This report is one in a series of volumes published by the U.S. Environmental Protection Agency (EPA) to provide information of general interest regarding environmental issues associated with specific industrial sectors. The documents were developed under contract by Abt Associates (Cambridge, MA), and Booz-Allen & Hamilton, Inc. (McLean, VA). This publication may be **purchased** from the Superintendent of Documents, U.S. Government Printing Office. A listing of available Sector Notebooks and document numbers is included on the following page.

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Electronic versions of all Sector Notebooks are available free of charge at the following web address: **www.epa.gov/oeca/sector**. Direct technical questions to the "Feedback" button at the bottom of the web page.

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EPA/310-R-95-008

EPA Office of Compliance Sector Notebook Project

Profile of the Metal Mining Industry

September 1995

Office of Compliance
Office of Enforcement and Compliance Assurance
U.S. Environmental Protection Agency
401 M St., SW (MC 2221-A)
Washington, DC 20460

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EPA/310-R-95-003.	Wood Furniture and Fixtures Industry	Bob Marshall	564-7021
EPA/310-R-95-004.	Inorganic Chemical Industry*	Walter DeRieux	564-7067
EPA/310-R-95-005.	Iron and Steel Industry	Maria Malave	564-7027
EPA/310-R-95-006.	Lumber and Wood Products Industry	Seth Heminway	564-7017
EPA/310-R-95-007.	Fabricated Metal Products Industry*	Scott Throwe	564-7013
EPA/310-R-95-008.	Metal Mining Industry	Jane Engert	564-5021
EPA/310-R-95-009.	Motor Vehicle Assembly Industry	Anthony Raia	564-6045
EPA/310-R-95-010.	Nonferrous Metals Industry	Jane Engert	564-5021
EPA/310-R-95-011.	Non-Fuel, Non-Metal Mining Industry	Rob Lischinsky	564-2628
EPA/310-R-95-012.	Organic Chemical Industry*	Walter DeRieux	564-7067
EPA/310-R-95-013.	Petroleum Refining Industry	Tom Ripp	564-7003
EPA/310-R-95-014.	Printing Industry	Ginger Gotliffe	564-7072
EPA/310-R-95-015.	Pulp and Paper Industry	Seth Heminway	564-7017
EPA/310-R-95-016.	Rubber and Plastic Industry	Maria Malave	564-7027
EPA/310-R-95-017.	Stone, Clay, Glass, and Concrete Industry	Scott Throwe	564-7013
EPA/310-R-95-018.	Transportation Equipment Cleaning Ind.	Virginia Lathrop	564-7057
EPA/310-R-97-001.	Air Transportation Industry	Virginia Lathrop	564-7057
EPA/310-R-97-002.	Ground Transportation Industry	Virginia Lathrop	564-7057
EPA/310-R-97-003.	Water Transportation Industry	Virginia Lathrop	564-7057
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EPA/310-R-97-005.	Pharmaceuticals Industry	Emily Chow	564-7071
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EPA/310-R-97-007.	Fossil Fuel Electric Power Generation Ind.	Rafael Sanchez	564-7028
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EPA/310-R-98-004.	Agricultural Livestock Production Ind.	Ginah Mortensen	(913)551-7864
EPA/310-R-98-005.	Oil and Gas Exploration and Production Industry	Dan Chadwick	564-7054
EPA/310-R-98-008.	Local Government Operations	John Dombrowski	564-7036

*Spanish translations available.

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LIST OF EXHIBITS

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(SIC 10)
LIST OF ACRONYMS

AFS - AIRS Facility Subsystem (CAA database)
AIRS - Aerometric Information Retrieval System (CAA database)
BIFs - Boilers and Industrial Furnaces (RCRA)
BOD - Biochemical Oxygen Demand
CAA - Clean Air Act
CAAA - Clean Air Act Amendments of 1990
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS - CERCLA Information System
CFCs - Chlorofluorocarbons
CO - Carbon Monoxide
COD - Chemical Oxygen Demand
CSI - Common Sense Initiative
CWA - Clean Water Act
D&B - Dun and Bradstreet Marketing Index
ELP - Environmental Leadership Program
EPA - United States Environmental Protection Agency
EPCRA Emergency Planning and Community Right-to-Know Act
FIFRA - Federal Insecticide, Fungicide, and Rodenticide Act
FINDS - Facility Indexing System
HAPs - Hazardous Air Pollutants (CAA)
HSDB - Hazardous Substances Data Bank
IDEA - Integrated Data for Enforcement Analysis
LDR - Land Disposal Restrictions (RCRA)
LEPCs - Local Emergency Planning Committees
MACT - Maximum Achievable Control Technology (CAA)
MCLGs - Maximum Contaminant Level Goals
MCLs - Maximum Contaminant Levels
MEK - Methyl Ethyl Ketone
MSDSs - Material Safety Data Sheets
NAAQS - National Ambient Air Quality Standards (CAA)
NAFTA - North American Free Trade Agreement
NCDB - National Compliance Database (for TSCA, FIFRA, EPCRA)
NCP - National Oil and Hazardous Substances Pollution Contingency Plan
NEIC - National Enforcement Investigation Center
NESHAP - National Emission Standards for Hazardous Air Pollutants

METAL MINING
(SIC 10)
LIST OF ACRONYMS (CONT'D)

NO_X -	Nitrogen Oxide
NOV -	Notice of Violation
NPDES -	National Pollution Discharge Elimination System (CWA)
NPL -	National Priorities List
NRC -	National Response Center
NSPS -	New Source Performance Standards (CAA)
OAR -	Office of Air and Radiation
OECA -	Office of Enforcement and Compliance Assurance
OPA -	Oil Pollution Act
OPPTS -	Office of Prevention, Pesticides, and Toxic Substances
OSHA -	Occupational Safety and Health Administration
OSW -	Office of Solid Waste
OSWER -	Office of Solid Waste and Emergency Response
OW -	Office of Water
P2 -	Pollution Prevention
PCS -	Permit Compliance System (CWA Database)
POTW -	Publicly Owned Treatments Works
RCRA -	Resource Conservation and Recovery Act
RCRIS -	RCRA Information System
SARA -	Superfund Amendments and Reauthorization Act
SDWA -	Safe Drinking Water Act
SEPs -	Supplementary Environmental Projects
SERCs -	State Emergency Response Commissions
SIC -	Standard Industrial Classification
SO_2 -	Sulfur Dioxide
SX/EW -	Solvent Extraction/Electrowinning
TRI -	Toxic Release Inventory
TRIS -	Toxic Release Inventory System
TRIS -	Toxic Chemical Release Inventory System
TSCA -	Toxic Substances Control Act
TSS -	Total Suspended Solids
UIC -	Underground Injection Control (SDWA)
UST -	Underground Storage Tanks (RCRA)
VOCs -	Volatile Organic Compounds

METAL MINING
(SIC 10)

I. INTRODUCTION TO THE SECTOR NOTEBOOK PROJECT

I.A. Summary of the Sector Notebook Project

Environmental policies based upon comprehensive analysis of air, water, and land pollution are an inevitable and logical supplement to traditional single-media approaches to environmental protection. Environmental regulatory agencies are beginning to embrace comprehensive, multi-statute solutions to facility permitting, enforcement and compliance assurance, education/outreach, research, and regulatory development issues. The central concepts driving the new policy direction are that pollutant releases to each environmental medium (air, water, and land) affect each other, and that environmental strategies must actively identify and address these inter-relationships by designing policies for the "whole" facility. One way to achieve a whole facility focus is to design environmental policies for similar industrial facilities. By doing so, environmental concerns that are common to the manufacturing of similar products can be addressed in a comprehensive manner. Recognition of the need to develop the industrial "sector-based” approach within the EPA Office of Compliance led to the creation of this document.

The Sector Notebook Project was initiated by the Office of Compliance within the Office of Enforcement and Compliance Assurance (OECA) to provide its staff and managers with summary information for eighteen specific industrial sectors. As other EPA offices, States, the regulated community, environmental groups, and the public became interested in this project, the scope of the original project was expanded. The ability to design comprehensive, common sense environmental protection measures for specific industries is dependent on knowledge of several inter-related topics. For the purposes of this project, the key elements chosen for inclusion are: general industry information (economic and geographic); a description of industrial processes; pollution outputs; pollution prevention opportunities; Federal statutory and regulatory framework; compliance history; and a description of partnerships that have been formed between regulatory agencies, the regulated community, and the public.

For any given industry, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue, and references where more in-depth information is available. Text within each profile was researched from a variety of sources, and was usually condensed from more detailed sources pertaining to specific topics. This approach allows for a wide coverage of activities that can be further explored based upon the citations and references listed at the end of this profile. As a check on the information included, each notebook went through an external review process. The Office of Compliance appreciates the efforts of all those that participated in this process and enabled us to develop more complete, accurate, and up-to-date summaries. Many of those who reviewed this notebook are listed as contacts in Section IX and may be sources of additional information. The individuals and groups on this list do not necessarily concur with all statements within this notebook.

I.B. Additional Information

Providing Comments

OECA's Office of Compliance plans to periodically review and update the notebooks and will make these updates available both in hard copy and electronically. If you have any comments on the existing notebook, or if you would like to provide additional information, please send a hard copy and computer disk to the EPA Office of Compliance, Sector Notebook Project, 401 M St., SW (2223-A), Washington, DC 20460. Comments can also be uploaded to the Enviroene Bulletin Board or the Enviroene World Wide Web for general access to all users of the system. Follow instructions in Appendix A for accessing these data systems. Once you have logged in, procedures for uploading text are available from the on-line Enviroene Help System.

Adapting Notebooks to Particular Needs

The scope of the existing notebooks reflect an approximation of the relative national occurrence of facility types that occur within each sector. In many instances, industries within specific geographic regions or States may have unique characteristics that are not fully captured in these profiles. For this reason, the Office of Compliance encourages State and local environmental agencies and other groups to supplement or re-package the information included in this notebook to include more specific industrial and regulatory information that may be available. Additionally, interested States may want to supplement the "Summary of Applicable Federal Statutes and Regulations" section with State and local requirements. Compliance or technical assistance providers may also want to develop the "Pollution Prevention" section in more detail. Please contact the appropriate specialist listed on the opening page of this notebook if your office is interested in assisting us in the further development of the information or policies addressed within this volume.

If you are interested in assisting in the development of new notebooks for sectors not covered in the original eighteen, please contact the Office of Compliance at 202-564-2395.

Because this profile was not intended to be a stand-alone document concerning the metal mining industry, appended is a full reference of additional EPA documents and reports on this subject, as listed in the March edition of the Federal Register.

II. INTRODUCTION TO THE METAL MINING INDUSTRY

This section provides background information on the size, geographic distribution, employment, production, sales, and economic condition of the metal mining industry. The type of facilities described within the document are also described in terms of their Standard Industrial Classification (SIC) codes.

II.A. Introduction, Background, and Scope of the Notebook

The metal mining industry includes facilities engaged primarily in exploring for metallic minerals, developing mines, and ore mining. These ores are valued chiefly for the metals they contain, which are recovered for use as constituents of alloys, chemicals, pigments, or other products. The industry sector also includes ore dressing and beneficiating operations. The categorization corresponds to the Standard Industrial Classification (SIC) code 10, published by the Department of Commerce to track the flow of goods and services within the economy.

The SIC 10 group consists of the following three-digit breakout of industries:

SIC 101 - Iron Ores
SIC 102 - Copper Ores
SIC 103 - Lead and Zinc Ores
SIC 104 - Gold and Silver Ores
SIC 106 - Ferroalloy Ores, Except Vanadium
SIC 108 - Metal Mining Services
SIC 109 - Miscellaneous Metal Ores.

Although the group includes all metal ore mining, the scope of mining industries with a significant domestic presence is concentrated in iron, copper, lead, zinc, gold, and silver. These represent the most common hardrock minerals mined domestically, and comprise an essential sector of the nation's economy by providing basic raw materials for major sectors of the U.S. economy. In addition, the extraction and beneficiation of these minerals generate large amounts of wastes. For these reasons, this profile's focus is limited to the above-stated sectors of the SIC 10 metal mining industry.

While such metals as molybdenum, platinum, and uranium are also included in SIC code 10, mining for these metals does not constitute a significant portion of the overall metal mining industry, nor of the waste generation in mining processes; these metals are therefore excluded from this profile.

In the global market, the U.S. is a major producer of iron, copper, lead, zinc, gold, and silver. In 1993, domestic mines were responsible for six percent of iron ore production, 13 percent of copper ore production, 13 percent of lead production, eight percent of zinc production, 14 percent of gold production, and 11 percent of silver production. Despite an extraordinary wealth of domestic metal sources, with the exception of gold, the U.S. is a net importer of all the above-mentioned metals.

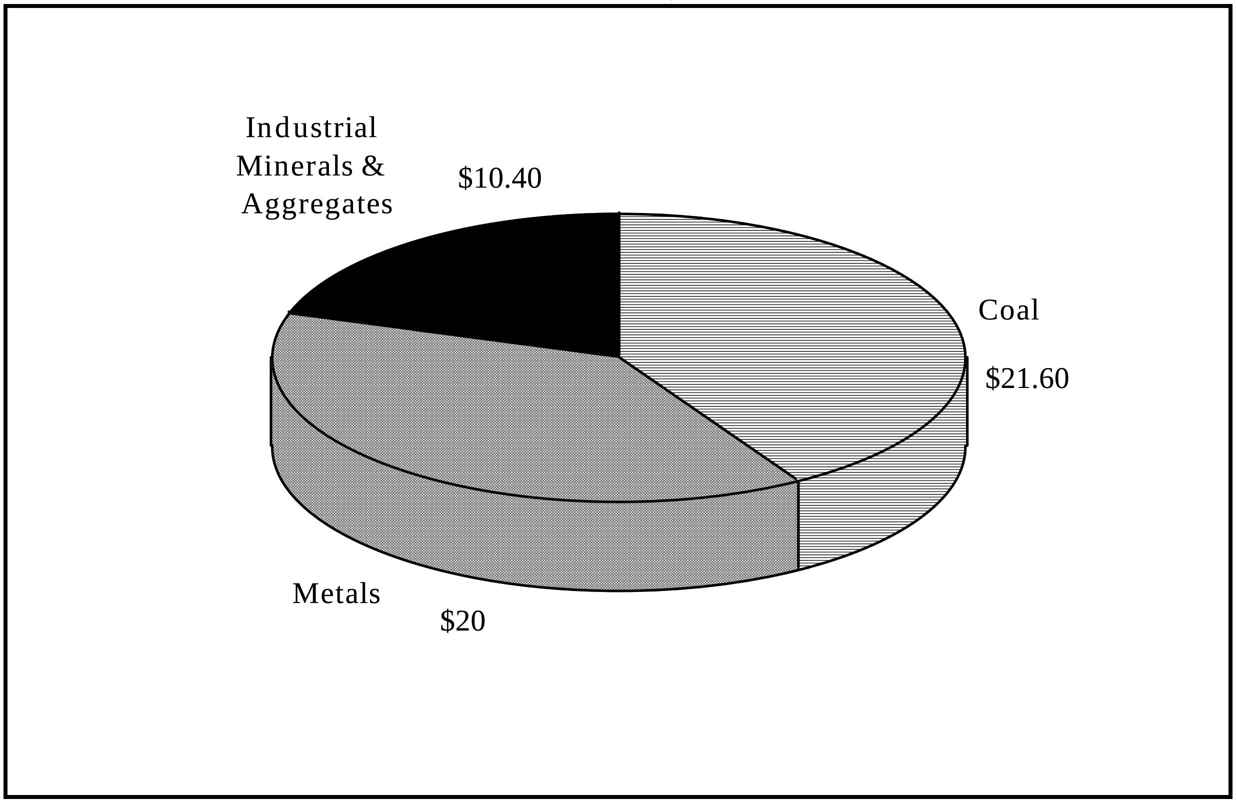
Regulations pertaining to the industry are numerous, but an emphasis is placed on point source discharges to waters, regulated by the Clean Water Act. These industries also face existing and future regulation under the Clean Water Act, Comprehensive Environmental Response, Compensation and Liability Act, and the Clean Air Act. Unlike manufacturing facilities, facilities involved in mining metals are not currently required to report chemical releases and transfers to the Toxic Release Inventory (TRI) Public Release Database under the Emergency Planning and Community Right-To-Know Act of 1986. As a result, TRI data is not available as a source of information on chemical releases in the metal mining industry; alternative sources of data have been identified for purposes of this profile.

II.B. Characterization of the Metal Mining Industry

The metal mining industry is predominantly located in the Western States, where most copper, silver, and gold mining occurs. Iron ore production is centered in the Great Lakes region, while zinc mining occurs in Tennessee and lead mining in Missouri. Large companies tend to dominate mining of such metals as copper, silver, and gold, while more diverse mine operators may be involved in mining lead, zinc, and iron metals. Metals generated from U.S. mining operations are used domestically in a wide range of products, including automobiles, electrical and industrial equipment, jewelry, and photographic materials. Metal mine production has remained somewhat stagnant over recent years, and metals exploration has declined, although future production is expected to climb as a result of continued industrial manufacturing and a growing economy.

The following exhibit depicts the proportion of metal mining production within the entire mining industry.

Exhibit 1
Total Mine Production - USA, in Billions of Dollars



Source: Randol Mining Directory 1994/95.

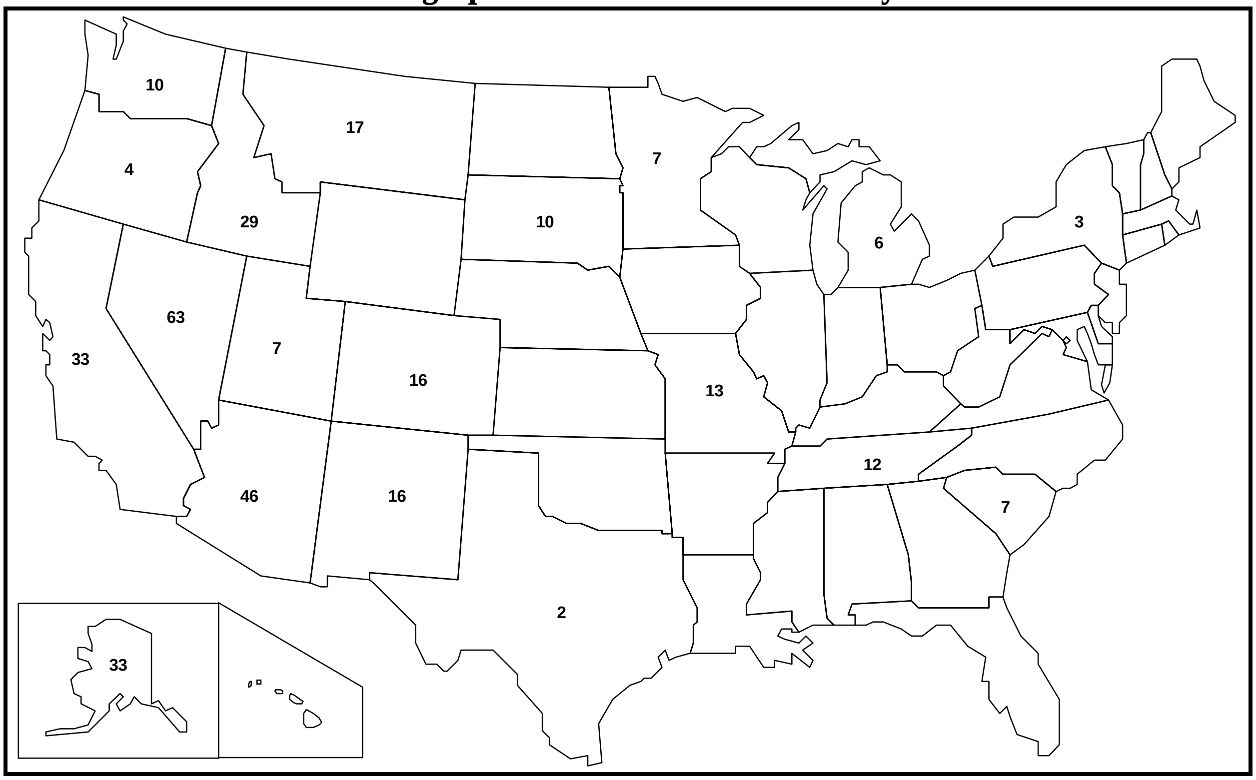
II.B.1. Industry Size and Distribution

Variation in facility counts occur across data sources due to many factors, including reporting and definition differences. This document does not attempt to reconcile these differences, but rather reports the data as they are maintained by each source.

