in an emergency, how to survive until help arrives; and
- Mine safety training; required for all personnel who work in active mines. The course is taught by instructors who have been trained and certified by the Mine Safety and Health Administration (MSHA), U.S. Department of Labor. Although this course emphasizes active mining, many of the instructors have experience with abandoned mines and might be able to offer helpful advice.

APPENDIX I

APPENDIX I
PUBLIC PARTICIPATION

Public participation can play a key role in some AML investigations. Public participation allows the community to become informed of actions at the site, especially if the AML site requires an expedited response. Public participation also can create an open line of communication when an AML site undergoes remediation or land use change. It is important to start the public participation process early in the AML investigation if community interest is expected, because it allows the Project Proponent to make more informed decisions and reduces the potential for delays that might arise if the community objects to or does not understand an action or decision. Consult the DTSC's PEA Manual (section 2.2) or DTSC's Public Participation Policy and Procedures Manual, July 1994, for further information regarding public participation.

APPENDIX J

APPENDIX J
WASTE EXTRACTION TEST

The Waste Extraction Test (WET) analysis was developed to measure the amount of waste constituents that may be leached from wastes in a landfill. The WET is considered more stringent for wastes containing inorganic constituents than the federal Toxicity Characterization Leaching Procedure (TCLP). The WET is conducted under very controlled and specific conditions (48 hour, 10x liquid/solid dilution, citrate extraction buffer @ pH 5). However, the WET is not an absolute indicator of solubility, because solubility depends on many variables (e.g., chemical form, particle size, pH, extraction solution chemistry, etc.). **THE WET IS NOT A BIOAVAILABILITY TEST AND THE RESULTS FROM THE WET ANALYSIS SHOULD NOT BE USED TO MAKE DECISIONS ON HUMAN HEALTH.**

In general, a solid waste is hazardous if the WET extract concentration of any constituent equals or exceeds its Soluble Threshold Limit Concentration (STLC), or the total concentration of any constituent equals or exceeds its Total Threshold Limit Concentration (TTLC) or other criteria as defined in the California Health and Safety Code, Section 25117. Although there are exceptions, mine wastes are generally exempt under state and federal hazardous waste law (Chapter 6.5, Health and Safety Code, Section 25143.1 (b)(1) and 40 CFR, Section 261.4 (b)(7) respectively). However, because of the intrinsic hazard of many mining wastes, DTSC relies on its authority under State "Superfund" law (Chapter 6.8 Health and Safety Code) and US EPA relies on its authority under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)) to require removal and remediation at AML sites where mining wastes pose a hazard to human health and the environment. If a hazardous substances removal action is determined to be necessary, most likely the landfill receiving this material will require WET data.

The WET can be run on the soil samples collected for total inorganic analysis. No special sample collection protocol is required. However, if a landfill has been identified for disposal of mine wastes, it is recommended that the landfill be contacted directly to obtain their testing and disposal requirements.

The specific laboratory protocol for conducting a WET is described in Title 22, California Code of Regulations, Section 66261.126 Appendix II. The WET must be conducted by a state certified laboratory.

NOTE: It is beyond the scope of this document to discuss the details of the WET and related hazardous waste laws as they apply to secondary use of mine wastes.

APPENDIX K

APPENDIX K
THE VOLUNTARY CLEANUP PROGRAM

The California Environmental Protection Agency's Department of Toxic Substances Control (DTSC) has introduced a streamlined program to protect human health, cleanup the environment and get property back to productive use. Corporations, real estate developers, and local and state agencies entering into Voluntary Cleanup Program agreements will be able to restore properties quickly and efficiently, rather than having their projects compete for DTSC's limited resources with other low-priority hazardous waste sites. This fact sheet describes how the Voluntary Cleanup Program works.

Prior to initiation of the Voluntary Cleanup Program, project proponents had few options for DTSC involvement in cleaning up low-risk sites. DTSC's statutory mandate is to identify, prioritize, manage and cleanup sites where releases of hazardous substances have occurred. For years, the mandate meant that, if the site presented grave threat to public health or the environment, then it was listed on the State Superfund list and parties responsible conducted the cleanup under an enforcement order, or DTSC used state funds to do so. Because of staff resource limitations, DTSC was unable to provide oversight at sites which posed lesser risk or had lower priority.