Geographic Distribution

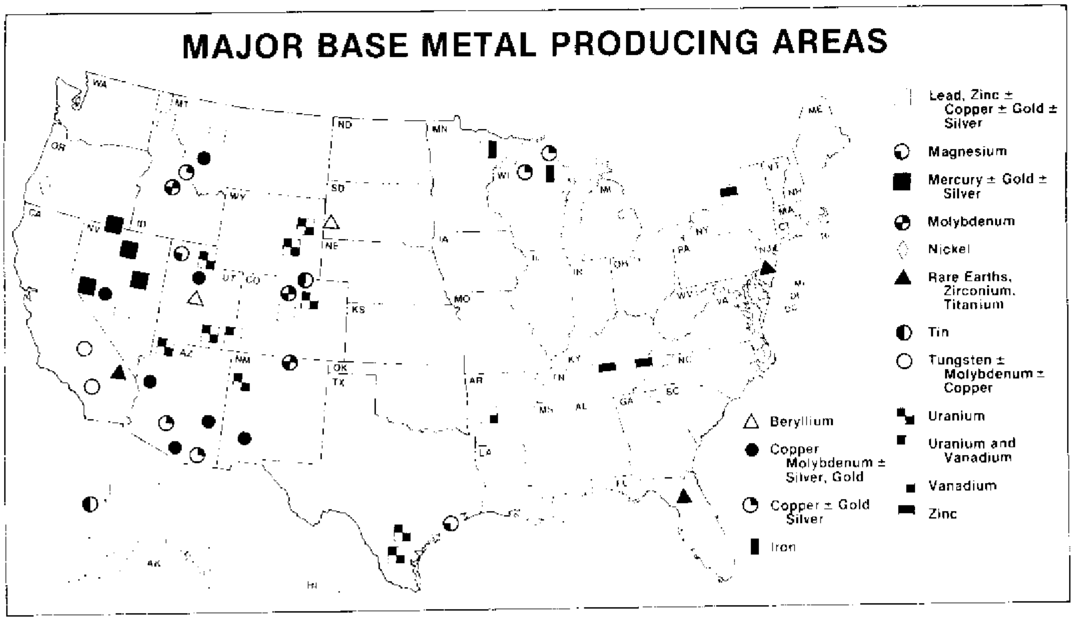
Though mining operations are performed throughout the U.S., the concentration of metal mining is located in the Western region of the country. Copper, gold, and silver deposits are primarily found in Utah, Montana, Nevada, California, and Arizona. Zinc is mined primarily in Alaska, Missouri, New York, and Tennessee. Lead deposits are mined primarily in Missouri, Alaska, Colorado, Idaho, and Montana, while Minnesota and Michigan are the primary sources of domestic iron ore production. The U.S. Bureau of Mines lists 482 active mines in its 1994 Mineral Commodity Summaries. (See Exhibits 2, 3, and 4). Exhibit 5 illustrates the number of facilities performing metal-specific operations by State.

Exhibit 2
Geographic Distribution of Industry



Source: Based on U.S. Bureau of Mines 1992 and 1994 Data.

Exhibits 3 & 4
Metal-Producing Areas



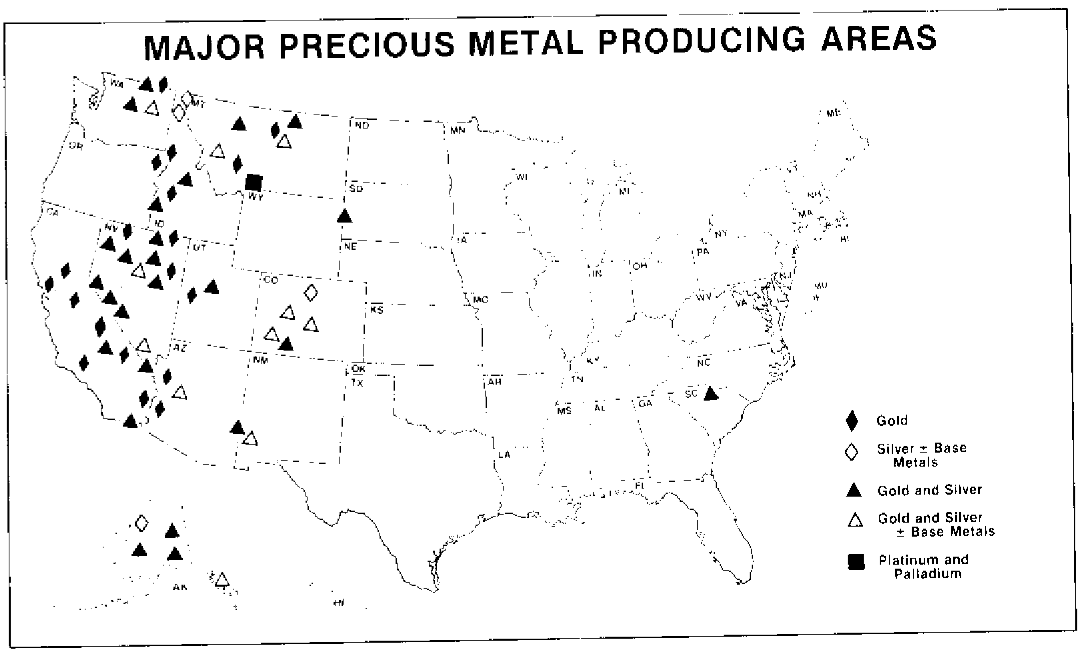


Exhibit 5
Number of Facilities per State

Type of Facility/ Total Number	States and Number of Mines
Iron Ore (22)	MI-2; MN-7; MT-1; SD-1; TX -2; UT-2
Silver (150)	AK-15; AZ-15; CA-14; CO-4; ID-12; MI-1; MT-9; NV-1; NY-1; OR-1; SC-3; SD-4; UT-4; WA-4
Gold (212)	AK-13; AZ-14; CA-19; CO-7; ID-11; MT-9; NM-5; NV-61; OR-2; SC-4; SD-5; WA-4; UT-2
Lead (23)	AK-2; AZ-1; CO-2; ID-1; IL-1; MO-7; MT-2; NM-2; NY-2; TN-2; WA-1
Zinc (25)	AK-3; CO-1; ID-2; MO-4; MT-1; NY-2; TN-10; WA-1
Copper (50)	AZ-16; CO-2; ID-3; MI-3; MO-2; MT-3; NM-9; NV-1; OR-1; UT-1

Source: U.S. Bureau of Mines 1992 and 1994 Data.

Metals mined under SIC 10 are used for a wide variety of products, and are the primary raw materials used in many industrial applications. As noted in a series of Technical Resource Documents prepared by EPA's Office of Solid Waste, copper is essential to the electronics and construction industry; iron ore provides the base material for the steel, automotive, and transportation industries; gold is used primarily in jewelry and the decorative arts, but is also used in the electronics industry and in dentistry. Gold also serves as an important investment vehicle and reserve asset. All of these metals are essential to the operation of a modern economy. Exhibit 6 provides a more detailed list of the uses for these metals.

Exhibit 6
Major Uses for Selected Metal Minerals

Commodity	Number of Mines	Major Uses	Total U.S. Production (metric tons)
Copper	50	Building construction, electrical and electronic products, industrial machinery and equipment, transportation equipment, and consumer and general products	1,765,000
Gold	212+	Jewelry and arts, industrial (mainly electronic), dental	329
Iron Ore	22	Steel	55,593,000
Lead	23	Transportation (batteries, fuel tanks, solder, seals, and bearings); electrical, electronic, and communications uses	398,000
Silver	150	Photographic products, electrical and electronic, electroplated ware, sterling ware, and jewelry	1,800
Zinc	25	Galvanizing, diecast alloys, brass, and bronze	524,000

Source: U.S. Bureau of Mines, Mineral Commodity Summaries 1994, and Minerals Yearbook, Volume I: Metals and Minerals, 1992.

II.B.2. Economic Trends

The estimated U.S. metal mine production value for 1993 was $12.15 billion, accounting for less than one percent of gross national product. In 1993, the total employment in the metal mining industry stood at nearly 50,000 according to the National Mining Association (See Exhibit 7 for the distribution of employment by facility size). Motor vehicle manufacturing helped support demand for materials such as steel (an iron alloy), copper, lead, and zinc. However, mining production volumes remained relatively stagnant. In some cases, ore production was down (lead - four percent; iron ore - one percent; zinc - four percent; silver - six percent). The other principal metal ore industries, copper and gold, remained even with 1992 production levels. Metals production in general is expected to increase, due to anticipated continued growth in the motor vehicle industry.

Exhibit 7
Facility Size Distribution

Type of Facility*	Facilities w/ 1 - 9 employees	Facilities w/ 10 - 99 employees	Facilities w/ 100 + employees	Total
SIC 1021 - Copper	102	30	24	156
SIC 1031 - Lead and Zinc	40	8	16	64
SIC 1041 - Gold	586	122	53	761
SIC 1011 - Iron	81	14	11	106
SIC 1044 - Silver	73	9	2	84

Source: Dun and Bradstreet, 1993.

**Note: Sources define the term "facility" differently, which causes the apparent disparity between those totals cited above and those accounted for by the U.S. Bureau of Mines. Represented in these facility numbers are recreational mine operators predominantly located in Alaska, California, and Montana.*

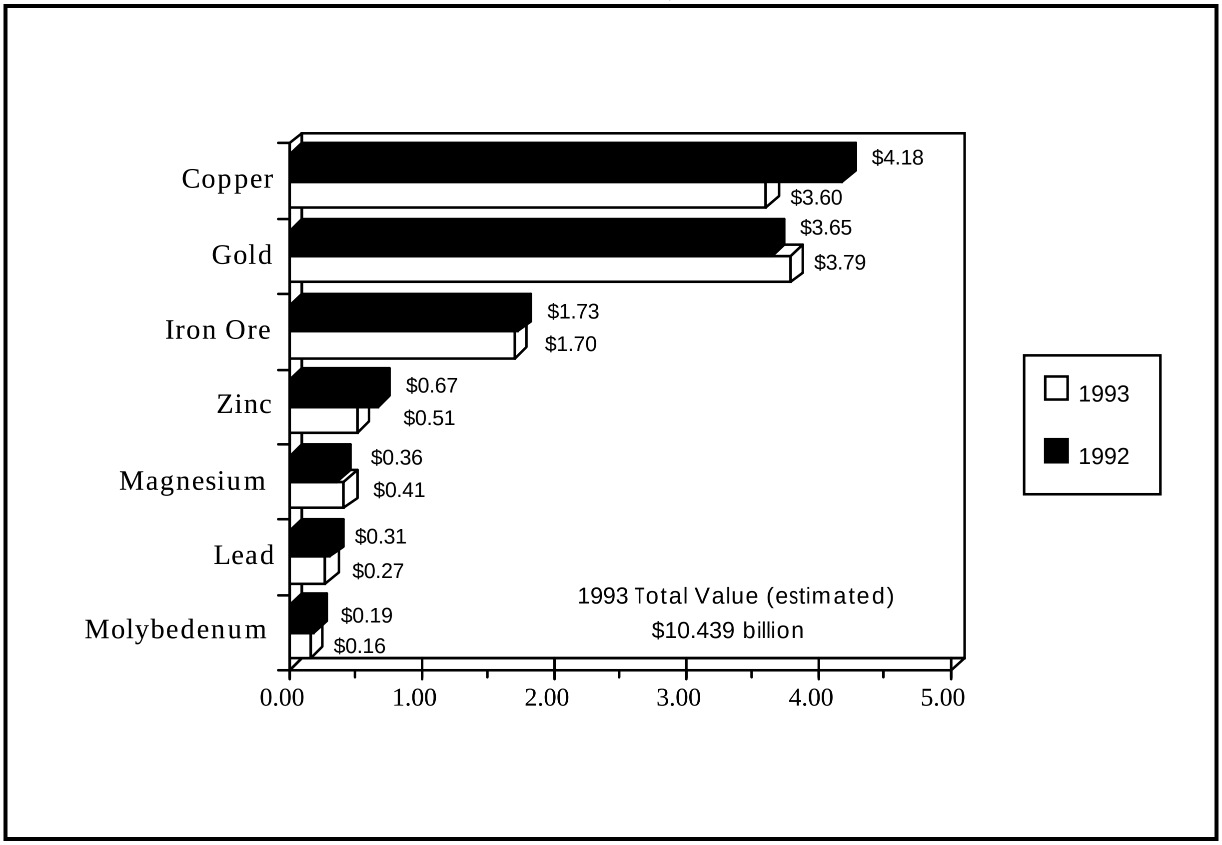
A preliminary evaluation of 1992 survey responses from 36 Canadian and 25 U.S. mineral companies operating in the U.S. suggests that the average corporate exploration budget was reduced by more than one-half from 1991 levels. Metal exploration in the U.S. during 1992 appears to have declined on an average company basis by more than 60 percent. Although specific gold and copper deposits continue to command attention, most U.S. programs have been curtailed. The BLM estimated that 75 percent of company claims were dropped during 1993 (Federal mining law grants sole mineral rights to a prospector if there is a discovery of economic value; prior to such a discovery, a "claim" is honored if the prospector maintains an actual presence on site and completes a progressive amount of developmental work per year).

The number of companies that have shifted portions of their exploration budgets to Latin America is growing. More than 250 companies, about 10 percent of the North American mining exploration industry, are now active in Latin America, especially Mexico and Chile. Among the forces driving U.S. companies abroad is the recent privatization of world-class mineral deposits, the presence of rich overseas ore deposits, depletion of prime domestic ore sources, labor costs, and the lack of significant regulatory pressure in the developing world.

The U.S. economy's slow but steady growth rate of the last several years is expected to spur demand in major domestic materials-consuming industries, such as the auto industry. In addition, developing economies in South America and Asia have had higher consumption of mineral materials as political regimes have liberalized their economies to meet demands for higher standards of living.

The following exhibit illustrates production values in 1993 for various metal mining industry sectors.

Exhibit 8
Metal Mine Production - USA, in Billions of Dollars



Source: Randol Mining Directory 1994/95.

Following is a brief summary of current trends in domestic mining industries. Much of the information presented is based on a report prepared by EPA's Office of Research and Development.

Iron

In 1993, domestic production of iron ore remained at approximately the same level as that of 1992. The value of usable ore shipped from mines in Minnesota, Michigan, and six other States in 1993 was estimated at $1.7 billion. Iron ore was produced domestically by 16 companies operating 22 mines, 16 concentration plants, and 10 pelletizing plants. The mines included 19 open pits and one underground operation. Nine of these mines, operated by six companies, accounted for the vast majority of the output.

The U.S. steel industry was the primary consumer of iron ore, accounting for 98 percent of domestic iron ore consumption in 1992. Domestic demand for iron ore has fallen behind that for iron and steel due to changes in industrial processes, including the increased use of scrap (especially by mini-mills) and the use of imported semi-finished steel. Twelve percent of domestic iron consumption in 1993 was imported. While world consumption of iron ore increased slightly, prices declined for the third consecutive year.

Copper

World copper production remained at approximately the same level in 1993 as in 1992, while world consumption of refined copper declined. However, refined copper demand in the U.S. and Canada ran counter to the world trend. Domestic demand for copper rose by approximately eight percent in 1993; the U.S. imported six percent of its copper needs in 1993. Consumption was expected to increase in 1994 to more than 2.4 million tons, up from the previous year's 2.3 million tons. Domestic brass mills (a mixture of copper and zinc) ran at capacity.

Copper was recovered at 50 mines in 1993, and the top 15 mines accounted for more than 95 percent of production. The primary end uses for copper are building construction (42 percent), electrical and electronic products (24 percent), industrial machinery and equipment (13 percent), transportation equipment (11 percent), and consumer and general products (10 percent).

According to Standard & Poor's, the copper mining industry is dominated by three producers (ASARCO Incorporated, Cyprus Amax Mining Company, and Phelps Dodge), which are financially viable operations. However, not all copper mining firms are as healthy financially. From 1989 to 1992, the industry was characterized by decreasing operating revenues and net income, while short and long-term liabilities increased for some companies. With the recent economic recovery, however, the overall outlook for the copper industry is financially secure.

Lead

The U.S. imported 15 percent of its lead needs in 1993. Transportation is the major end use for lead, with approximately 83 percent being used to produce batteries, fuel tanks, solder, seals, and bearings. Electrical, electronic, and communications uses, ammunition, TV glass, construction, and protective coatings accounted for more than nine percent of lead consumption.

According to the U.S. Bureau of Mines, U.S. lead production has remained relatively constant through 1994, while prices for lead continued an upward trend that began in 1993. Consumption of lead in the U.S. increased in 1994, due to greater demand for original equipment batteries in the automotive industry. This trend is expected to continue.

Zinc

In 1993, the U.S. imported 26 percent of its zinc needs. Domestically, 25 zinc mines produced 99 percent of the output; Alaska's Red Dog Mine accounted for nearly one-half of the total. Zinc's main use has traditionally been to provide corrosion protection through galvanization for iron and steel. In 1991, the largest consumers of zinc were the construction (43 percent), transportation (20 percent), machinery (12 percent), and electrical (12 percent) sectors.

Domestic mine production increased substantially in 1994 in response to domestic demand, according to the U.S. Bureau of Mines. The largest growth occurred in the galvanizing and brass and bronze industries, due to increased automobile production. Exports of zinc concentrates were up slightly in 1994.

Gold

Domestic gold mines continue to produce at record levels, maintaining the U.S. position as the world's second largest gold-producing nation (12 percent of world resources), after the Republic of South Africa. The U.S was a net exporter of gold in 1993. Gold was produced at 200 lode mines and numerous placer mines (see discussion below for definition of lode and placer mines). Twenty-five mines yielded 75 percent of the gold produced. Estimated end-uses for 1993 were as follows: jewelry and arts (70 percent); industrial (mainly electronic; 23 percent); and dental (seven percent).

The gold mining industry is dominated by a few firms that are gaining an increasing portion of the market share and that remain financially strong. Smaller firms have seen decreasing operating revenues and net incomes, and may have greater difficulty in the future meeting short-term debt. The trend in gold exploration activities continues to be toward Latin American nations, where favorable geology and liberalized mining regulations hold the promise for greater long-term success and reduced risk to investment capital.

Silver

Continuing the trend begun in 1991, several large domestic silver producers halted mining operations in 1993 due to the continuing low price of silver. As a result, U.S. mine production of silver declined for the fourth consecutive year, and three major silver producers had negative net income. Silver prices have recently begun to rise, however; with the prospect of continued higher prices, some companies are considering resuming operations at currently inactive mines.

The U.S. is a net importer of silver. One hundred and fifty mines in 14 States mined silver in 1993. However, Nevada, Idaho, Arizona, and Montana accounted for 74 percent of all domestic production. Estimated end-uses for 1993 were as follows: photographic products (50 percent); and electrical and electronic products (20 percent).

III. Industrial Process Description

This section describes the major industrial processes within the metal mining industry, including the materials and equipment used, and the processes employed. The section is designed for those interested in gaining a general understanding of the industry, and for those interested in the inter-relationship between the industrial process and the topics described in subsequent sections of this profile -- pollutant outputs, pollution prevention opportunities, and Federal regulations. This section does not attempt to replicate published engineering information that is available for this industry. Refer to Section IX for a list of available reference documents.

This section describes commonly used production processes, associated raw materials, the byproducts produced or released, and the materials either recycled or transferred off-site. This discussion, coupled with schematic drawings of the identified processes, provide a concise description of where wastes may be produced in the process. This section also describes the potential fate (air, water, land) of these waste products.

III.A. Industrial Processes in the Metal Mining Industry

Much of the following information has been presented previously in reports and issue papers drafted in support of various EPA offices, including the Office of Solid Waste, the Office of Pollution Prevention and Toxics, and the Office of Enforcement and Compliance Assurance. For a complete listing of reference documents, please see Section IX.

Metals are mined from two types of deposits. The first, lode deposits, are concentrated deposits that are fairly well-defined from surrounding rock. Iron, copper, lead, gold, silver, and zinc are mined mainly from lode deposits. The second type of deposits, placer deposits, occur with sand, gravel, and rock; they are usually deposited by flowing water or ice, and contain metals that were once part of a lode deposit. Only a small percentage of domestic gold and silver is derived from placer deposits.

There are three general approaches to mining metals:

Surface or **open-pit mining** requires extensive blasting, as well as rock, soil, and vegetation removal, to reach lode deposits. Benches are cut into the walls of the mine to provide access to progressively deeper ore, as upper-level ore is depleted. Ore is removed from the mine and transported to milling and beneficiating plants for concentrating the ore, and smelting, and/or refining. Open pit mining is the primary domestic source of iron, copper, gold, and silver.

Underground mining entails sinking a shaft to reach the main body of ore. "Drifts," or passages, are then cut from the shaft at various depths to access the ore, which is removed to the surface, crushed, concentrated, and refined. While underground mines do not create the volume of overburden waste associated with surface mining, some waste rock must still be brought to the surface for disposal. Waste rock may either be returned to the mine as fill or put in a disposal area. In the U.S., only lead, antimony, and zinc are solely underground operations.

Solution or fluid mining entails drilling into intact rock and using chemical solutions to dissolve lode deposits. During solution mining, the leaching solution (usually a dilute acid) penetrates the ore, dissolving soluble metals. This pregnant leach solution is then retrieved for recovery at a solvent extraction and electrowinning (SX/EW) plant. This method of mining is used in some parts of Arizona, Nevada, and New Mexico to recover copper.

Historically, the primary mining method has been underground mining. However, with the advent in recent decades of large earth moving equipment, less expensive energy sources, and improved extraction and beneficiation technologies, surface mining now prevails in most industry sectors. Open-pit mining is generally more economical and safer than underground mining, especially when the ore body is large and the overburden (surface vegetation, soil, and rock) relatively shallow. In fact, the lower cost of surface mining has allowed much lower-grade ores to be exploited economically in some industry sectors.

Metal mining processes include extraction and beneficiation steps during production. Extraction removes the ore from the ground, while beneficiation concentrates the valuable metal in the ore by removing unwanted constituents. Often, more than one metal is targeted in beneficiation processes. For example, silver is often beneficiated and recovered with copper. The beneficiation method selected varies with mining operations and depends on ore characteristics and economic considerations.

The following sections provide more detail on extraction methods and beneficiation processes, as they relate to the mining of each metal.

Extraction Processes

As described in a report drafted for EPA's Office of Pollution Prevention and Toxics, extraction involves removing any overburden, then drilling, blasting, and mucking the broken ore and waste rock.

Mobile rigs drill holes in rock, which can then be filled with explosives for blasting waste rock and ore. Potential pollutants involved in this step in the mining process include the fuel, lubricants, and hydraulic oils consumed by the rigs; fuels and oils typically contain such constituents as benzene, ethylbenzene, and toluene.

Explosives (usually a mixture of ammonium nitrate and fuel oil) are used to break up the rock. Other explosives, including trinitrotoluene (TNT) and nitroglycerine, may also be used.

Mucking is the process of removing broken ore from the mine, using a variety of loading and hauling equipment to transport ore to a mill for beneficiation. Depending on ore volume, trucks, rail cars, conveyers, and elevators may all be required to haul ore. Equipment involved in this step of the mining process uses hydraulic fluid (containing glycol ethers); batteries (containing sulfuric acid, lead, antimony, and arsenic); and lubricants and fuel (containing petroleum hydrocarbons).

Beneficiation Methods

Ore beneficiation is the processing of ores to regulate the size of the product, to remove unwanted constituents, or to improve the quality, purity, or grade of a desired product. Under regulations drafted pursuant to the Resource Conservation and Recovery Act (40 CFR §261.4), beneficiation is restricted to the following activities: crushing; grinding; washing; dissolution; crystallization; filtration; sorting; sizing; drying; sintering; pelletizing, briquetting; calcining to remove water and/or carbon dioxide; roasting, autoclaving, and/or chlorination in preparation for leaching; gravity concentration; magnetic separation; electrostatic separation; flotation; ion exchange; solvent extraction; electrowinning; precipitation; amalgamation; and heap, dump, vat, tank, and *in situ* leaching.

The most common beneficiation processes include gravity concentration (used only with placer gold deposits); milling and floating (used for base metal ores); leaching (used for tank and heap leaching); dump leaching (used for low-grade copper); and magnetic separation. Typical beneficiation steps include one or more of the following: milling;

washing; filtration; sorting; sizing; magnetic separation; pressure oxidation; flotation; leaching; gravity concentration; and agglomeration (pelletizing, sintering, briquetting, or nodulizing).

Milling extracted ore produces uniform-sized particles, using crushing and grinding processes. As many as three crushing steps may be required to reduce the ore to the desired particle size. Milled ore in the form of a slurry is then pumped to the next beneficiation stage.

Magnetic separation is used to separate iron ores from less magnetic material, and can be classified as either high- or low-intensity (requiring as little as 1,000 gauss or as much as 20,000). Particle size and the solids content of the ore slurry determine which type of magnetic separator system is used.

Flotation uses a chemical reagent to make one or a group of minerals adhere to air bubbles for collection. Chemical reagents include collectors, frothers, antifoams, activators, and depressants; the type of reagent used depends on the characteristics of a given ore. These flotation agents may contain sulfur dioxide, sulfuric acid, cyanide compounds, cresols, petroleum hydrocarbons, hydrochloric acids, copper compounds, and zinc fume or dust.

Gravity concentration separates minerals based on differences in their gravity. The size of the particles being separated is important, thus sizes are kept uniform with classifiers (such as screens and hydrocyclones).

Thickening/filtering removes most of the liquid from both slurried concentrates and mill tailings. Thickened tailings are discharged to a tailings impoundment; the liquid is usually recycled to a holding pond for reuse at the mill. Chemical flocculants, such as aluminum sulfate, lime, iron, calcium salts, and starches, may be added to increase the efficiency of the thickening process.

Leaching is the process of extracting a soluble metallic compound from an ore by selectively dissolving it in a solvent such as water, sulfuric or hydrochloric acid, or cyanide solution. The desired metal is then removed from the "pregnant" leach solution by chemical precipitation or another chemical or electrochemical process. Leaching methods include "dump," heap," and "tank" operations. Heap leaching is widely used in the gold industry, and dump leaching in the copper industry.

The following exhibit summarizes the various processes used within each mining sector, and the primary wastes associated with those processes.

Exhibit 9
Sector-Specific Processes and Wastes/Materials

Sector	Mining Type	Beneficiation/Processing	Primary Wastes/Materials
Gold-Silver	• Surface • Underground • *In Situ* (experimental)	• Cyanidation • Elution • Electrowinning / zinc precipitation • Milling • Base metal flotation • Smelting • Amalgamation (historic)	• Mine water * • Overburden / waste rock • Spent process solutions • Tailings • Spent Ore
Gold Placer	• Surface	• Gravity separation •Roughing, cleaning, fine separation • Some magnetic separation	• Mine water* • Overburden / waste rock • Tailings
Lead-Zinc	• Underground (exclusively)	• Milling • Flotation • Sintering • Smelting	• Mine water* • Overburden / waste rock • Tailings • Slag
Copper	• Surface • Underground • *In Situ*	• Milling • Flotation • Smelting • Acid leaching • SX / EW recovery • Iron precipitation / smelting	• Mine water* • Overburden / waste rock • Tailings • Slag • Spent ore • Spent leach solutions
Iron	• Surface (almost exclusively) • Underground	• Milling • Magnetic separation • Gravity separation • Flotation • Agglomeration • Blast furnace	• Mine water* • Overburden / waste rock • Tailings • Slag

** Note: Mine water is a waste if it is discharged to the environment via a point source*
Source: U.S. EPA, Office of Solid Waste, Technical Document, Background for NEPA Reviewers: Non-Coal Mining Operations.

Below is a more detailed discussion of the various beneficiation methods and processes used for each of the sectors presented in the table above.

Iron Ore

Typical beneficiation steps applied to iron ore include: milling, washing, sorting, sizing, magnetic separation, flotation, and agglomeration. Milling followed by magnetic separation is the most common beneficiation sequence used, according to the American Iron Ore Association. Flotation is primarily used to upgrade the concentrates generated from magnetic separation, using frothers, collectors, and antifoams.

Steel mills generally agglomerate or pelletize the iron ore concentrates to improve blast furnace operations that utilize iron ore. Pelletizing operations produce a moist pellet (often using clay as a binder), which is then hardened through heat treatment. Agglomeration generates by-products in the form of particulates and gases, including compounds such as carbon dioxide, sulfur compounds, chlorides, and fluorides. These emissions are usually treated using cyclones, electrostatic precipitators, and scrubbing equipment. These treatment technologies generate iron-containing effluent, which is recycled into the operation. Agglomeration produces large volumes of sulfur dioxide and nitrogen dioxide.

Copper

Copper is commonly extracted from surface, underground, and, increasingly, from *in situ* operations. According to the U.S. Bureau of Mines, surface mining accounted for 83 percent of copper production in 1992, with underground mining accounting for the remainder. *In situ* mining is the practice of percolating dilute sulfuric acid through ore to extract copper, by pumping copper-laden acid solutions to the surface for solvent extraction/electrowinning (SX/EW). This leaching operation uses both ammonium nitrate and sulfuric acid.

Beneficiation of copper consists of crushing and grinding; washing; filtration; sorting and sizing; gravity concentration; flotation; roasting; autoclaving; chlorination; dump and *in situ* leaching; ion exchange; solvent extraction; electrowinning; and precipitation. The methods selected vary according to ore characteristics and economic factors; approximately half of copper beneficiation occurs through dump leaching, while a combination of solvent extraction/froth flotation/electrowinning is generally used for the other half. Often, more than one metal is the target of beneficiation activities (silver, for example, is often recovered with copper).

According to EPA's Office of Solid Waste *Technical Resource Document*, copper is increasingly recovered by solution methods, including dump and *in situ* leaching. Because most copper ores are insoluble in water, chemical reactions are required to convert copper into a water-soluble form; copper is recovered from a leaching solution through precipitation or by SX/EW. Solution beneficiation methods account for approximately 30 percent of domestic copper production; two-thirds of all domestic copper mines use some form of solution operations. Typical leaching agents used in solution beneficiation are hydrochloric and sulfuric acids. Microbial (or bacterial) leaching is used for low-grade sulfide ores, however this type of leaching is much slower than standard acid leaching and its use is still being piloted.

Dump leaching is a method of treating copper ore that has been extracted from a deposit, and refers to the leaching of oxide and low-grade sulfide ore on (typically) unlined surfaces. These operations involve the application of leaching solution, collection of pregnant leach solution (PLS), and the extraction of copper by SX/EW or cementation. Natural precipitation or mine water is generally used to leach low grade sulfide ore, while dilute sulfuric acid is commonly used to leach oxide ores. Copper dump leaches are massive, ranging in height from 20 to hundreds of feet, covering hundreds of acres, and containing millions of tons of ore. Dump leaching operations may take place over several years.

The solvent extraction process is a two-stage method; in the first stage, low-grade, impure leach solutions containing copper, iron, and other base-metal ions are fed to the extraction stage mixer-settler. In the mixer, the aqueous solution contacts an active organic extractant in an organic diluent (usually kerosene), forming a copper-organic complex; impurities are left behind in the aqueous phase. The barren aqueous solution, called raffinate, is typically recirculated back to the leaching units while the loaded organic solution is transferred from the extraction section to the stripping section. In the second stage, the loaded organic solution is stripped with concentrated sulfuric acid solution to produce a clean, high-grade solution of copper for electrowinning. Electrowinning is the method used to recover copper from the electrolyte solution produced by solvent extraction.

Exhibits 10 and 11 illustrate a typical dump leach operation and a representative solution-based process for recovering copper from ore. Variations exist in exact methods and processes used at each operation.

Exhibit 10
Copper Dump Leach Operation

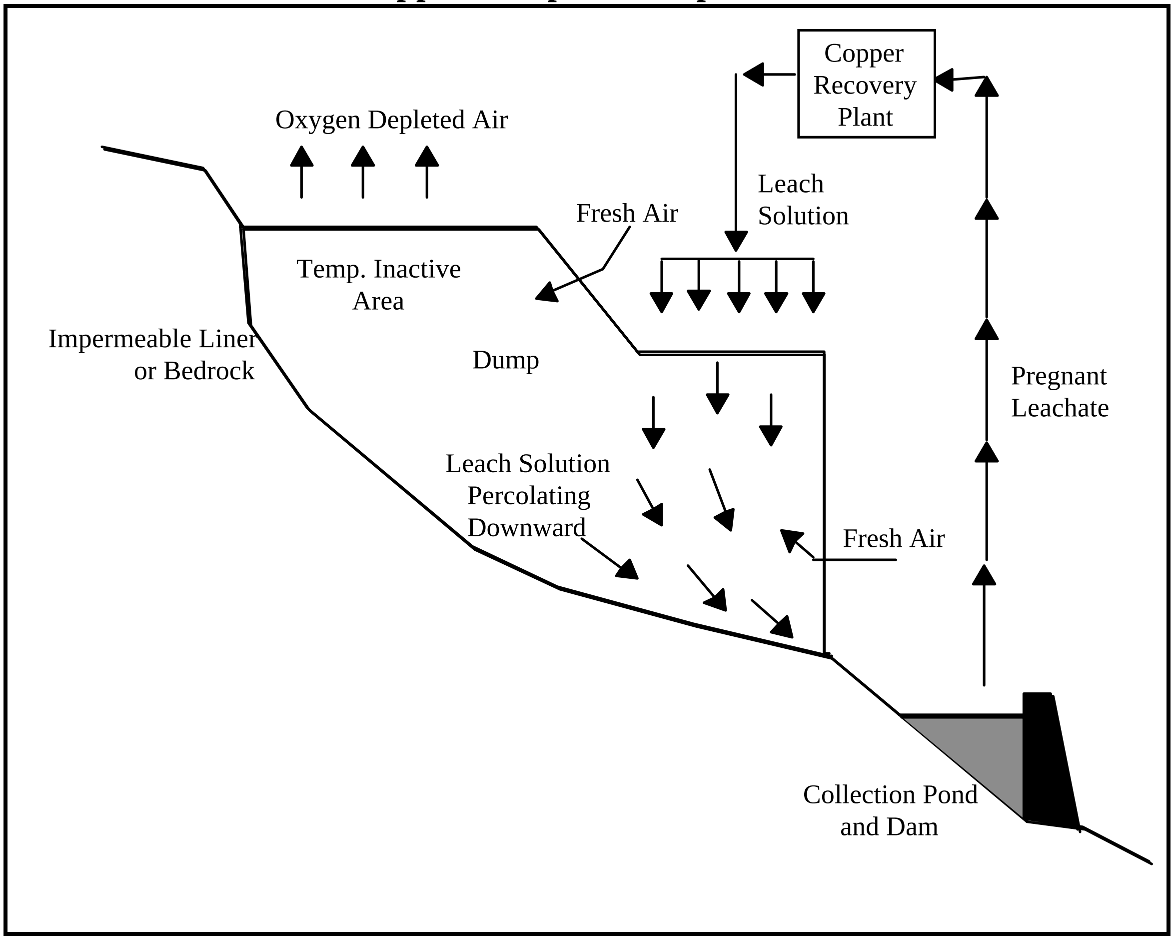
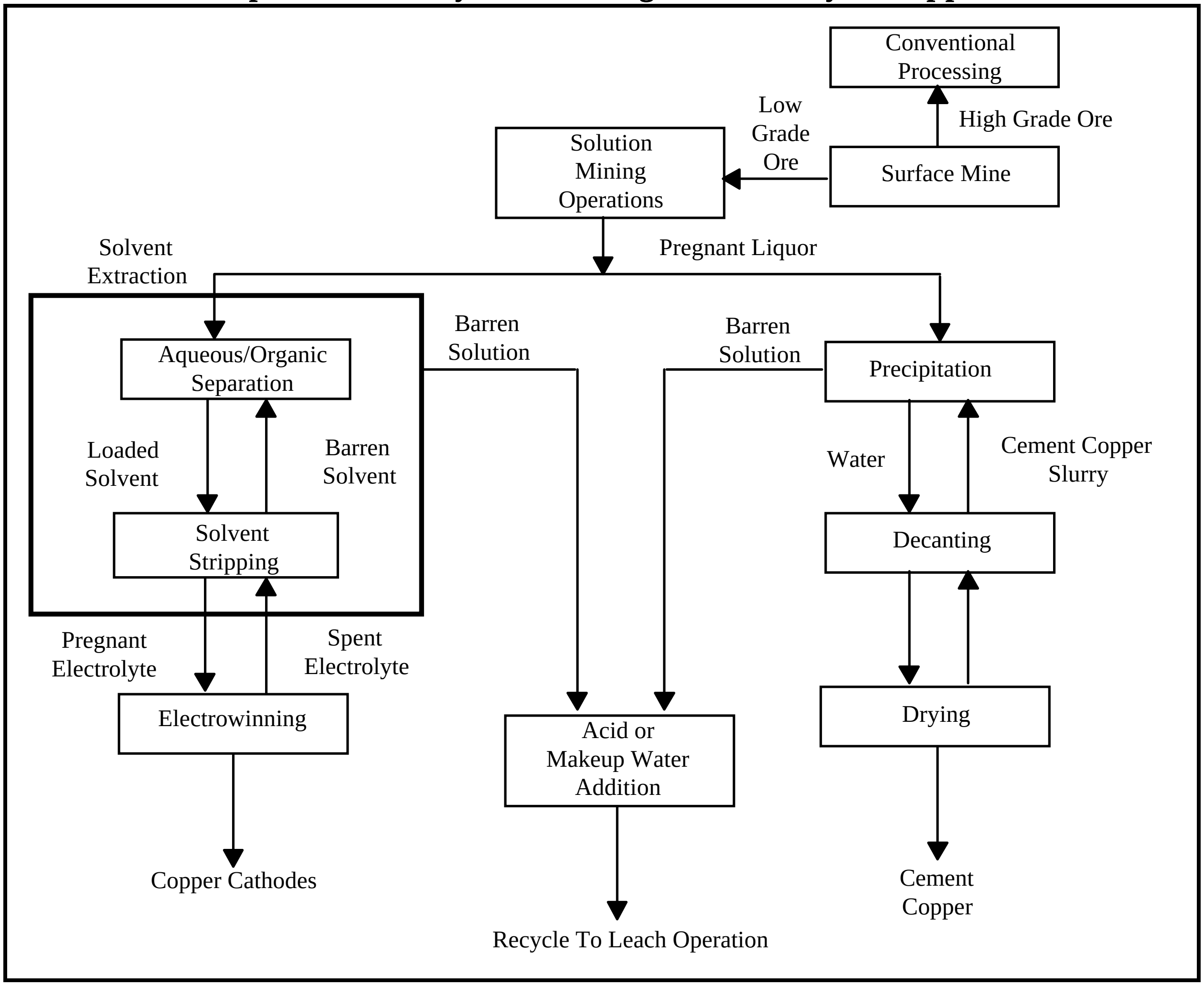


Exhibit 11
Representative Hydrometallurgical Recovery of Copper



Source: *Technical Resource Document: Extraction and Beneficiation of Ores and Minerals, Volume 4, Copper, August 1994 U.S. EPA.*

Lead and Zinc

Beneficiation of lead and zinc ores includes crushing and grinding; filtration; sizing; flotation; and sintering of concentrates. Flotation is the most common method for concentrating lead-zinc minerals. Ore may be treated with conditioners during or after milling to prepare the ore pulp for flotation. Common conditioners may include lime, soda ash, caustic soda, or sulfuric acid. The conditioned ore is then slurried in fresh or salt water with chemical reagents to beneficiate the ore. Several separate flotation steps may be needed to concentrate individual metal values from the ore. Reagents used in the flotation processes typically include such chemicals as sulfur dioxide, zinc sulfate, coal tar, copper sulfate, and sodium or calcium cyanide.

Lead and zinc mineral concentrates that will be smelted and refined may require sintering, typically performed at the smelter site. Sintering partially fuses the ore concentrates into an agglomerated material for processing, and involves several steps. First, ore concentrates are blended with moisture and then fired (sintered) and cooled. During cooling, the sinter is crushed, graded, and further crushed to produce a smaller sinter product. By-products of the roasting and sintering processes include sulfur dioxide, nitrogen dioxide, and carbon monoxide. Residues generated also include dust and primary lead process water.

Gold and Silver

Three principal techniques are used to process gold and silver ore: cyanide leaching, flotation of base metal ores followed by smelting, and gravity concentration. According to the U.S. Bureau of Mines, cyanide leaching generated 88 percent of all domestic lode gold in 1991, and 38 percent of silver. Processing of base metal ores produced 11 percent of the gold; over half of the silver produced in 1991 was from smelting concentrates produced by flotation of silver and base metal ores. Gravity concentration is used primarily by gold and silver placer operations.

Cyanide leaching is a relatively inexpensive method of treating gold ores and is the chief method in use. In this technique, sodium or potassium cyanide solution is either applied directly to ore on open heaps or is mixed with a fine ore slurry in tanks; heap leaching is generally used to recover gold from low-grade ore, while tank leaching is used for higher grade ore.

Compared to tank leaching, **heap leaching** has several advantages, including simplicity of design, lower capital and operating costs, and shorter start-up times. Depending on the local topography, a heap or a valley fill method is typically employed. The size of heaps and valley fills can range from a few acres to several hundred. Heap leaching may involve any or all of the following steps:

- Preparation of a pad with an impervious liner. Some liners may simply be compacted soils and clays, while others may be of more sophisticated design, incorporating clay liners, french drains, and multiple synthetic liners.
- Placement of historic tailings, crushed ore, or other relatively uniform and pervious material on the uppermost liner to protect it from damage by heavy equipment or other circumstances.