DTSC long ago recognized that no one's interests are served by leaving sites contaminated and unusable. The Voluntary Cleanup Program allows motivated parties who are able to fund the cleanup–and DTSC's oversight—to move ahead at their own speed to investigate and remediate their sites. DTSC has found that working cooperatively with willing and able project proponents is a more efficient and cost-effective approach to site investigation and cleanup. There are four steps to this process:

- Eligibility and Application
- Negotiating the Agreement
- Site Activities
- Certification and Property Restoration

The rest of this fact sheet describes those steps and gives DTSC contacts.

Step 1: Eligibility and Application

Most sites are eligible. The main exclusions are if the site is listed as a Federal or State Superfund site, is a military facility, or if it falls outside of DTSC's jurisdiction, as in the case where a site contains only petroleum products or waste. Another possible limitation is if another agency currently has oversight, e.g., a county (for underground storage tanks), The Regional Water Quality Control Board (for contamination that is primarily limited to groundwater), etc. The current oversight agency must consent to transfer the cleanup responsibilities to DTSC before the proponent can enter into a Voluntary Cleanup Program agreement. Additionally, DTSC can enter into an agreement to work on a specified element of a cleanup (risk assessment or public participation, for example), if the primary oversight agency gives its consent.

If neither of these exclusions apply, the proponent submits an application to DTSC, providing details about site conditions, proposed land use and potential community concerns: no fee is required to apply for the Voluntary Cleanup Program.

Step 2: Negotiating the Agreement

Once the DTSC accepts the application, the proponent meets with experienced DTSC professionals to negotiate the agreement. The agreement can range from services for an initial site assessment, to oversight and certification of a full site cleanup, based on the proponent's financial and scheduling objectives.

The Voluntary Cleanup Program agreement specifies the estimated DTSC costs, scheduling for the project, and DTSC services to be provided. Because every project must meet the same legal and technical cleanup requirements as do State Superfund sites, and because DTSC staff provide oversight, the proponent is assured that the project will be completed in an environmentally sound manner.

In the agreement, DTSC retains its authority to take enforcement action if, during the investigation or cleanup, it determines that the site presents a serious health threat, and proper and timely action is not otherwise being taken. The agreement also allows the project proponent to terminate the Voluntary Cleanup Program agreement with 30 days written notice if they are not satisfied that it is meeting their needs.

Step 3: Site Activities

Prior to beginning any work, the proponent must have: signed the Voluntary Cleanup Program agreement; made the advance payment; and committed to paying all project costs, including those associated with DTSC's oversight. The project manager will track the project to make sure that DTSC is on schedule and within budget. DTSC will bill its costs quarterly so that large, unexpected balances will not occur.

Once the proponent and DTSC have entered into a Voluntary Cleanup Program agreement, initial site assessment, site investigation or cleanup activities may begin. The proponent will find that DTSC's staff includes experts in every vital area. The assigned project manager is either a highly-qualified Hazardous Substances Scientist or Hazardous Substances Engineer. That project manager has the support of well-trained DTSC toxicologists, geologists, industrial hygienists and specialists in public involvement.

The project manager may call on any of these specialists to join the team, providing guidance, review, comment, and, as necessary, approval of individual documents and other work products. That team will also coordinate with other agencies, as appropriate, and will offer assistance in complying with other laws, such as the Resource Conservation and Recovery Act.

Step 4: Certification and Property Restoration

When remediation is complete, DTSC will issue either a site certification of completion or a "No Further Action" letter, depending on the project circumstances. Either means that what was, "The Site," is now property that is ready for productive economic use.

To learn more about the Voluntary Cleanup Program, contact the DTSC representative in the Regional office nearest you:

Southern California
Don Johnson
1011 Grandview Avenue
Glendale, CA 91201
(818) 551-2862

North Coast California
Lynn Nakashima
700 Heinz Avenue, Suite 200
Berkeley, CA 94710-2737
(818) 551-2862

Central California
Eric Garcia
10151 Croydon Way, Suite 3
Sacramento, CA 95827
(916) 255-3709

Central California
Fresno Satellite
Tom Kovac
1515 Tollhouse Road
Clovis, CA 93612
(209) 297-3939

APPENDIX L

APPENDIX L
LIST OF STATE AND FEDERAL AGENCIES

State

California Department of Conservation

Division of Mines and Geology
Library
801 K Street
Sacramento, CA 95814
(916)445-5716