- Crushing and/or agglomerating the ore.
- Placing the ore on the pad(s).
- Applying cyanide solution using drip, spray, or pond irrigation systems, with application rates generally between 0.5 and 1.0 pounds of sodium cyanide per ton of solution. This is known as the barren solution because it contains little or no gold.
- Collecting the solution via piping laid on the liner, ditches on the perimeter of the heap, or pipes/wells laid through the heap into sumps at the liner surface. The recovered pregnant solution, now laden with gold (and silver), may be stored in ponds or routed directly to tanks for gold recovery, or it may be reapplied to the heap for additional leaching.
- Recovering the gold from the pregnant solution (typically containing between 1 and 3 ppm of gold).

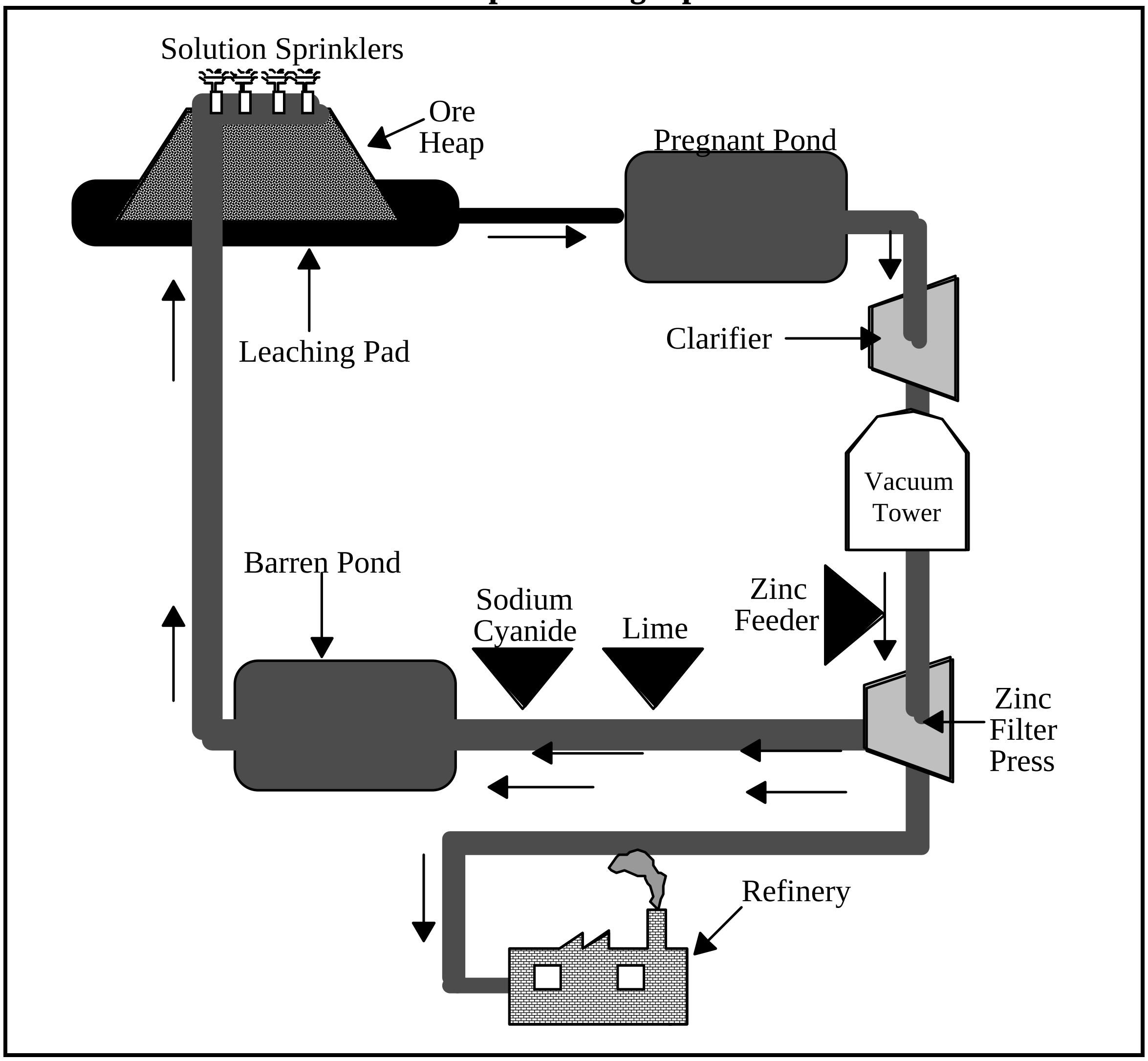
The leaching cycle can range from weeks to several months, depending on permeability, size of the pile, and ore characteristics. The average leach cycle is approximately three months.

Recovery of gold from the pregnant solution is accomplished using carbon adsorption or, less commonly, by direct precipitation with zinc dust. These techniques may be used separately or in a series with carbon adsorption followed by zinc precipitation. Both methods separate the gold-cyanide complex from other remaining wastes. Carbon adsorption involves pumping the pregnant solution into a series of activated carbon columns, which collect gold from the cyanide leachate. The precious metals are then stripped from the carbon by elution with the use of a boiling caustic cyanide stripping solution, or similar solution. Gold in the pregnant eluate solution may be electrowon or zinc precipitated.

Although carbon adsorption/electrowinning is the most common method of gold recovery domestically, zinc precipitation is the most widely used method for gold ore containing large amounts of silver. In zinc precipitation, pregnant solution (or the pregnant eluate stripped from carbon) is filtered and combined with metallic zinc dust resulting in a chemical reaction which generates a gold precipitate. The solution is then forced through a filter that removes the gold.

The following exhibit illustrates a typical gold heap leach operation using zinc precipitation; variations exist in exact processes and methods used at each operation.

Exhibit 12
Gold Heap Leaching Operation



Source: U.S. EPA, Office of Enforcement and Compliance Assurance.

To prepare for **tank leaching**, ore is ground to expose the metal values to the cyanide. Finely ground ore is slurried with the leaching solution in tanks. The resulting gold-cyanide complex is then adsorbed on activated carbon. The pregnant carbon then undergoes elution, followed either by electrowinning or zinc precipitation, as described previously. The recovery efficiencies attained by tank leaching are significantly higher than for heap leaching. The tank leaching process may occur over a series of days, rather than the weeks or months required in heap leaching.

After heap leaching and rinsing, the spent ore becomes waste and is left as is or is deposited in disposal areas similar to those used for waste rock. Spent ore may contain wastewater from rinsing the ore, residual cyanide, metal-cyanide complexes, and small quantities of heavy metals. Tailings produced from tank leaching may contain arsenic, barium, chloride, nitrate, sodium, and sulfate. Cyanide residues may require destruction using alkaline chlorination, ozone, or hydrogen peroxide addition.

Gravity concentration, a beneficiation method used mostly in placer mines, involves passing a slurry of ore and water over a series of riffles to catch heavier gold particles. Amalgamation, or wetting metallic gold with mercury to form an amalgam, is another recovery technique used in placer operations. Its high cost, inefficiency for large-scale mining operations, and environmental and safety considerations have greatly restricted amalgamation's previous widespread use.

Chemical Usage

The following exhibit lists the chemicals used in greatest volume in the metal mining processes for several of the main commodities. While volume does not necessarily correlate with potency, this data indicates which chemicals are present in greatest quantity, and to which chemicals mine workers may be most frequently exposed. Although it does not appear in the chart below, cyanide is also consumed in massive quantities by the gold industry. In 1990 alone, Dow Chemical supplied over 160 million pounds of reagent-grade cyanide for use in gold mining, according to the *Chicago Tribune* (February 2, 1992, p.27).

Exhibit 13
Chemicals Used in High Volume

Type of Mine	Chemical Name	Volume/Mass at Mine Site
Iron Ore	Acetylene	5,577,726 gallons
	Argon	15,892,577 gallons
	Diesel Fuel	3,417,487 gallons
	Nitrogen	9,398,026 gallons
Lead/Zinc	Acetylene	1,021,795 gallons
	Calcium Oxide	932,129 lbs.
	Diesel Fuel No. 2	1,640,271 gallons
	Propane	171,733 lbs.; 1,015,962 gallons
	Sulfur Dioxide*	1,843,080 lbs.

Exhibit 13 (cont'd)
Chemicals Used in High Volume

Type of Mine	Chemical Name	Volume/Mass at Mine Site
Copper	Acetylene	10,909,868 gallons
	Calcium Oxide	512,620,243 lbs.
	Chlorine**	17,242,059 lbs.; 138,015 gallons
	Coal	2,375,684,593 lbs.
	Copper ore concentrate**	24,000,000 lbs.
	Copper Slag	10,833,500 lbs.
	Diesel Fuel No. 2	47,301,433 gallons
	Limestone	154,280,000 lbs.
	Natural Gas	8.6 x 10^12 gallons
	Nitrogen	189,315,331 gallons
	Pyrites	38,400,000 lbs.
	Sulfuric Acid**	82,907,916 lbs.; 5,772 gallons
Gold	Acetylene	829,460 lbs.; 2,033,041 gallons
	Calcium Oxide	58,394,968 lbs.
	Chlorine**	66,090,022 lbs.; 165 gallons
	Diesel Fuel No. 2	13,425,408 gallons
	Propane	1,218 lbs.; 2,743,927 gallons
	Sulfuric Acid**	1,800,501 lbs.

Source: NIOSH 1990/91

* Proposed TRI chemical
** Current TRI chemical

III.B. Mining Process Pollution Outputs

The extraction and beneficiation of metals produce significant amounts of waste and byproducts. Total waste produced can range from 10 percent of the total material mined to well over 99.99 percent. The volume of total waste can be enormous: in 1992, gold mining alone produced over 540 million metric tons of waste. The following exhibit provides further detail on the volume of product and waste material generated from metal mineral mining.

Exhibit 14
Volume of Waste Generated for Selected Metals

Commodity	Number of Mines	Total Commodity Produced (1,000 mt)	Tailings Generated (1,000 mt)	Other Waste Handled (1,000 mt)
Copper	50	1,765	337,733	393,332
Gold	+212	0.329	247,533	293,128
Iron Ore	22	55,593	80,204	106,233
Lead	23	398	6,361	--
Silver	150	1.8	2,822	--
Zinc	25	524	4,227	--

Source: U.S. Bureau of Mines, Mineral Commodity Summaries 1994 and Minerals Yearbook, Volume I: Metals and Minerals, 1992.

The industry (including non-metallic minerals) is estimated to have generated 50 billion metric tons of waste through 1985, and currently generates approximately one billion metric tons annually. It is important to note, however, that virtually none of this annual production related to extraction and beneficiation is classified as RCRA hazardous waste. Exhibit 15 summarizes some of the potential effects of industrial mining on the environment.

Exhibit 15
Steps in the Mining Process and Their Potential Environmental Impacts

Mining Process	Process Wastes	Air Emissions	Other Waste	Land, Habitat, Wildlife
Site Preparation	Erosion due to removal of vegetation	Exhaust from construction vehicles; fugitive dust	Run-off sediment	Deforestation and habitat loss from road and site construction
Blasting/ Excavation	Acid Rock Drainage (ARD); erosion of sediments; petroleum wastes from trucks	Dust blown to surrounding area; exhaust from heavy machinery	Non-reused overburden; waste rock	Loss of habitat; increase in erosion; loss of plant population from dust and water pollution; reduction in localized groundwater recharge resulting from increased runoff; loss of fish population from water pollution; nearby structural damages from vibration and settling; competition for land use
Crushing/ Concentration	Acid Rock Drainage (ARD) from tailings	Dust created during transportation	Additional waste rock; tailings	

Exhibit 15(cont'd)
Steps in the Mining Process and Their Potential Environmental Impacts

Mining Process	Process Wastes	Air Emissions	Other Waste	Land, Habitat, Wildlife
Leaching	ARD; water pollution from ruptures in pipes or ponds holding leach solution		Sludges from neutralization of contaminated water	Loss of plant, fish, and water fowl population from water pollution

Source: Mining Support Package,. Draft, U.S. EPA, April 1994.

Wastes

Several wastes are created when metal ores are extracted from the earth. The first is overburden and waste rock, which is soil and rock removed in order to access an ore or mineral body. Overburden typically includes surface soils and vegetation, while waste rock also includes rock removed while sinking shafts, accessing or exploiting the ore body, and rock embedded within the ore or mineral body.

Most overburden and waste rock are disposed of in piles near the mine site, although approximately nine percent is backfilled in previously excavated areas, and nearly four percent is used off-site for construction. Waste rock dumps are generally constructed on unlined terrain, with underlying soils stripped, graded, or compacted depending on engineering considerations. Drainage systems may be incorporated into dump foundations to prevent instability due to foundation failures from groundwater saturation, and may be constructed of gravel-filled trenches or gravel blankets.

Tailings are a second type of common mining waste. Most beneficiation processes generate tailings, which contain a mixture of impurities, trace metals, and residue of chemicals used in the beneficiation process. Tailings usually leave the mill as a slurry consisting of 40 to 70 percent liquid mill effluent and 30 to 60 percent solids; liquids are commonly re-used in milling processes. Most mine tailings are disposed in on-site impoundments. Design of the impoundment depends on natural topography, site conditions, and economic factors; generally it is economically advantageous to use natural depressions to contain tailings. Impoundments are designed to control the movement of fluids both vertically and horizontally.

In some cases, tailings are dewatered or dried and disposed in piles; this minimizes seepage volumes and the amount of land required for an impoundment. However, dry disposal methods can be prohibitively expensive due to additional equipment and energy costs.

Slurried tailings are sometimes disposed of in underground mines as backfill to provide ground or wall support. This decreases the above-ground surface disturbance and can stabilize mined-out areas. Subaqueous tailings disposal, practiced primarily in Canada, is the placement of tailings below a permanent water surface such as a lake or ocean; it is used primarily to minimize the acid-generating potential of tailings by preventing sulfide ore from oxidizing. This disposal method is not currently practiced commercially in the United Stated.

Water

Water removed from a mine to gain or facilitate access to an ore body is known as mine water. Mine water can originate from precipitation, from flows into pits or underground workings, and/or from groundwater aquifers that are intercepted by the mine. Mine water is only a waste if it is discharged to the environment via a point source. Mine water can be a significant problem at many mines, and enormous quantities may have to be pumped continuously during operations. When a mine closes, removal of mine water generally ends. However, underground mines can then fill and mine water may be released through adits or fractures that reach the surface. Surface mines that extend below the water table fill to that level when pumping ceases, either forming a lake in the pit or inundating and saturating fill material. Pumped mine water is typically managed in on-site impoundments. Collected water may be allowed to infiltrate/evaporate, used as process water or for other on-site applications such as dust control, and/or discharged to surface water, subject to permit requirements.

Acid drainage is a potentially severe pollution hazard associated with mining, and can be difficult to predict. It occurs when pyrite and other sulfide minerals, upon exposure to oxygen and water, oxidize to create ferrous ions and sulfuric acid. Catalyzed by bacteria, the ferrous ions react further with oxygen, producing hydrated iron oxide, known as "yellowboy." This combination of yellowboy and sulfuric acid may contaminate surrounding soil, groundwater, and surface water, producing water with a low pH. When this reaction occurs within a mine it is called Acid Mine Drainage (AMD). When it occurs in waste rock and tailings piles it is often known as Acid Rock Drainage (ARD), although AMD is the most widely used term for both.

AMD is a significant problem at many abandoned mine sites: a 1993 survey by the U.S. Forest Service (*Acid Mine Drainage from Mines on*

National Forests, A Management Challenge) estimates that 5,000 to 10,000 miles of domestic streams and rivers are impacted by acid drainage. Acid drainage can lower the pH of surrounding water, making it corrosive and unable to support many forms of aquatic life; vegetation growing along streams can also be affected. Mine water can also carry toxic, metal-bearing sediment into streams, which can kill waterborne plant and animal species. In extreme cases, acid drainage can kill all living organisms in nearby streams. Humans may also increase disease risks by consuming drinking water and fish tissue with a heavy metal content.

According to the 1994 *Technical Document/ Background for NEPA Reviewers: Non-Coal Mining Operations,* prepared by EPA's Office of Solid Waste (OSW), acid drainage can pose significant threats to surface and groundwater quality and resources during active mining and for decades after operations cease. Although mines that began operating after 1978 are required to treat their effluent water, the need for water treatment may persist for decades after mining operations have ceased. Abandoned mines and refuse piles can produce acid damage for over 50 years. According to EPA's hardrock mining strategy framework, for example, "negative changes in geochemistry over time can occur when the materials' environment changes (e.g., going from a reducing environment to an oxidizing one) or buffering capacity is exceeded (such as when the total neutralizing capacity of a rock mass is exceeded by acid generation). When these conditions are present, a facility can close in full environmental compliance, only to have a severe problem show up decades later." Because remediating acid drainage is so damaging and costly, predictive tools, design performance, financial assurance, and monitoring have become increasingly important.

Acid leaching operations are an additional source of water pollution. The leaching process itself resembles acid drainage, but it is conducted using high concentrations of acids to extract metals from ore. Since acid leaching produces large volumes of metal-bearing acid solutions, it is vital that leach dumps and associated extraction areas be designed to prevent releases. Most environmental damage associated with acid leaching is caused by leakage, spillage, or seepage of the leaching solution at various stages of the process. Potential problems include: seepage of acid solutions through soils and liners beneath leach piles; leakage from solution-holding ponds and transfer channels; spills from ruptured pipes and recovery equipment; pond overflow caused by excessive runoff; and ruptures of dams or liners in solution-holding ponds. Cyanide leaching solution processes carry a similar potential for damage as a result of leakages, spills, overflows, and ruptures.

Solution ponds associated with leaching operations are potential sources of acid and metal releases to ground and surface water. Ponds associated with precious metal leaching operations and newer copper facilities are generally lined with synthetic materials (although liners are often susceptible to failure). At older copper sites, solution ponds may be unlined or lined only with natural materials. Leakage, run-off from precipitation, and the like, may cause contamination of ground and surface waters.

Air

Substantial air pollution can occur at mining sites during excavation and transportation. Fugitive dust may be a significant problem at some sites, depending on site conditions and management practices, and is created at many stages of the mining process. The inherent toxicity of the dust depends on the proximity of environmental receptors and type of ore being mined; high levels of arsenic, lead, and radionuclides in windblown dust tend to pose the greatest risk, according to EPA's 1995 hardrock mining framework strategy. Sources of dust may be from road traffic in the mine pit and surrounding areas, rock crushers located in pits and in mills, and tailings ponds.

Dust control methods aim to reduce amounts and concentrations of dust produced and to minimize human exposure to remaining dust. The most important element of dust control at underground mines is a properly designed ventilation system. Water sprays are also used during ore transportation and crushing, and can greatly reduce dust levels at the site. Dust suppressants, such as lignin sulfonates and magnesium chloride, can stabilize solid piles or tailing areas that might otherwise become airborne in windy conditions. After mine closure, revegetation or other stabilizing methods may be used for dust control.

Exhaust fumes from diesel engines and blasting agents may also be serious hazards at underground mines. These exhausts produce carbon monoxide and nitrogen oxide gas, which collect in underground areas. Ventilation and monitoring are important steps taken to reduce the potential harm these fumes may cause workers.

The following exhibit, derived from EPA's OSW 1994 *Technical Document/Background for NEPA Reviewers: Non-Coal Mining Operations*, describes the various measures mining operators may take to mitigate potential environmental impacts of waste products generated through different phases of the extraction and beneficiation processes.

Exhibit 16
Potential Mine Waste Mitigation Measures

Mining Waste Product	Mitigation Measures
Extraction - Mine Workings	• Evaporation and re-use of mine water in processing operations • Run-on and runoff control measures, such as berms and ditches • Neutralization / precipitation or other treatment practices prior to discharges • Clean-up of blasting residuals • Provide for post-closure mine water management • Monitor discharges and surface water quality • Site mine water containment units to minimize potential for surface water recharge
Extraction - Waste Rock/ Overburden	• Backfill into dry mine workings with waste rock • Maximize use of overburden in reclamation • Collect and monitor seepage, drainage, and runoff • Segregate and cover reactive waste rock with non-reactive materials where ARD is observed • Use non-reactive waste rock for on-site construction • Provide for adequate dump drainage to minimize potential for slope failure • Conduct baseline surface water monitoring; continue monitoring throughout operation and post-closure • Use run-on controls to minimize potential for infiltration
Beneficiation - Tailings Impoundments	• Design unit to contain maximum reasonable storm event • Consider natural and / or synthetic liners for units located in drainages; consider liners for any seepage / runoff collection sumps / ditches • Maximize the reclaim / reuse of tailings water • Limit mill reagents to least extent necessary • Provide adequate drainage of berms • Include secondary containment of tailings pipelines • Continue ARD testing throughout operations and closure • Collect and treat runoff / seepage from outer slopes of impoundment

Exhibit 16 (cont'd)
Potential Mine Waste Mitigation Measures

Mining Waste Product	Mitigation Measures
Beneficiation - Copper Dump Leach Operations and SX/EW Plants, Gold Heap Leaching	• Design dump leach units to fully drain to collection areas • Ensure that collection, pregnant solution, and raffinate ponds are designed to contain up to the maximum reasonable storm event; line process ponds, heap leach pads, and conveyances • Install leachate detection and collection systems under ponds and heaps; construct seepage ponds downgradient of ponds, heaps, and dumps • Recycle process water • Lime neutralization or wetlands treatment of acid drainage • Provide secondary containment for solution pipes to minimize impacts from pipe failures/spills • Collect and treat drainage that occurs after closure, as necessary • Perform baseline groundwater monitoring and conduct groundwater quality monitoring during operations and post-closure; monitor post-closure discharges and downstream surface water quality • Detoxification of heaps, dumps, and any spent solutions to reduce cyanide, acidity, and metal loadings • Biological treatment for cyanides, nitrates, and heavy metals
Beneficiation - Cyanide Leaching Operations	• Where possible, do not locate leaching operations in or near drainages • Ensure that pregnant and barren ponds and ditches are designed to contain all solution flows and any runoff up to the maximum reasonable storm event • Use double liners and leak detection systems for all heaps, ponds, and drainage ditches • Test detoxified materials prior to disposal or closure to ensure cyanide levels are reduced • Collect and test seepage and runoff from spent ore piles; treat runoff/seepage as necessary; perform downstream water quality monitoring
Beneficiation - *In Situ* Mining	• Ensure proper production well installation/completion to avoid uncontrolled solution releases; provide for adequate well abandonment • Perform a detailed characterization of the site hydrogeology to guide design of recovery systems and determine potential for releases • Carefully monitor pumping pressures of solutions entering and leaving deposits to assure that solutions are not migrating into groundwater • Line surface collection systems and provide for leak detection; design collection systems to contain maximum volumes of leaching solutions and runoff/precipitation/snow melt

Because proposed mining activities may also impact aquatic resources, vegetation, and wildlife, EPA suggests the following potential mitigation measures for use at mine sites:

Exhibit 17
Ecosystem Mitigation Measures

- Employ sediment retention structures to minimize amount of sediment migrating off-site
- Employ spill prevention and control plans to minimize discharge of toxic/hazardous materials into water bodies
- Site roads, facilities, and structures to minimize extent of physical disturbance
- Avoid construction or new disturbance during critical life stages
- Reduce the chance of cyanide poisoning of waterfowl and other wildlife by neutralizing cyanide in tailings ponds or by installing fences and netting to keep wildlife out of ponds
- Minimize use of fences or other such obstacles in big game migration corridors; if fences are necessary, use tunnels, gates, or ramps to allow passage of these animals
- Use "raptor proof" designs on power poles to prevent electrocution of raptors
- Use buses to transport employees to and from mine from outer parking areas to minimize animals killed on mine-related roadways
- Limit impacts from habitat fragmentation, minimize number of access roads, and close and restore roads no longer in use
- Prohibit use of firearms on site to minimize poaching

IV. WASTE RELEASE PROFILE

This section provides a general overview of the waste release activities and issues common to the metal mining industry. Unlike facilities covered by SIC codes 20 through 39 (manufacturing facilities), metal mining (extraction and beneficiation) facilities are not required by the Emergency Planning and Community Right-to-Know Act to report to the Toxic Release Inventory (TRI). EPA is considering expanding TRI reporting requirements in the future, including participation of previously exempt industries such as metal mining. Because TRI reporting is not required in the metal mining industry, other sources of waste release data have been identified for this profile.

IV.A. Waste Release Data for the Metal Mining Industry

In 1994 EPA's OSW studied the unpermitted mining waste releases and environmental effects for nine States: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, South Carolina, and South Dakota. Researchers examined State records to document waste release events for various types of mines throughout each State. These releases generally were not authorized under existing permits or regulations, and therefore should not be considered "accepted," "standard," or "typical" waste outputs of metal mining facilities. Rather, the data presented below offer a picture of representative unpermitted mining release events, and of the magnitude of these events in many Western States, where most metal mining facilities are located. It should be noted that most of these releases were properly mitigated by the associated mining companies.

The release information presented below is categorized by mineral type, and is derived from the *Mining Waste Releases and Environmental Effects Summaries* reports prepared for OSW (see "References" for further information). Release data are presented in the units of measurement reported by each State and are therefore not standardized. Iron ore is not represented in the data because all U.S. iron ore mining occurs outside of the States selected for the survey. Note that the common types of waste released pose the greatest potential for polluting water sources, as stated elsewhere in this profile. Breaches of tailings impoundments, and subsequent spills of tailings, are not included in the data.

Copper

As evidenced in the following exhibit, the most prevalent waste release events related to copper mining involve leachate or process wastewater, reflecting the predominant extraction method for this ore. Acid Mine Drainage is a significant release associated with abandoned copper mines.

Exhibit 18
Copper-Related Waste Releases

Site	Waste Released	Release Event Year
Cyprus Miami Mine, Claypool, AZ	Copper leachate (amount unknown) Waste water (amount unknown) Non-potable water (37,000 gallons) (min 185, 000 gallons)	1990 1980, 85, 86 1990 1989
Magma Copper, Miami Tailings Reprocessing Pit and Copper Cities Pit, Miami, AZ	Pregnant leach (5000-10000 gallons) Slurry (15,600 gallons, 35,000 gallons, 1000-2000 gallons, 216,600 gallons) Recycle (1,320 gallons) Effluent (amount unknown)	1984 1989 1991 1991 1989 1991
Oracle Ridge Mine, Pima County, AZ	Copper concentrate (100 pounds) Process water (5000 gallons)	1991 1991
ASARCO, Ray Mines, Gila County, AZ	Diesel fuel (amount unknown) PCB, dielectric fluid (10 gallons) Sulfuric acid (20 tons) Gasoline (amount unknown) Acidic water (amount unknown) Cooling tower blowdown (4340m^3/day) Sulfur dioxide (amount unknown)	1989 1989 1989 1989 1985 1985 1988
Sierrita Mine and Mill, Cyprus Minerals Corp., Pima County, AZ	Process water (1 gallon/min) Pregnant leachate (amount unknown)	1987 extended
Chino Mines, NM	Heavy metals and sulfuric acid Acidic water (16,200 gallons) (2 million gallons)	extended 1986 1988
Tyearone Mine, NM	TDS and sulfuric acid from tailings (4,270 acre feet per year)	1978-89
Montana Resources, Inc. Butte, MT	Leach (amount unknown)	1986
Bully Hill Mine, Redding, CA	Acid mine drainage (30 gallons/min)	since 1927
Penn Mine, New Penne Mines, Inc., Campo Seco, CA	Acid mine drainage Leaching of heavy metals (no known flow rate)	since 1955
Walker Mine, Calicopia Corp., Plumas County, CA	Acid mine drainage Heavy metals (no known flow rate)	since 1941
Mammoth, Keystone & Stowell Mines, Shasta County, CA	Acid mine drainage (100-275 gallons/min)	extended time period
Red Ledge Mine, NV	See Gold and Silver	
Arimetco Facility, ArimetcoInc./Copper Tek Corp., Lyon County, NV	Acid leach (amount unknown) Pregnant solution (2000 gallons)	1989-91 1990
Nevada Moly Project, Cyprus Tononpah Mining, Tononpah, NV	Process solution (amount unknown) Mercury (5.783 kg)	1989 1990
Rio Tinto Mine, US Forest Service, Elko County, NV	Acid (amount unknown)	extended

Lead and Zinc

Because lead and zinc are often mined as a byproduct of other primary ores (copper or silver, for example), less data is available concerning releases specific to lead and zinc mining processes. Unless a mine operates exclusively as a lead / zinc operation, waste releases associated with these minerals are generally subsumed in the primary ore category and is included in the "Gold and Silver" data.

Exhibit 19
Lead and Zinc - Related Waste Releases

Site	Waste Released	Release Event Year
Black Cloud Mine, Res-ASARCO Joint Venture, Lake County, CO	Copper sulfate (2 gallons, 10 gallons, 50 gallons, amount unknown) Water and sediments (amount unknown) Acid leak (amount unknown)	1987 1987 1983 extended
Taylor/Ward Project ,White Pine County, NV	Lead only, see gold and silver	
Central Valley of CA	Zinc only, see gold and silver	
Red Ledge Mine, ID	Zinc only, see gold and silver	
Montana Tunnels Mine, MT	See gold and silver	
Lucky Friday Mine, Mullan, ID	See gold and silver	
Taylor/Ward Project, Alta Gold Co., White Pine County, NV	Lead only, see gold and silver	

Gold and Silver

As might be expected from the predominant beneficiation methods associated with gold and silver mining, release of leachate solutions (pregnant, process, barren, etc.) is by far the most common type of release for these ores, followed by release of cyanide, a common treatment solution. Release of cyanide is reported as presented in State files and is presumed to be released in solution form. Acid Mine Drainage is also problematic for gold and silver ore mining.

Exhibit 20 Gold- and Silver -Related Waste Releases

Site	Waste Released	Release Event Year
American Girl Mine, American Girl Mining Co., Imperial County, CA	Pregnant solution (1700 gallons) Process solution (4320-8640 gallons) Barren solution (5000 gallons)	1987 1988 1989
Carson Hill Gold Mine, Western Mining Co., Calaveras County, CA	Pregnant leach solution (91,450 gallons)	1989
Goldfields Operating Co., Mesquite, CA	Leaching solution (amount unknown) (770, 50, 2520, 33, 26 gallons) Pregnant solution (4000 gallons) (52 gallons)	1986 1990 1989 1990
Goldstripe Project, Plumas County, CA	Leaching solution (amount unknown) Residue solution (amount unknown)	1986 1986-87
Gray Eagle Mine, Noranda, Siskiyou County, CA	Slurry (15 and 30 gallons/min) (1000-1500 gallons) (19,100 gallons) Untreated water (2-3 gallons/min for hours)	1983 1983 1986 1989
Jamestown Mine, Sonora Mining Corp., Tuolumne County, CA	Flotation solution (500 gallons) Reagents (2,700 gallons) Process water (1000 and 1500 gallons) Soda ash solution (3000 gallons) Supernatant (20 gallons/min) Concentrate (amount unknown, 10 tons, amount unknown)	1987 1987 1989, 90 1990 1987 1988, 90, 91
Kanaka Creek Joint Venture, Alleghany, CA	Effluent with arsenic (28 gpm)	1989
McLaughlin Mine, Homestake Mining Co., Napa & Yolo Counties, CA	Ore slurry (amount unknown)	1989
Morning Star Mine, Vanderbilt Gold Corp., San Bernardino, CA	Pregnant solution (2500 gallons)	1988
Mt. Gaines Mine, Texas Hill Mining Co., Mariposa, CA	Leaching solution (308,000 gallons)	1991
Central Valley of CA, numerous closed mines	Acid mine drainage Copper, zinc, cadmium (2 tons/year) Iron (22 tons/year)	extended
Picacho Mine, Chemgold Inc., Imperial County, CA	Cyanide solution (min 1200 gallons)	since 1987
Snow Caps Mine, Sunshine Mining Co., Independence, CA	Leaching solution (6000 gallons and amount unkn.)	1989 1988
Yellow Aster Mine, Rand Mining Co., Randsburg, CA	Leaching solution (amount unknown)	1989
Atlantic and Pacific Mine, 2900 Development Corp., Madison County, MT	Effluent (amount unknown)	1988

Exhibit 20 (cont'd)
Gold- and Silver-Related Waste Releases

Site	Waste Released	Release Event Year
Basin Creek Mine, Lewis & Clark, Jefferson Counties, MT	Acid mine drainage (amount unknown) Cyanide (amount unknown, amount unknown)	extended 1988 1989
Cable Creek Project, Deer Lodge County, MT	Effluent from main sediment pond (amount unknown)	1989
Golden Sunlight Mine, Placer Amex, Inc., Whitehall, MT	Pregnant solution (2000 gallons) Acidic water (amount unknown) Waste rock (amount unknown)	1986 1980 1987
Mineral Hill Mine/Jardine Joint Venture, Jardine, MT	Seepage return solution (20-50 gallons) Cyanide (200 gallons)	1990 1990
Landusky Mine, Zortman, MT	Cyanide (few gallons/hour) Pregnant solution (amount unknown)	1987 1988
Montana Tunnels Mine, Jefferson County, MT	Cyanide (amount unknown)	1987, 88
Pony Custom Gold Mill, Chicago Mining Corp., Pony, MT	Slurry (20 gallons/day, max 15 gallons/day, amount unknown)	1990 1990 1990
Copperstone Project, **Parker, AZ**	Leaching solution (2000 gallons, 5 gallons) Process solution(150-200 gallons) Process water (500 gallons) Slurry (300-400 gallons, 200 gallons)	1987, 88 1989 1990 1988 1990, 92
Portland Mine, Bullhead City, AZ	Heap slide (amount unknown)	1986
Bullger Basin Mine, Pennsylvania Mining Inc., Park City, CO	Sediment (amount unknown) Oil (amount unknown)	1986 1986
Cross Gold Mine, Hendricks Mining Co., Caribou, CO	Mine water with cadmium, zinc, copper, lead (amount unknown)	1985, 1990
Jerry Johnson Group Cyanide Leach, El Paso County, CO	Fresh ore (amount unknown)	1986
Rubie Heap Leach, American Rare Minerals Inc., Teller County, CO	Cyanide (amount unknown)	1985-92
Gilt Edge Project, Brohm Mining Co., Deadwood, SD	Cyanide (amount unknown, amount unknown) Process solution (300 gallons) Neutralization solution (1,329 gallons) Pregnant solution (47.05 gpd) Leaching solution (amount unknown)	1991 1991 1990 1990 1989 1988-90

Exhibit 20 (cont'd)
Gold and Silver- Related Waste Releases

Site	Waste Released	Release Event Year
Annie Creek Mine, Wharf Resources, Lawrence County, SD	Process water (1 gallons/hr, amount unknown) Leachate (100 gallons, 10,000 gallons, amount unknown) Cyanide (500 gallons, amount unknown, 200 gallons, amount unknown, 1000 gallons, amount unknown, 50-60 gallons, 1317 gpd, 1288 gpd) Pregnant solution (5 gallons, amount unknown, amount unknown) Neutralization solution (amount unknown) Sedimentation pond (amount unknown) Diesel fuel (4000 gallons) Carbon slimes (amount unknown) Diesel free product (amount unknown)	1986 1989 1988, 90 1987 1988, 84, 84, 85, 90, 90, 84, 91, 91 1984, 89 1990 1989 1990-91 1987 1990 1991
Golden Reward Mine, Lead, SD	Barren solution (500 gallons) Leach heap (300 gallons/cell) Surge pond solution (500 gpd) Cyanide (120 gallons, 125 gallons, 1000-2000 gallons, 400 gallons, 50 gallons, 29 gallons, 25-50 gallons, 25-50 gallons, 200 gallons) Hydraulic oil (150 gallons)	1990 1990 1990 1989 90, 90, 91 1991 1990
Homestake Gold Mine, Lead, SD	Cyanide (amount unknown) Waste bench run-off (amount unknown)	1988 1988
Richmond Hill Mine, Bond Gold Co., Lawrence County, SD	Cyanide (200 gallons, 1350 gallons, 150 gallons) Ore (40 tons)	1989, 90 1990 1990
Brewer Gold Mine, Westmont Mining Inc., Jefferson, Chesterfield Counties, SC	Process water (amount unknown) Cyanide (1,800 gallons, 1683 gallons, 10-12 million gallons) Partially leached ore (500 tons) Barren solution (750 gallons, 1000 gallons, 1000 gallons, 150 gallons) Pregnant solution (500-600 gallons, 8741 gallons) Emergency pond solution (300-2250 gallons/day for 14 days) Ore (100 tons, amount unknown) Rinse solution (2250 gallons) Spent ore (125 ft^3)	1987 1988, 89 1990 1987 1990, 87 1988 1988 1990 1989 1989, 90 1989 1989

Luck Friday Mine, Hecla Mining Co., Mullan, ID	Copper sulfate (100 gallons)	1988
Marigold II Mine, Powell & Micro Gold II, Florence, ID	Mercury (12 pounds.)	1983
Princess Blue Ribbon Mine, Precious Metals Technology, Camas County, ID	Cyanide (amount unknown) Sediment (amount unknown)	1988-90 1990

Exhibit 20 (cont'd)
Gold and Silver- Related Waste Releases

Site	Waste Released	Release Event Year
Red Ledge Mine, Alta Gold Co., Adams County, ID	Acid mine drainage (.2 cfs)	since 1973
Stibnite Mine Project, Valley County, ID	Diesel oil (900 gallons) Cyanide (amount unknown)	1989-90 1989
Yellow Jacket Mine, Glen Martin, Cobalt, ID	Cyanide (amount unknown)	1983
ACH-Dayton Project, American Eagle Resources, Lyon County, NV	Cyanide (amount unknown) Barren pond (amount unknown)	1986 1989
Alligator Ridge Mine, USMX Inc., Ely, NV	Cyanide (100,000-200,000 gallons, 32,000-34,000 gallons, amount unknown) Pregnant solution (amount unknown) Process water (amount unknown, amount unknown)	1983 1986 1986 1985-89 1990 1990
Aurora Gold Project, Aurora Partnership, Mineral County, NV	Pregnant solution (4500 gallons)	1988
Bald Mountain Mine, Placer Dome U.S. Inc., White Plain County, NV	Barren solution (9,000 gallons, 5,000 gallons)	1989 1991
Big Springs Project, Independence Mining Co., Elko County, NV	Tails liquor (23,000 gallons) Cyanide (amount unknown)	1989 1990
Borealis Gold Project, Tenneco Mining, Mineral County, NV	Cyanide (2,000 gallons, 1,000 gallons)	1988
Buckhorn Mine, Cominco American Inc., Eureka County, NV	Process solution (3,000-5,000 gallons)	1990
Candelaria Mine, Necro Metals Inc., Hawthorne, Esmeralda, and Mineral Counties, NV	Pregnant solution (20,000-25,000 gallons)	1986
Chimney Creek Project, Gold Fields Mining Corp., Humboldt County, NV	Ammonium nitrate (4940 pounds.) Cyanide (1 gallons, 400 gallons, 360 gallons, 80 L, 80 gallons) Descalant solution (10 gallons) Diesel fuel (125 gallons) Hydraulic oil (78 gallons)	1991 1991 1991 1991 1991 1991
Coeur Rochester, Love Lock, Pershing County, NV	Barren solution (90,000-130,000 gallons) Pregnant solution (5,000-10,000 gallons)	1987 1987
Cortez Gold Mines, Cortez Joint Venture, Cortez, NV	Process solution (600 gallons)	1991

Crofoot & Lewis Projects, Hycroft Resources & Development, Humboldt County, NV	Pregnant solution (5000 gallons, 17,000 gallons, 228,000 gallons, 72,000 gallons)	1990, 91 1990 1990
Dee Gold Mine, Dee Gold Mining Co., Elko, NV	Tailings reclaim water (142,968 gallons)	1986
	Cyanide (58 pounds, amount unknown)	1990, 91