Office of Mine Reclamation
801 K Street
Sacramento, CA 95814
(916)323-9198

California Department of Fish and Game

Headquarters: 1416 Ninth Street, 12th Flr.
Sacramento, CA 95814
(916)653-7664

Region 1: Northern California-North Coast Region
601 Locust Street
Redding, CA 96001
(916)225-2300

Region 2: Sacramento Valley-Central Sierra Region
1701 Nimbus Road
Rancho Cordova, CA 95670
(916)358-2900

Region 3: Central Coast Region
7329 Silverado Trail
Napa, CA 94558
(707)944-5500

Region 4: San Joaquin Valley-Southern Sierra Region
1234 E. Shaw Avenue
Fresno, CA 93710
(209)243-4005

Region 5: Southern California- Eastern Sierra Region
330 Golden Shore, Suite 50
Long Beach, CA 90802
(562)590-5132

California Department of Toxic Substances Control

Headquarters: 400 P Street, 4th Floor
P.O. Box 806
Sacramento, CA 95812-0806
(916)324-1826

Sacramento: Office 10151 Croydon Way, Suite 3
Sacramento, CA 95827-2106
(916)255-3617

Berkeley: Office 700 Heinz Ave., Bldg. F, Suite 200
Berkeley, CA 94710
(510)540-3739

Glendale: Office 1011 N. Grandview Avenue
Glendale, CA 91201
(818)551-2830

Long Beach: Office 245 West Broadway, Suite 425
Long Beach, CA 90802
(562)590-4968

California Regional Water Quality Control Board

North Coast Region
5550 Skylane Blvd., Suite A
Santa Rosa, CA 95403
(707)576-2220

San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, CA 94612
(510)286-1255

Central Coast Region
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5427
(805)549-3147

Los Angeles Region
101 Centre Plaza Drive
Monterey Park, CA 91754-2156
(213)266-7500

Central Valley Region
3443 Routier Road
Sacramento, CA 95827-3098
(916)255-3000

Fresno Office
3614 E. Ashlan
Fresno, CA 93726
(209)445-5116

Redding Office
415 Knollcrest Drive
Redding, CA 96002
(916)224-4845

Lahontan Region
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150
(916)542-5400

Colorado River Basin Region
73-720 Fred Waring Drive, Suite 100
Palm Desert, CA 92260
(760)346-7495

Santa Ana Region
3737 Main Street, Suite 500
Riverside, CA 92501-3339
(909)782-4130

San Diego Region
9771 Clairemont Mesa Blvd., Suite A
San Diego, CA 92124
(619)467-2952

State Water Resources Control Board

901 P Street
Sacramento, CA 95814
(916)657-2390

Department of Water Resources

Division of Safety of Dams
2200 X Street, Suite 200
Sacramento, CA 95814
(916)445-7606

Federal

Bureau of Land Management

2135 Butano Drive
Sacramento, CA 95825
(916)978-4400

Forest Service

630 Sansome Street
San Francisco, CA
(415)705-2874

Natural Resources Conservation Service

2121 C Street
Davis, CA 95616
(530)757-8289
[Note: formerly Soil Conservation Service]

United States Environmental Protection Agency

Region 9
75 Hawthorne Street
San Francisco, CA 94105

General Information: 415-744-1500
PRG Information: 415-744-2419
CERCLIS Information: 415-744-2427
STORET Information: 415-744-1964
Freedom of Information Requests: 415-744-1593
Publications: 415-744-1510

United States Geological Survey

MRDS Information: Mr. Bruce R. Lipin, U.S. Geological Survey, MS954 National Center, Reston, VA 20192.
703-648-6430, e-mail <blipin@usgs.gov>

MAS/MILS Information: Mr. Donald Bleiwas, U.S. Geological Survey, P.O. Box 25046, MS750 Denver, CO 80225
303-236-8747 ext. 340, e-mail <bleiwas@usgs.gov>

Earth Science Information Center
U.S. Geological Survey
345 Middlefield Rd
Menlo Park, CA 94025
(650)329-4309

Water Resources Division
U.S. Geological Survey
6000 J Street
Placer Hall
Sacramento, CA 95819
(916)278-3100

United States Department of Health and Human Services

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE
Mailstop E-29
Atlanta, GA 30333
(800)447-1544

United States Department of Commerce

National Technical Information Service
Springfield, VA 22161
(703)487-4650