Exhibit 20 (cont'd)
Gold and Silver-Related Waste Releases

Site	Waste Released	Release Event Year
Denton-Rawhide Project, Kennecott Rawhide Mining Co., Mineral County, NV	Safety pond solution (167 gpd)	1990
Easy Junior Mine, Alta Gold Co., White Pine County, NV	Used oil (13 barrels, 3000 gallons)	????
Elder Creek Mine, Alta Gold Co., Lander County, NV	Barren solution (4000 gallons, small amount,	1989, 90
	amount unknown)	1990
	Pregnant solution (10,000 gallons)	1990
Florida Canyon Mine, Pegasus Gold Corp., Pershing County, NV	Barren solution (1200 gallons, 500 gallons)	1991
	Pregnant solution (30 gallons)	1990
	Leaching solution (112 gallons)	1991
Flowery Project, American Eagle Resources, Virginia City, NV	Cyanide (amount unknown)	1988
	Leaching solution (160-290 ml/min,	1991
	amount unknown)	1991
Gretchell Mine, First Miss Gold Inc., Winnemucca, NV	Laboratory samples (8-16 gpd)	1989-90
	Sulfuric acid (20 gallons)	1991
Gold Bar Project, Atlas Gold Mining Inc., Eureka County, NV	Process fluid (amount unknown)	1989
	Cyanide (amount unknown)	1988
Golden Butte Project, Alta Gold Co., White Pine County, NV	Cyanide (75 gallons, 50-55 gallons,	1990
	amount unknown)	1990
	Pregnant solution (2.4 gpm, 6,500-	1989, 89
	17,500 gallons, 1000 gallons)	1990
Gooseberry Tailings Pond, Asamera Minerals Inc., Storey County, NV	Barren solution (300 gallons)	1990
Haywood Leach Facility, Oliver Hills Mining, Co., Lyon County, NV	Cyanide (amount unknown)	1989
Hog Ranch Mine, Western Mining Co., Valmy, NV	Cyanide (250,000 gallons)	1989
	Barren solution (3,500 gallons)	1990
Jerritt Canyon Project, Elko County, NV	Cyanide (20,000 gallons)	1989
Marigold Mine, Marigold Mining Co., Valmy, NV	Leaching solution (amount unknown)	1991
Mother Lode Project, US Nevada Gold Search Joint Venture, Beatty, NV	Pregnant solution (228 gpd,	1989
	640 gpd)	1990
	Cyanide (.4 pounds)	1990
Nevada Mineral Processing Mill, Nevada Mineral Processing, Mineral County, NV	Cyanide (amount unknown)	1991
North Area Leach Project, Newmont Gold Co., Eureka County, NV	Pregnant solution (2500 gallons)	1988

Northumberland Mine, Western Minerals Corp., Nye County, NV	Pregnant solution (555,000 gallons) Leaching solution (8-100 gallons, 400 gallons)	1983 1989 1985

Exhibit 20 (cont'd)
Gold and Silver-Related Waste Releases

Site	Waste Released	Release Event Year
Paradise Peak Project, FMC Gold Co., Nye County, NV	Cyanide (275 pounds, 48 pounds)	1989, 91
Rain Facility, Newmont Mining Co., Carlin, NV	Acid drainage (3 gpm)	1990
Santa Fe Project, Corona Gold Inc., Hawthorne, NV	Leaching solution (5 gpm) Barren solution (amount unknown) Waste oil (amount unknown)	1989 1990 1989
Silver Peak Project, Homestead Minerals Corp., Esmeralda County, NV	Cyanide (20-25 gallons, 8,000-10,000 gallons) Leach thickener (15, 750 gallons)	1988 1986 1991
6-Mile Canyon Project, Gold Canyon Placer Inc., Dayton, NV	Cyanide (amount unknown, 10 tons)	1986, 90
Sleeper Mine, Amax Gold Inc.	Reclaimed seepage pond solution (610 gallons) Barren solution (3,000 gallons, 2,000 gallons 300 gallons, 3600 gallons, 2000 gallons, 4000 gallons) Cyanide (149 pounds, 7.66 pounds, 265 pounds) Pregnant solution (amount unknown) Process water (4100 gallons, 6240 gallons, 45,000 gallons) Ore processing evaporation pond (1 gpm) Mill make-up water (3000 gallons)	1989 1989, 89 1989, 89 1990 1989, 90 1990 1990 1991 1991, 90 1990 1990
South Leach Project, Newmont GoldInc., Eureka County, NV	Pregnant solution (amount unknown, amount unknown)	1991 1991
Tonkin Springs Gold Mining Co., Eureka County, NV	Pregnant solution (500,000 gallons) Leach seepage solution (amount unknown, amount unknown)	1988 1988 1990
USX Project, Ivanhoe Gold Co., Elko County, NV	Leaching solution (150 gpd, amount unknown)	1990 1991
Willard Project, Western States Mineral Corp., Pershing County, NV	Pregnant solution (450 gallons) Barren solution (100 gallons, 600 gallons) Strip solution (450 gallons, 6000 gallons)	1989 1989, 90 1989, 90
Wind Mountain Project, Washoe, NV	Cyanide (385,000 gallons, 1.7 pounds, 300 gallons, 30 gallons)	1989, 90 1991

IV.B Other Data Sources

AIRS Data

The Aerometric Information Retrieval System (AIRS) is an air pollution data delivery system managed by the Technical Support Division in EPA's Office of Air Quality Planning and Standards, located in Research Triangle Park, North Carolina. AIRS is a national repository of data related to air pollution monitoring and control. It contains a wide range of information related to stationary sources of air pollution, including the emissions of a number of air pollutants which may be of concern within a particular industry. States are the primary suppliers of data to AIRS. Data are used to support monitoring, planning, tracking, and enforcement related to implementation of the Clean Air Act. AIRS users include State environmental agency staff, EPA staff, the scientific community, other countries, and the general public.

Exhibit 21 summarizes AIRS annual releases of carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter of 10 microns or less (PM10), total particulates (PT), sulfur dioxide (SO_2), and volatile organic compounds (VOCs). This information is compared across industry sectors.

Exhibit 22 lists the air emissions of particular chemicals reported for the metal mining industry in the Air Facility Subsystem (AFS) of AIRS, presented in a "SIC Code Profile, Metal Mining," prepared by EPA's Office of Pollution Prevention and Toxics in April, 1992. The release data are expressed in pounds released per year, per facility. Most of the chemicals released in the highest quantities and those released by the largest number of facilities are metals. In total, 17,654,112 pounds of the chemicals listed in Exhibit 22 were released by the mines covered.

Exhibit 21
Pollutant Releases (Short Tons/Years)

Industry	CO	NO_2	PM_{10}	PT	SO_2	VOC
U.S. Total	97,208,000	23,402,000	45,489,000	7,836,000	21,888,000	23,312,000
Metal Mining	**5,391**	**28,583**	**39,359**	**140,052**	**84,222**	**1,283**
Nonmetal Mining	4,525	28,804	59,305	167,948	24,129	1,736
Lumber and Wood Products	123,756	42,658	14,135	63,761	9,149	41,423
Wood Furniture and Fixtures	2,069	2,981	2,165	3,178	1,606	59,426
Pulp and Paper	624,291	394,448	35,579	113,571	341,002	96,875
Printing	8,463	4,915	399	1,031	1,728	101,537
Inorganic Chemicals	166,147	108,575	4,107	39,082	182,189	52,091
Organic Chemicals	146,947	236,826	26,493	44,860	132,459	201,888
Petroleum Refining	419,311	380,641	18,787	36,877	648,153	309,058
Rubber and Misc. Plastic Products	2,090	11,914	2,407	5,355	29,364	140,741
Stone, Clay, Glass, and Concrete	58,043	338,482	74,623	171,853	339,216	30,262
Iron and Steel	1,518,642	138,985	42,368	83,017	238,268	82,292
Nonferrous Metals	448,758	55,658	20,074	22,490	373,007	27,375
Fabricated Metals	3,851	16,424	1,185	3,136	4,019	102,186
Electronics	367	1,129	207	293	453	4,854
Motor Vehicles, Bodies, Parts, and Accessories	35,303	23,725	2,406	12,853	25,462	101,275
Dry Cleaning	101	179	3	28	152	7,310

Source U.S. EPA Office of Air and Radiation, AIRS Database, May 1995.

Exhibit 22
AIRS Releases

Chemical	Facilities	Med. Releases (lbs/Year/ Facility)	Total Releases (lbs/Year/ Facility)
Acetaldehyde	3	200	546
Acetone	8	147	19,366
Acrolein	3	136	381
Acrylic acid	2	72	143
Acrylonitrile	2	92	185
Aniline	2	126	251
Antimony	38	1,568	1,499,719
Arsenic	60	636	2,189,992
Barium	62	77	54,284
Benzene	15	226	9,929
Benzyl chloride	2	67	134
Beryllium	2	1	3
Biphenyl	2	2	3
1,3-Butadiene	4	108	380
Butyl acrylate	2	68	137
sec-Butyl alcohol	2	54	108
tert-Butyl alcohol	2	67	134
Butyraldehyde	3	72	212
Cadmium	60	166	613,554
Carbon disulfide	2	14	29
Chlorine	64	3,450	3,197,210
Chlorobenzene	2	113	226
Chloroethane	2	46	92
Chloroform	2	81	162
Chloroprene	2	54	108
Chromium	64	292	227,682
Cobalt	56	119	93,723
Copper	63	1,625	1,887,139
Creosote	2	59	118
Cresol (mixed isomers)	2	60	121
Cumene	2	60	121
Cyclohexane	13	34	1,032
1,2-Dibromoethane	2	67	134
Dibutyl phthalate	2	6	13
1,2-Dichlorobenzene	2	64	127
1,4-Dichlorobenzene	2	115	229
Dichlorodifluoromethane CFC-1	2	56	111
1,2-Dichoroethane	2	92	185
Dichloromethane	2	119	239

Exhibit 22 (cont'd)
AIRS Releases

Chemical	Facilities	Med. Releases (lbs/Year/ Facility)	Total Releases (lbs/Year/ Facility)
Dichlorotetrafluoroethane	2	2	3
Dimethyl phthalate	2	10	19
Epichlorohydrin	2	67	134
2-Ethoxyethanol	2	57	115
Ethyl acrylate	2	80	159
Ethylbenzene	5	52	333
Ethylene	9	192	7,160
Ethylene glycol	2	59	118
Ethylene oxide	2	60	121
Formaldehyde	154	256	36,290
Formic acid	2	67	134
Freon	2	64	127
Glycol Ethers	2	70	140
HCFC-22	2	25	51
Hydrogen sulfide	1	3	3
Isobutyraldehyde	2	67	134
Lead	64	2,218	4,065,664
Maleic anhydride	2	11	22
Manganese	64	451	572,225
Mercury	36	14	8,365
Methanol	2	223	446
2-Methoxyethanol	2	62	124
Methyl acrylate	2	60	121
Methyl ethyl ketone	2	194	388
Methyl isobutyl ketone	2	89	178
Methyl methacrylate	2	73	146
Methylene bromide	2	5	10
Monochloropenta-fluoroethane	2	3	6
Naphthalene	7	48	1,716
n-Butyl alcohol	2	110	220
Nickel	62	164	132,525
Nitrobenzene	2	53	105
Phenol	3	35	154
Phosphorus (yellow or white)	62	190	142,058
Phthalic anhydride	2	32	64
Propionaldehyde	3	57	191
Propylene oxide	2	80	159

Exhibit 22 (cont'd)
AIRS Releases

Chemical	Facilities	Med. Releases (lbs/Year/ Facility)	Total Releases (lbs/Year/ Facility)
Propylene (Propene)	9	201	3,067
Selenium	56	78	54,673
Silver	35	59	41,069
Styrene	3	96	405
Tetrachloroethylene	2	111	223
Toluene	15	125	3,323
1,1,1-Trichloroethane	2	68	137
1,1,2-Trichloroethane	2	56	111
Trichloroethylene	2	68	137
Trichlorofluoromethane CFC-11	2	97	194
1,2,4-Trimethylbenzene	2	2	3
Vinyl acetate	2	88	175
Vinyl chloride	2	67	134
m-Xylene	2	91	181
o-Xylene	5	47	252
p-Xylene	2	64	127
Xylene (mixed isomers)	2	111	223
Zinc (fume or dust)	64	1,694	2,781,488

National Priorities List

Presented in Exhibit 23 is a table of mining sites listed on the National Priorities List (NPL) for environmental remediation. These sites have been involved primarily in the extraction and beneficiation of those metal ores covered in this profile and represent only a small fraction of the total number of sites on the NPL, currently numbering over 1,200. The total number of mining-related sites on the NPL is far greater, and includes smelting and other metal processing facilities, and a wider range of metal and non-metal mining facilities.

Exhibit 23
Selected NPL Mining Sites

Site Name/Location	Type of Mine	Contaminant of Concern	Environmental Damage
Silver Bow Creek, Butte, MT	Copper	Arsenic, heavy metals	Contaminated surface soils and sediments; contamination of primary drinking water sources
Clear Creek/Central City Site, Clear Creek, CO	Gold, silver, copper, lead, zinc, molybdenum	AMD, aluminum, arsenic, cadmium, chromium, lead, manganese, nickel, silver, copper, fluoride, zinc	Surface water contamination from AMD; contaminated sediments and groundwater; potential air-borne contamination from tailings
Silver Mountain Mine, Loomis, WA	Silver, gold, copper	Arsenic, antimony, cyanide	Soil, groundwater, and surface water contamination
Summitville Mine, South Fork, CO	Gold, copper, silver	AMD, heavy metals, cyanide	Surface water contamination; fishkills
Whitewood Creek, Lawrence/Meade/Butte Co's., SD	Gold	Arsenic, cadmium, copper, manganese, other metals	Contaminated alluvial groundwater, surface water, surface soils, and vegetation
Cherokee County-Galena Subsite, Cherokee Co., KS	Lead and Zinc	Cadmium, lead, zinc, AMD	Ground and surface water contamination; contaminated soils
Oronogo-Duenweg Mining Belt, Jasper Co., MO	Lead and Zinc	Cadmium, lead, zinc	Contaminated ground and surface water, and sediments; contamination of primary drinking water supplies
Tar Creek, Ottawa Co., OK/Cherokee Co., KS	Lead and Zinc	AMD, heavy metals	Contaminated aquifer serving approx. 21,000 residents; acute surface water contamination; high mortality rate of most surface water biota
California Gulch, Leadville, CO	Gold, silver, lead, zinc, copper	AMD, cadmium, copper, lead, zinc	Contaminated surface water, groundwater, and sediments
Eagle Mine, Gilman, CO	Zinc, copper, silver	AMD, antimony, arsenic, cadmium, chromium, copper, lead, manganese, nickel, silver, thallium, uranium, zinc	Contaminated surface water and groundwater; contaminated soils and sediments
Iron Mountain Mine, Redding, CA	Gold, silver, copper, zinc, pyrite	AMD, cadmium, copper, zinc	Contamination of surface water; elimination of aquatic life; fishkills
Richardson Flat Tailings	Multiple	Arsenic, cadmium, copper, lead, selenium, zinc	Surface water contamination; possible contamination of wetlands
Smuggler Mountain, Pitkin County, CO	Silver, lead, zinc	Lead, cadmium, zinc, arsenic, barium, copper, manganese, silver, mercury	Soil contamination; potential air, ground and surface water contamination

V. POLLUTION PREVENTION OPPORTUNITIES

As a national policy, the Pollution Prevention Act of 1990 (PPA) and the Resource Conservation and Recovery Act (RCRA) encourage the reduction in volume, quantity, and toxicity of waste. While RCRA focuses primarily on the reduction in volume and/or toxicity of hazardous waste, the PPA encourages maximum possible elimination of all waste through source reduction.

In the PPA, Congress defined source reduction as any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise releases into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. Source reduction includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

The best way to reduce pollution is to prevent it in the first place. Some companies have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways, such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, employee awareness and education, and employing substitutions for toxic chemicals.

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the metal mining industry. While the list is not exhaustive, it does provide core information that can be used as a starting point for facilities interested in beginning their own pollution prevention projects. When possible, this section provides information from real activities that can or are being implemented by this sector. This section provides summary information from activities that may be, or are being implemented by this sector. When possible, information is provided that gives the context in which the techniques can be effectively used. Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector. Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects, air, land, and water pollutant releases.

Much of the information presented is drawn from EPA's OSW report on *Innovative Methods of Managing Environmental Releases at Mine sites, April 1994.*

V.A. Controlling and Mitigating Mining Wastes

Mining Water Control

As discussed previously, acid drainage is an environmental concern at many mining sites. There are no widely-applicable technologies to stop a fully-developed acid drainage situation. This makes it particularly important to prevent acid drainage before it starts. Prevention of acid drainage requires control of oxygen, water, bacteria, and sulfide minerals. Within a mine, oxygen levels cannot be controlled, so AMD prevention measures focus on control of the other three parameters, particularly on water flows.

The primary strategy for minimizing acid drainage focuses on water control. A comprehensive water control strategy works both to limit contact between water and exposed mine rock and to control the flow of water that has been contaminated by mineral-bearing rock. Development of systems for water control at mine sites requires consideration of rainfall runoff as well as process water used or produced when mine dewatering is required in excavation, concentration, and leaching. Although the type of water controls used varies widely according to topography, rock type, and climactic conditions, efforts are typically aimed at directing water flows to containment ponds for treatment or evaporation. The five principal technologies used to control water flow at mine sites are: diversion systems, containment ponds, groundwater pumping systems, subsurface drainage systems, and subsurface barriers.

Surface water is controlled by diversion systems, made up primarily of drainage ditches. Some drainage ditches channel water away from mining sites before runoff reaches exposed minerals, while others direct contaminated water into holding ponds for evaporation or treatment. The ponds used to hold leaching solutions are more sophisticated than holding ponds for mine runoff because of environmental concerns and the valuable nature of the metal-rich solutions in leaching holding ponds.

Groundwater sources can also be protected with water control systems. Groundwater pumping systems are used to control or reduce underground seepage of contaminated water from collection ponds and waste piles. Wells are drilled where underground water movement is detected, and pumps are then used to move the water out of the ground to holding ponds and/or to a treatment plant. Subsurface drainage systems are also used to control seepage in mining areas. These systems use a drain channel and wells to collect contaminated water that has seeped underground and move it to a treatment plant. Subsurface barriers are used to divert groundwater away from mining operations. The most common forms are slurry walls and grouting. Slurry walls are made of low-permeability materials that are sunk into the ground around mining operations.

Grouting involves the injection of a liquid solution, which then solidifies, into rock crevices and joints to reduce water flow. The EPA and DOE-sponsored Mining Waste Technology Program (MWTP) in Butte, Montana is conducting a clay-based grouting demonstration project at the Mike Horse Mine in Lincoln. Researchers have found that clay-based grouts retain their plasticity throughout stabilization, unlike cement-based grouts; clay grouts are not easily eroded; and clay grouts generally penetrate mine fractures better than cement-based grouts. Through this project, researchers hope to use a clay grout, developed specifically for the site's geological characteristics, to isolate specific mineralized structures within the mine. This grouting barrier will lower the groundwater flow entering the mine, reducing contact with the mine's sulfide minerals. Consequently, acid generation will decrease and lower quantities of acid and dissolved metals will be delivered to area surface water sources.

MWTP is also demonstrating a sulfate-reducing bacteria project at the nearby abandoned Lilly/Orphan Boy mine, where acid production is a continuing problem. This technology uses bacteria to reduce contamination in mine wastewater by reducing sulfates to hydrogen sulfide. This hydrogen sulfide reacts with dissolved metals, resulting in the formation of insoluble metal sulfides. Finally, the sulfate reduction produces bicarbonate, which increases the pH of the water. This biotechnology also acts as a source control by slowing or reversing the process of acid generation. Because biological sulfate reduction is an anaerobic process, it reduces the quantity of dissolved oxygen in the mine water and increases the pH, thereby slowing or stopping the production of acid. Final reporting on this demonstration project is expected after the three-year trial ends in late 1997.

Waste Rock Disposal Area and Tailing Impoundment Design

In addition to controlling water flow, acid drainage minimization also requires that waste rock disposal areas and tailings impoundments be properly designed and sited. When selecting a site for waste disposal areas, mine operators should consider the topography of the site and the proximity to groundwater, streams, and rivers. Waste rock can be sloped to minimize uncontrolled runoff and to control the velocity of water that flows into containment ponds.

Wetlands

One promising technique for treating AMD is the use of constructed wetlands. There are currently approximately 400 such systems in operation, mostly as a result of U.S. Bureau of Mines research programs. Constructed wetlands systems have been particularly effective at removing iron from acid mine water. These wetlands rely on bacterial sulfate reduction (the opposite of bacterial oxidation, the formation of acid) to remove iron and other minerals and to reduce the acidity of contaminated water. The iron is precipitated out, deposited in the substrate, and eventually accumulated by plants. Although a few wetland systems have been built to treat large flows of acid mine drainage, the technique seems best suited to handling seeps and small flows. Their effectiveness is also limited when there are large seasonal changes in flow rates, or high concentrations of nonferrous metals, as occurs in some metal mining areas.

The Dunka mine site, an iron ore mine operated by LTV Steel Mining Company (LTV SMCo) is currently using wetlands treatment methods to mitigate an existing seepage problem. The facility has experienced seepage from a specific type of acid generating waste rock found at the site. Seepage from the waste rock piles has flowed to a creek, which enters Birch Lake; a previous study estimated 50 million gallons a year of discharge. Studies conducted at the mine's active wetlands site indicate 30 percent removal of nickel and 100 percent removal of copper by peat sequestration. Overall mass analyses indicate more than 80 percent of copper entering the wetlands were retained. Other technologies currently being used at the site include pile capping to reduce infiltration; diverting the creek away from the waste rock stockpiles; and a lime neutralization treatment system for removing metals from collected waste rock seepage.

Pump and Treat

The conventional approach to treating contaminated ground or surface water produced through acid drainage involves an expensive, multi-step process that pumps polluted water to a treatment facility, neutralizes the contaminants in the water, and turns these neutralized wastes into sludge for disposal. The first step in the process, equalization, involves pumping polluted water into a holding basin. The holding basin may be the containment pond at the base of the waste rock disposal area or tailings impoundment, or may be an additional basin constructed for this purpose. A steady "equalized" flow of water is then pumped out of the holding basin to a treatment plant for neutralization. Lime is commonly added to the water in the treatment plant to neutralize the acid. The next step, aeration, involves moving the treated water to another basin where it is exposed to air. The metals precipitate typically as hydroxides, forming a gelatinous sludge. The floc then settles to the bottom of the pond as sediment. This sediment contains most of the contaminants that had previously been mixed with the water, as well as unreacted neutralizing reagents. The accumulated sludge at the bottom of the basin can then be removed for disposal.

MWTP is exploring a variety of options for improving mine wastewater treatment technologies. Among its projects is an effort to use photoassisted electron transfer to remove toxic substances, specifically nitrate and cyanide, from wastewater. Researchers are also developing new treatment technologies involving chemical precipitation, with or without aeration, to neutralize acid waters and precipitate contaminants from a nearby abandoned open-pit mine that contains over 20 billion gallons of wastewater. Final study results for this project will be published in early 1996.

Sludge Disposal

Sludge disposal is the most expensive and difficult part of acid drainage treatment. The easiest method for final disposal is to pump the sludge into abandoned mines. The long-term environmental impact of this method is undetermined. While the mine is still active, the sludge may be placed in a basin next to the sediment pond. The sludge is left in this second pond until evaporation takes place and the sludge dries. The sludge can then be transferred to an appropriate location for long-term storage or disposal.

MWTP is currently completing a research project on sludge stabilization. The research team, led by faculty at University of Montana's Montana Tech, is studying the properties and stability of sludges generated through water treatment techniques for acid-polluted water from sulfide mines. Researchers are analyzing the chemical properties of sludges, and will propose various storage environments to optimize long-term sludge stability.

Mine Planning

One way to mitigate the problems caused by acid water draining from underground and surface mines is to carefully consider a site's topography, geology, hydrogeology, geochemistry, and the like in determining approaches to ore production and the siting of such process wastes as waste rock piles, tailings impoundments, and solution ponds. Proper planning of operations can greatly reduce such environmental hazards as potential releases to ground and surface waters and AMD production.

Acid Zone Isolation

An alternative to removing acid producing zones, which may be neither feasible nor economical, is to isolate them by using a mining sequence that avoids extracting material that will create AMD-producing wastes and exposing "hot" zones. This is accomplished by leaving rock barriers between mining operations and the potential acid-producing zone, and, if necessary, grouting or otherwise sealing off the flow of water into the "hot" zone.

V.B. Innovative Waste Management Practices

New techniques for recovering metal resources that may have less of an environmental impact include *in-situ* leaching, use of robotic systems, and underground leaching. These techniques could reduce surface disturbances and eliminate waste piles and impoundments, but may have serious impacts on groundwater. Alternatively, existing waste piles may be remined to meet environmental standards, if economically feasible. Another possibility is the development of techniques to extract metals more economically from common rocks. Waste from these common rocks may not contain the hazardous components common in the sulfide ore that are the source of many metals. Industry groups suggest, however, that metals in common rock may not be present in recoverable form and amounts.

The Bureau of Mines has developed a froth flotation process to remove heavy-metal-bearing minerals from tailings. This process recovers not only the desired mineral components of the tailings, but also the acid-forming minerals, and renders the wastes less susceptible to AMD. A combination of conventional and non-conventional flotation reagents lowers the metal content of tailings by as much as 95 percent. Two other possibilities for dealing with wastes created during processing is to concentrate potential contaminants, which would then require a smaller disposal area, or to treat contaminants with a chemical or physical coating, which reduces the rate of release.

Following is an exhibit that describes some of the waste minimization/prevention opportunities for different steps of the mining process.

Exhibit 24
Waste Minimization and Prevention Opportunities

Activity	Waste	Waste Minimization Options
Flotation	Sodium cyanide	• Non-toxic reagents may be substituted for cyanide compounds in copper beneficiation; sodium sulfide/ bisulfide may be used as alternatives to sodium cyanide
	Zinc sulfate, sodium cyanide	• Flotation process control equipment w/sensors, computing elements, and control units may be installed to reduce amount of flotation reagents necessary and to improve separation of waste from product
	Ammonia	• Alkalinity in the beneficiation circuits may be maintained by reagents less toxic than ammonia, such as lime
Tailings Management	Sulfuric acid	• Pyrites could be segregated from other gangue material before discharge to tailings impoundments to reduce the potential for sulfuric acid formation after closure • Thin Layer (TL) process for copper reduces water use by as much as 75 percent as the amount needed for agitation leaching; also reduces fugitive dust generation • Up to 90 percent of metals and cyanide can be removed through use of ion exchange, heavy metal removal systems and cyanide destruction systems, precipitation of heavy metals using lime, oxidization of cyanide using sodium hypochlorite, then electrolysis, and filtration through a high flow rate sand filter
	Water (and associated pollutants)	• Water may be removed from the tailings slurry for reuse in the milling circuit
Leaching	Trace metals	• A Pachuca reactor reduces the elution time for recovering cobalt from spent copper leach solutions • Substitute thiourea, thiosulfate, malononitriles, bromine, and chlorine compounds for cyanide under certain conditions
Metal Parts Cleaning	Miscellaneous chlorinated solvents	• Switching to semi-aqueous cleaners such as terpene and hydrocarbon cleaners or aqueous cleaners which are water-based cleaning solutions would reduce or eliminate solvent emission and liquid waste generation
Blasting	Ammonium nitrate	• Maintain storage containers properly • Use used oil instead of new oil in the preparation of ANFO (if allowed by MSHA)
Crushing	Zinc liners	• Zinc mantle liner pieces in the secondary crushers may be recycled

Source: Draft Report to U.S. EPA Office of Pollution Prevention and Toxics, September 1994.

Metals Recovery

In cooperation with domestic steel makers, the Bureau of Mines has developed an innovative, efficient, and cost-effective recycling process to treat the estimated 1.8 million annual tons of iron-rich dusts and sludges that are contaminated with heavy metals, by mixing various dusts and wastes to produce recyclable metal pellets. The process has been proven on a 1,000 lb/hour pilot scale, and full scale industrial tests are being scheduled. In addition, the Bureau of Mines has worked with DOE and industry representatives to develop a 1,000 lb/hour electric arc furnace suitable for demonstrating the vitrification of mineral wastes and/or the recovery of heavy-metal-rich fume products for recycling. If the contaminated mineral wastes cannot be easily treated, furnace treatment is possible. This treatment has been shown to be effective in rendering unleachable and safe for discarding any unrecoverable trace metals left in the resulting slag.

Cyanide Removal

Bureau of Mines scientists are also investigating new methods of rinsing heaps to remove cyanide. Researchers have determined that interrupted or pulsed water rinsing, as opposed to continuous washing, more efficiently rinses cyanide from heaps and produces less liquid waste to be chemically neutralized or destroyed. Chemical neutralization methods are also being studied for a suite of cyanide complexes typically found in mining waste. In addition, an alternative to destroying cyanide or preventing its escape is the development of leaching agents other than cyanide. Several reagents such as thiourea are effective for recovering gold under certain circumstances. Thiosulfate, malononitriles, bromine, and chlorine compounds also have been shown to leach gold under specific conditions.

Reclamation

Bureau of Mines researchers are currently developing methods for reclamation and closure of mining operations. The focus of this work is on controlling hydrology at sites, decontaminating wastes when necessary, and stabilizing wastes for closure. For example, the current practice for sealing mine shafts is to install a concrete plug. This practice is difficult and expensive because it requires drilling into rock walls to provide support for the plug; access to remote shafts and portals is also a problem. One possible solution being investigated is the use of low-density foaming plastics and/or cements. The cost of the foaming plastic closure is about one-half that of concrete plugs, and the expansion characteristic of the foaming materials may eliminate the need for drilling into intact rock. Another important advantage of using foamed plastic or cement plugs is that these materials may provide a resistant seal to acidic mine waters.

Flotation Technology

Flotation mills separate metalliferrous minerals from waste rock, using surfactants to cause air bubbles to attach themselves to mineral particles and to float to the top of a frothing bath of ore slurry. The goal of flotation mill operators is to maximize the amount of valuable material floated, while minimizing the ore concentrate's gangue content. In order to also improve environmental quality, operators must minimize the amount of surfactants and heavy metals in the waste stream fed to the tailings pond. Reliable on-line measurements of metals content at various points throughout the mill is thus necessary to effect control of the operation.

X-Ray Fluorescence (XRF) is an analytical technique designed to rapidly measure the metals content of a flotation slurry sample. In mills with on-line X-ray analyzers, operators can base their responses to process changes on absolute determinations of the metals content of each stream sampled. In its simplest form the operator uses output information from the analyzer to adjust surfactant addition rates to meet quality goals. Some mills are moving toward a more advanced system of incorporating XRF technology, using central computers to store historical data and/or a detailed model of the total process to establish automatic control setpoints.

This technology is now in use at the Doe Run Fletcher mill, which beneficiates a mixed sulfide ore. During the flotation process, assay data from the XRF unit is sent to a process control computer. Flowmeter readings from all of the reagent addition lines are also sent to the computer, as are the outputs from a variety of process monitors. The computer displays most of this data on an operator console in the mill control room. Based on the data presented, the operator can vary the reagent addition rates to obtain better mineral separation. The computer maintains an archive of the historical behavior of the mill, enabling mill managers to specify empirical formulae relating reagent needs to assay results.

Use of an on-line X-ray analyzer, coupled with a process control computer, greatly simplifies the operation of a mill. One mill required 24 operators, three engineers, and three supervisors before this technology was introduced; it now requires about eight staff to operate. Benefits associated with this process control technology may include a decrease in reagent consumption, a significant environmental benefit; a stabilized process, increasing metal recovery rates; and more effective grinding control, allowing an increase in mill tonnage throughput. Doe Run estimates its cost savings to approach $785,000 per year, including a 14 percent reduction in reagent costs per year and improved metallurgy resulting from higher purity concentrates. In addition, the technology has resulted in a reduction of 4,500 to 5,000 pounds of metal entering the tailings pond per day.

Pyrite Flotation

At the Superior Mine in Arizona, Magma Copper Company is currently producing a high grade pyrite product by subjecting copper tailings to an additional flotation circuit. Instead of generating a tailings high in sulfide, the facility produces less reactive tailings and two marketable pyrite products.

Pyrite easily oxidizes to form sulfuric acid and, at many mine sites, is associated with acid generation from tailings piles and other mining activities. Removing pyrite prior to discharging the tailings will decrease the potential for acid generation from tailings, which may in turn minimize possible waste treatment and remediation costs.

Magma's pyrite flotation circuit is similar to its copper flotation circuit and uses existing flotation equipment. Operators use reagents to float pyrite from copper tailings, producing a 99 percent pure pyrite concentrate. This concentrate is pumped to a settling pond for dewatering after exiting the flotation circuit. As the pyrite dries, it is excavated from the pond and sent to the plant to package for sale.

Currently, the operation of pyrite flotation circuit is demand-driven, with the circuit used only as needed to meet the demand for the pyrite product. At other times, the pyrite is discharged with the tailings to the tailings impoundment. According to Magma's facility personnel, "breaking even" financially with the pyrite flotation project is a satisfactory result because of the resultant savings or avoidance of waste treatment costs associated with acid generation caused by pyrite in the tailings.

Possible limitations to widespread application of this technology are related to the Superior Mine's unique ore, in which pyrite concentration reaches 25 percent (concentration at most copper mines is closer to five percent). Lower pyrite concentrations in other ore may make pyrite flotation more difficult and/or expensive. In addition, because the operation is demand-driven and operates only when needed, pyrite is removed from only a portion of the copper tailings.

Tailings Reprocessing

Magma Copper is also recovering additional copper from a tailings pile at its Pinto Valley operation. The tailings pile covers 210 acres and contains 38 million tons of tailings; it was deposited between 1911 and 1932. Pinto Valley hydraulically mines the tailings pile, leaches the tailings, and produces copper by using a SX/EW facility. After leaching and washing of the slurried tailings, the remaining slurry is piped overland approximately five miles to an abandoned open copper pit mine for final disposal.

The pile's oldest tailings contain .72 percent copper, while those deposited most recently contain .11 percent copper; Magma thus pre-strips the top layer in order to get to an economically recoverable zone. Magma still reprocesses this pre-stripped layer, although the copper recovered is extremely low.

The hydraulic mining system's water jets and vacuum pumps break down clay aggregates, allowing more efficient tailings separation, and renders the tailings into a slurry for beneficiation processes. The slurry first enters a leach tank, then goes to the first of two thickeners. Overflow from this thickener becomes the pregnant leach solution (PLS), which is sent to the solvent extraction circuit. The underflow from the first thickener is pumped to a second thickener. Overflow from this thickener is returned to the mining circuit as feed for the hydraulic operations; the underflow is pumped into a tailings disposal area. Magma uses the same SX/EW operation for reprocessed tailings and its in situ leach operation; there is no difference between the SX/EW operation for the reprocessed tailings and other SX/EW plants in use at other copper sites.

According to facility personnel, the operation has recently been financially profitable due to the increase of copper prices and is expected to continue to be profitable in the future. Environmentally, the benefit derived from the operation results from the removal of the tailings pile located in a drainage adjacent to a town and redepositing the tailings in an abandoned open pit in a relatively remote location. Magma credits the success of this operation to the high concentration of copper present in the tailings; other sites may have a lower percentage of copper in the tailings, which may make reprocessing less economical.

Pipe Recycling/Reuse

IMC operates phosphate rock mines in West Central Florida, and has implemented a waste minimization program involving the reuse and recycling of steel pipe used to transport slurry, water, tailings, and other materials. IMC obtains maximum use from its pipe in several ways:

- Pipe used for matrix and clay transport is periodically rotated to ensure that wear is evenly spaced over the full diameter of the pipe
- To the extent possible, pipe no longer suitable for the most demanding use is used in other, less demanding pipelines
- Pipe no longer suitable for use in pipelines is either used for other purposes (such as culverts) or is sold for off-site reuse or scrap.

IMC has developed a computerized model to predict how long a section of pipe can remain in each position and when it needs to be turned. When pipe can no longer be used for materials transport, any undamaged portions of pipe are removed for onsite reuse as culvert or sold to a local scrap dealer as usable pipe. Damaged pipe is sold to a scrap dealer. By reusing pipe onsite, IMC estimates that it saves approximately $1.5 million each year. In 1991, $316,000 was received for pipe that could be reused offsite, and 4,200 tons of scrap piping was sold for an estimated total of $42,000 - $84,000. IMC's program reduces capital expenditures by reducing the amount of new pipe that must be purchased, as well as saving operating costs by avoiding costly shutdowns when pipes fail.

Mine Tire Recycling

Mine representatives have estimated the price of one large tire to range from $10,000 to $16,000, or over $100,000 to fit one large piece of equipment. Several options exist for recycling or reusing whole large tires. One alternative is retreading the tires for reuse; retreading reduces the demand for new tires and conserves resources (retreading a used tire requires less than 40 percent of the fossil fuel to make a new tire). The purchase price for retreaded tires is less than for new tires, providing an additional savings incentive. In addition to retreading, whole scrap tires are used in civil engineering applications, including construction, erosion control, and agriculture (feeding troughs, for example).

Processing scrap tires involves shearing, cutting and/or shredding tires into smaller pieces. The major markets for processed tires are as tire derived fuel and in civil engineering applications. Scrap tires are an excellent fuel source, generating about 80 percent as much energy as crude oil per pound. In recent years, there have been major increases in the use of scrap tires as fuel by a number of industries, including power plants, cement kilns, pulp and paper mills, and tire manufacturing facilities.

Mining companies may be able to access the tire retreading market through their current tire vendors. Depending on their condition and suitability, some vendors may offer reimbursement for used tires. Cobre, a tire vendor for the Dee Gold Mine, performs on-site evaluations of used tires to determine each tire's potential for retreading. If a tire is retreadable, Dee Gold Mine is reimbursed $500 per tire; if it isn't, Cobre will remove the tire free of charge.

Two major impediments to recycling mine vehicle tires are the distance to existing resource recovery markets and the size of these large scrap tires. Large mining operations are not usually located near their potential markets in larger cities. For remote mine locations, some added effort may be necessary to find or develop markets. In order to reduce size and handling difficulties associated with used mine tires, shredders or shears may be used to cut large tires into pieces more suited to handling.

Mine Water Management

One of the major concerns regarding runoff from mining activities is the potential for acid generation and metal mobilization in waste associated with mining. Sources of potentially contaminated non-process waters at a mine site include: seepage from underground mine workings; runoff from abandoned/inactive mines; runoff from waste rock, overburden, and tailings piles; overflow from ponds or pits, especially during high precipitation or snow melt events; runoff from chemical storage areas; former mining and processing areas with contaminated residue; leaks from liquid/slurry transport lines; and runoff from other areas disturbed by mining operations.

Effective practices for managing and controlling runon/runoff are also known as best management practices, or BMPs. BMPs can be measures or practices used to reduce the amount of pollution entering surface or groundwater, air, or land, and may take the form of a process, activity, or physical structure. BMPs include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, waste disposal, drainage from raw material storage or other disturbed areas. BMPs applicable to mine site discharges can be divided into three general areas: 1) construction/reclamation; 2) management and housekeeping; and 3) treatment. The following table provides examples of specific techniques used within each of these areas.

Exhibit 25
Mine Water Management Techniques

Construction/Reclamation Techniques	Management & Housekeeping Techniques	Treatment Techniques
Diversion ditches and drainage systems	Comprehensive pollution prevention plan	Sedimentation basins Oil/water separators
Rip-rap	Immediate spill clean-up	Neutralization
Dikes and berms	Inspection	Artificial wetlands
Grading or terracing	Training and education	
Collection basins	Routine maintenance	
Capping or sealing	Proper handling procedures	
Vegetation and mulching	Periodic systems reviews	
Silt fences		

The following cases illustrate how some facilities are approaching water management at their operations. First, the Hayden Hill Project is operated in Lassen County, California by Lassen Gold Mining, Inc., a subsidiary of Amax Gold Inc.. Amax Gold won a California Mining Association award for its facility reclamation plan, and the 1992 DuPont/Conoco Environmental Leadership Award for environmental excellence in the precious metals industry. Mining operations include an open pit mine, waste rock disposal area, a heap leach pad, and mill processing facilities.

Storm water control measures undertaken at Hayden Hill include:

- Baseline and continual monitoring of ground and surface water
- Double liner and leak detection for heap leach pad and processing ponds
- Lined tailings impoundment, with a surrounding freeboard berm to protect against runon and overflow
- Erosion control measures, such as retention ponds to intercept runoff and stream crossing constructed during low flow periods
- Protection of stream bank to prevent grazing impacts
- Groundwater springs near the open pit will be rerouted

- Diversion of natural drainage around the heap leach pad
- Solution pipes located in lined ditches.

In addition, all runoff from the shops and warehouse areas is collected in a storm water collection ditch; above the mill area are storm water diversion ditches to route storm water around the mill to avoid potential contact with material at the mill. The waste rock dump basin is designed with interior benches that slope towards the inside of the basin to allow storm water to be captured as it flows across the bench. These "V" ditches will drain the runoff to a heap toe drain.

Revegetation will be an important step in the mine's reclamation. To aid this effort, various erosion controls will be used, including rip-rap in shallow interception ditches, sediment collection basins, rock dikes, and straw bales as check dams around culverts. Expectations are to return the site to livestock grazing, watershed protection, wildlife habitat, and recreational use after mining is complete.

The Cyprus Bagdad Mine, operated by the Cyprus Bagdad Copper Corporation in Baghdad, Arizona, is another facility using an integrated approach to water management as part of its pollution prevention plan. Cyprus' pollution prevention plan was prepared in response to Arizona Department of Environmental Quality requirements, and addresses many areas of the facility, including non-mining activities such as vehicle fueling.

Examples of Cyprus' pollution prevention controls include:

- Diversion ditches to carry runoff away from the solvent exchange leach and tailings disposal areas; regular ditch inspections and repairs
- Runoff and spills channeled to collection basins and surge ponds; planned upgrades for many existing ponds with double liners and leak detection systems
- Earthen berms around petroleum tanks to prevent runon from contacting the tank and surrounding areas
- Visual leak / spill inspections of tailing disposal, reclaim water, seepage return, and leaching systems
- Redirection and control of water from mine shop parking lot

- Collection and recycling of spilled fuel and oil; monitor equipment areas for spilled fuel and oil
- Cover copper-concentrate trucks with heavy tarps to prevent in transit losses; store concentrate on concrete and asphalt pads
- Construction of a lined impoundment and oil/water separator at truck wash area; chlorinated solvents no longer used at the truck wash, eliminating a contaminant source.

A notable feature of Cyprus' pollution prevention and control plan is its comprehensiveness. All facets of facility operation are addressed, including frequency of routine maintenance and inspections; employee training; supervisor maintenance of monitoring logs; emergency backup systems testing, inspection of piping, sumps, and liners; and monitoring pump rates and pond and dam elevations.

Lastly, the Valdez Creek Mine in Cantwell, Alaska is using stream diversion to both improve access to ore and prevent stream discharges. In order to access ore sources beneath an active stream channel, the Valdez Creek was diverted by constructing a diversion dam upstream of the active pit; the dam impounds water, which then flows through the diversion channel approximately one mile before rejoining the stream. The diversion channel is lined with a synthetic liner and rip-rap to prevent erosion and incision of the channel. To aid water management in the active pit, the facility uses two diversion ditches on either side of the valley above the mined area to intercept runoff before it reaches the pit.

The lined diversion channel for Valdez Creek and the diversion ditches minimize impact to the downstream environment by reducing turbidity and sedimentation caused by mining operations. Stream diversion not only prevents stream discharges, but also improves access to the ore and has lowered operating costs by reducing pit dewatering requirements.

VI. SUMMARY OF FEDERAL STATUTES AND REGULATIONS

This section discusses the Federal statutes and regulations that may apply to this sector. The purpose of this section is to highlight, and briefly describe the applicable Federal requirements, and to provide citations for more detailed information. The three following sections are included.

- Section IV.A contains a general overview of major statutes
- Section IV.B contains a list of regulations specific to this industry
- Section IV.C contains a list of pending and proposed regulations

The descriptions within Section IV are intended solely for general information. Depending upon the nature or scope of the activities at a particular facility, these summaries may or may not necessarily describe all applicable environmental requirements. Moreover, they do not constitute formal interpretations or clarifications of the statutes and regulations. For further information, readers should consult the Code of Federal Regulations and other state or local regulatory agencies. EPA Hotline contacts are also provided for each major statute.

VI.A. General Description of Major Statutes

Resource Conservation And Recovery Act

The Resource Conservation And Recovery Act (RCRA) of 1976 which amended the Solid Waste Disposal Act, addresses solid (Subtitle D) and hazardous (Subtitle C) waste management activities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 strengthened RCRA's waste management provisions and added Subtitle I, which governs underground storage tanks (USTs).

Regulations promulgated pursuant to Subtitle C of RCRA (40 CFR Parts 260-299) establish a "cradle-to-grave" system governing hazardous waste from the point of generation to disposal. RCRA hazardous wastes include the specific materials listed in the regulations (commercial chemical products, designated with the code "P" or "U"; hazardous wastes from specific industries/sources, designated with the code "K"; or hazardous wastes from non-specific sources, designated with the code "F") or materials which exhibit a hazardous waste characteristic (ignitability, corrosivity, reactivity, or toxicity and designated with the code "D").

Regulated entities that generate hazardous waste are subject to waste accumulation, manifesting, and recordkeeping standards. Facilities that treat, store, or dispose of hazardous waste must obtain a permit, either from EPA or from a State agency which EPA has authorized to implement the permitting program. Subtitle C permits contain general facility standards such as contingency plans, emergency procedures, recordkeeping and reporting requirements, financial assurance mechanisms, and unit-specific standards. RCRA also contains provisions (40 CFR Part 264 Subpart S and §264.10) for conducting corrective actions which govern the cleanup of releases of hazardous waste or constituents from solid waste management units at RCRA-regulated facilities.

Although RCRA is a Federal statute, many States implement the RCRA program. Currently, EPA has delegated its authority to implement various provisions of RCRA to 46 of the 50 States.

Most RCRA requirements are not industry specific but apply to any company that transports, treats, stores, or disposes of hazardous waste. Here are some important RCRA regulatory requirements:

- **Identification of Solid and Hazardous Wastes** (40 CFR Part 261) lays out the procedure every generator should follow to determine whether the material created is considered a hazardous waste, solid waste, or is exempted from regulation.

- **Standards for Generators of Hazardous Waste** (40 CFR Part 262) establishes the responsibilities of hazardous waste generators including obtaining an ID number, preparing a manifest, ensuring proper packaging and labeling, meeting standards for waste accumulation units, and recordkeeping and reporting requirements. Generators can accumulate hazardous waste for up to 90 days (or 180 days depending on the amount of waste generated) without obtaining a permit.

- **Land Disposal Restrictions** (LDRs) are regulations prohibiting the disposal of hazardous waste on land without prior treatment. Under the LDRs (40 CFR 268), materials must meet land disposal restriction (LDR) treatment standards prior to placement in a RCRA land disposal unit (landfill, land treatment unit, waste pile, or surface impoundment). Wastes subject to the LDRs include solvents, electroplating wastes, heavy metals, and acids. Generators of waste subject to the LDRs must provide notification of such to the designated TSD facility to ensure proper treatment prior to disposal.

- **Used Oil Management Standards** (40 CFR Part 279) impose management requirements affecting the storage, transportation, burning, processing, and re-refining of the used oil. For parties that merely generate used oil, regulations establish storage standards. For a party considered a used oil marketer (one who generates and sells off-specification used oil directly to a used oil burner), additional tracking and paperwork requirements must be satisfied.

- **Tanks and Containers** used to store hazardous waste with a high volatile organic concentration must meet emission standards under RCRA. Regulations (40 CFR Part 264-265, Subpart CC) require generators to test the waste to determine the concentration of the waste, to satisfy tank and container emissions standards, and to inspect and monitor regulated units. These regulations apply to all facilities who store such waste, including generators operating under the 90-day accumulation rule.

- **Underground Storage Tanks** (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA. Subtitle I regulations (40 CFR Part 280) contain tank design and release detection requirements, as well as financial responsibility and corrective action standards for USTs. The UST program also establishes increasingly stringent standards, including upgrade requirements for existing tanks, that must be met by 1998.

- **Boilers and Industrial Furnaces** (BIFs) that use or burn fuel containing hazardous waste must comply with strict design and operating standards. BIF regulations (40 CFR Part 266, Subpart H) address unit design, provide performance standards, require emissions monitoring, and restrict the type of waste that may be burned.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, responds to questions and distributes guidance regarding all RCRA regulations. The RCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., EST, excluding Federal holidays.

Comprehensive Environmental Response, Compensation, And Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a 1980 law commonly known as Superfund, authorizes EPA to respond to releases, or threatened releases, of hazardous substances that may endanger public health, welfare, or the environment. CERCLA also enables EPA to force parties responsible for environmental contamination to clean it up or to reimburse the Superfund for response costs incurred by EPA. The Superfund Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for the Superfund, and created a free-standing law, SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The CERCLA **hazardous substance release reporting regulations** (40 CFR Part 302) direct the person in charge of a facility to report to the National Response Center (NRC) any environmental release of a hazardous substance which exceeds a reportable quantity. Reportable quantities are defined and listed in 40 CFR § 302.4. A release report may trigger a response by EPA, or by one or more Federal or State emergency response authorities.

EPA implements **hazardous substance responses** according to procedures outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as "removals." EPA generally takes remedial actions only at sites on the National Priorities List (NPL), which currently includes approximately 1300 sites. Both EPA and states can act at other sites; however, EPA provides responsible parties the opportunity to conduct removal and remedial actions and encourages community involvement throughout the Superfund response process.

EPA's RCRA/Superfund/UST Hotline, at (800) 424-9346, answers questions and references guidance pertaining to the Superfund program. The CERCLA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., EST, excluding Federal holidays.

Emergency Planning And Community Right-To-Know Act

The Superfund Amendments and Reauthorization Act (SARA) of 1986 created the Emergency Planning and Community Right-to-Know Act (EPCRA, also known as SARA Title III), a statute designed to improve community access to information about chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA required the establishment of State emergency response commissions (SERCs), responsible for coordinating certain emergency response activities and for appointing local emergency planning committees (LEPCs).

EPCRA and the EPCRA regulations (40 CFR Parts 350-372) establish four types of reporting obligations for facilities which store or manage specified chemicals:

- **EPCRA §302** requires facilities to notify the SERC and LEPC of the presence of any "extremely hazardous substance" (the list of such substances is in 40 CFR Part 355, Appendices A and B) if it has such substance in excess of the substance's threshold planning quantity, and directs the facility to appoint an emergency response coordinator.

- **EPCRA §304** requires the facility to notify the SERC and the LEPC in the event of a release exceeding the reportable quantity of a CERCLA hazardous substance or an EPCRA extremely hazardous substance.

- **EPCRA §§311 and 312** require a facility at which a hazardous chemical, as defined by the Occupational Safety and Health Act, is present in an amount exceeding a specified threshold to submit to the SERC, LEPC, and local fire department material safety data sheets (MSDSs) or lists of MSDSs and hazardous chemical inventory forms (also known as Tier I and II forms). This information helps the local government respond in the event of a spill or release of the chemical.

- **EPCRA §313** requires manufacturing facilities included in SIC codes 20 through 39, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report. This report, commonly known as the Form R, covers releases and transfers of toxic chemicals to various facilities and environmental media, and allows EPA to compile the national Toxic Release Inventory (TRI) database.

All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

EPA's EPCRA Hotline, at (800) 535-0202, answers questions and distributes guidance regarding the emergency planning and community right-to-know regulations. The EPCRA Hotline operates weekdays from 8:30 a.m. to 7:30 p.m., EST, excluding Federal holidays.

Clean Water Act

The primary objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority.

The CWA regulates both direct and indirect discharges. The **National Pollutant Discharge Elimination System (NPDES)** program (CWA §402) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits, issued by either EPA or an authorized State (EPA has presently authorized forty States to administer the NPDES program), contain industry-specific, technology-based and/or water quality-based limits, and establish pollutant monitoring and reporting requirements. A facility that intends to discharge into the nation's waters must obtain a permit prior to initiating its discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set forth the conditions and effluent limitations under which a facility may make a discharge.

A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards, that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs. Water quality criteria and standards vary from State to State, and site to site, depending on the use classification of the receiving body of water. Most States follow EPA guidelines which propose aquatic life and human health criteria for many of the 126 priority pollutants.

Storm Water Discharges

In 1987 the CWA was amended to require EPA to establish a program to address **storm water discharges**. In response, EPA promulgated the NPDES storm water permit application regulations. Storm water discharge associated with industrial activity means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant (40 CFR 122.26(b)(14)). These regulations require that facilities with the following storm water discharges apply for a NPDES permit: (1) a discharge associated with industrial activity; (2) a discharge from a large or medium municipal storm sewer system; or (3) a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

The term "storm water discharge associated with industrial activity" means a storm water discharge from one of 11 categories of industrial activity defined at 40 CFR 122.26. Six of the categories are defined by SIC codes while the other five are identified through narrative descriptions of the regulated industrial activity. If the primary SIC code of the facility is one of those identified in the regulations, the facility is subject to the storm water permit application requirements. If any activity at a facility is covered by one of the five narrative categories, storm water discharges from those areas where the activities occur are subject to storm water discharge permit application requirements.

Those facilities/activities that are subject to storm water discharge permit application requirements are identified below. To determine whether a particular facility falls within one of these categories, the regulation should be consulted.

Category i: Facilities subject to storm water effluent guidelines, new source performance standards, or toxic pollutant effluent standards.

Category ii: Facilities classified as SIC 24-lumber and wood products (except wood kitchen cabinets); SIC 26-paper and allied products (except paperboard containers and products); SIC 28-chemicals and allied products (except drugs and paints); SIC 29-petroleum refining; and SIC 311-leather tanning and finishing.

Category iii: Facilities classified as SIC 10-metal mining; SIC 12-coal mining; SIC 13-oil and gas extraction; and SIC 14-nonmetallic mineral mining.

Category iv: Hazardous waste treatment, storage, or disposal facilities.

Category v: Landfills, land application sites, and open dumps that receive or have received industrial wastes.

Category vi: Facilities classified as SIC 5015-used motor vehicle parts; and SIC 5093-automotive scrap and waste material recycling facilities.

Category vii: Steam electric power generating facilities.

Category viii: Facilities classified as SIC 40-railroad transportation; SIC 41-local passenger transportation; SIC 42-trucking and warehousing (except public warehousing and storage); SIC 43-U.S. Postal Service; SIC

44-water transportation; SIC 45-transportation by air; and SIC 5171-petroleum bulk storage stations and terminals.

Category ix: Sewage treatment works.

Category x: Construction activities except operations that result in the disturbance of less than five acres of total land area.

Category xi: Facilities classified as SIC 20-food and kindred products; SIC 21-tobacco products; SIC 22-textile mill products; SIC 23-apparel related products; SIC 2434-wood kitchen cabinets manufacturing; SIC 25-furniture and fixtures; SIC 265-paperboard containers and boxes; SIC 267-converted paper and paperboard products; SIC 27-printing, publishing, and allied industries; SIC 283-drugs; SIC 285-paints, varnishes, lacquer, enamels, and allied products; SIC 30-rubber and plastics; SIC 31-leather and leather products (except leather and tanning and finishing); SIC 323-glass products; SIC 34-fabricated metal products (except fabricated structural metal); SIC 35-industrial and commercial machinery and computer equipment; SIC 36-electronic and other electrical equipment and components; SIC 37-transportation equipment (except ship and boat building and repairing); SIC 38-measuring, analyzing, and controlling instruments; SIC 39-miscellaneous manufacturing industries; and SIC 4221-4225-public warehousing and storage.

Pretreatment Program

Another type of discharge that is regulated by the CWA is one that goes to a publicly-owned treatment works (POTWs). The national **pretreatment program** (CWA §307(b)) controls the indirect discharge of pollutants to POTWs by "industrial users." Facilities regulated under §307(b) must meet certain pretreatment standards. The goal of the pretreatment program is to protect municipal wastewater treatment plants from damage that may occur when hazardous, toxic, or other wastes are discharged into a sewer system and to protect the quality of sludge generated by these plants. Discharges to a POTW are regulated primarily by the POTW itself, rather than the State or EPA.

EPA has developed technology-based standards for industrial users of POTWs. Different standards apply to existing and new sources within each category. "Categorical" pretreatment standards applicable to an industry on a nationwide basis are developed by EPA. In addition, another kind of pretreatment standard, "local limits," are developed by the POTW in order to assist the POTW in achieving the effluent limitations in its NPDES permit.

Regardless of whether a State is authorized to implement either the NPDES or the pretreatment program, if it develops its own program, it may enforce requirements more stringent than Federal standards.

EPA's Office of Water, at (202) 260-5700, will direct callers with questions about the CWA to the appropriate EPA office. EPA also maintains a bibliographic database of Office of Water publications which can be accessed through the Ground Water and Drinking Water resource center, at (202) 260-7786.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) mandates that EPA establish regulations to protect human health from contaminants in drinking water. The law authorizes EPA to develop national drinking water standards and to create a joint Federal-State system to ensure compliance with these standards. The SDWA also directs EPA to protect underground sources of drinking water through the control of underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its SDWA authority. EPA and authorized States enforce the primary drinking water standards, which are contaminant-specific concentration limits that apply to certain public drinking water supplies. Primary drinking water standards consist of maximum contaminant level goals (MCLGs), which are non-enforceable health-based goals, and maximum contaminant levels (MCLs), which are enforceable limits set as close to MCLGs as possible, considering cost and feasibility of attainment.

The SDWA **Underground Injection Control (UIC)** program (40 CFR Parts 144-148) is a permit program which protects underground sources of drinking water by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA land disposal restrictions standards. The UIC permit program is primarily State-enforced, since EPA has authorized all but a few States to administer the program.

The SDWA also provides for a Federally-implemented Sole Source Aquifer program, which prohibits Federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area, and for a State-implemented Wellhead Protection program, designed to protect drinking water wells and drinking water recharge areas.

EPA's Safe Drinking Water Hotline, at (800) 426-4791, answers questions and distributes guidance pertaining to SDWA standards. The Hotline operates from 9:00 a.m. through 5:30 p.m., EST, excluding Federal holidays.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) granted EPA authority to create a regulatory framework to collect data on chemicals in order to evaluate, assess, mitigate, and control risks which may be posed by their manufacture, processing, and use. TSCA provides a variety of control methods to prevent chemicals from posing unreasonable risk.

TSCA standards may apply at any point during a chemical's life cycle. Under TSCA §5, EPA has established an inventory of chemical substances. If a chemical is not already on the inventory, and has not been excluded by TSCA, a premanufacture notice (PMN) must be submitted to EPA prior to manufacture or import. The PMN must identify the chemical and provide available information on health and environmental effects. If available data are not sufficient to evaluate the chemical's effects, EPA can impose restrictions pending the development of information on its health and environmental effects. EPA can also restrict significant new uses of chemicals based upon factors such as the projected volume and use of the chemical.

Under TSCA §6, EPA can ban the manufacture or distribution in commerce, limit the use, require labeling, or place other restrictions on chemicals that pose unreasonable risks. Among the chemicals EPA regulates under §6 authority are asbestos, chlorofluorocarbons (CFCs), and polychlorinated biphenyls (PCBs).

EPA's TSCA Assistance Information Service, at (202) 554-1404, answers questions and distributes guidance pertaining to Toxic Substances Control Act standards. The Service operates from 8:30 a.m. through 4:30 p.m., EST, excluding Federal holidays.

Clean Air Act

The Clean Air Act (CAA) and its amendments, including the Clean Air Act Amendments (CAAA) of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50-99.

Pursuant to Title I of the CAA, EPA has established national ambient air quality standards (NAAQSs) to limit levels of "criteria pollutants," including carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur dioxide. Geographic areas that meet NAAQSs for a given pollutant are classified as attainment areas; those that do not meet NAAQSs are classified as non-attainment areas. Under §110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards.

Title I also authorizes EPA to establish New Source Performance Standards (NSPSs), which are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPSs are based on the pollution control technology available to that category of industrial source but allow the affected industries the flexibility to devise a cost-effective means of reducing emissions.

Under Title I, EPA establishes and enforces National Emission Standards for Hazardous Air Pollutants (NESHAPs), nationally uniform standards oriented towards controlling particular hazardous air pollutants (HAPs). Title III of the CAAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards will be developed for both new and existing sources based on "maximum achievable control technology" (MACT). The MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors.

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapor recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV establishes a sulfur dioxide emissions program designed to reduce the formation of acid rain. Reduction of sulfur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which, beginning in 1995, will be set below previous levels of sulfur dioxide releases.

Title V of the CAAA of 1990 created a permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing the permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State.

Title VI is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restrict their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs), will be phased out entirely by the year 2000, while certain hydrochlorofluorocarbons (HCFCs) will be phased out by 2030.

EPA's Control Technology Center, at (919) 541-0800, provides general assistance and information on CAA standards. The Stratospheric Ozone Information Hotline, at (800) 296-1996, provides general information about regulations promulgated under Title VI of the CAA, and EPA's EPCRA Hotline, at (800) 535-0202, answers questions about accidental release prevention under CAA §112(r). In addition, the Technology Transfer Network Bulletin Board System (modem access (919) 541-5742)) includes recent CAA rules, EPA guidance documents, and updates of EPA activities.

VI.B. Industry-Specific Requirements

Three types of laws govern and/or regulate the mining of metal resources. The first type, (i.e., the Mining in National Parks Act and the Wild and Scenic Rivers Act), define areas that are off-limits to metal mining. The second type of law, (i.e., the General Mining Law of 1872), defines methods for allocating metal deposits for extraction. The third type of law, those governing the extraction process and establishing restrictions on the types and amounts of wastes that may be generated, comprises most of the following discussion.

General Mining Law of 1872

The General Mining Law of 1872 is one of the major statutes that direct the Federal government's land management policy. The Mining Law grants free access to individuals and corporations to prospect for minerals in public domain lands, and allows them, on discovery, to stake a claim on that deposit. According to staff in EPA's Office of Solid Waste, roughly 40 percent of U.S. mines operate under this provision.

The Bureau of Land Management (BLM), under the Department of the Interior, has authority to regulate these mining claim operations under the Federal Land Policy and Management Act (FLPMA) of 1976. FLPMA established BLM's general land management and planning authority (43 CFR Part 3809), and requires that mining operations on Federal lands are regulated to prevent "unnecessary and undue degradation."

While mining operations are subject to varying levels of scrutiny, all operations must be reclaimed and must comply with all applicable State and Federal laws, including air and water quality standards such as those established under the CAA and CWA, and standards for the disposal of solid waste under RCRA.

In addition to requiring reclamation bond posting, BLM requires mining operations that involve cyanide leaching to meet the following standards:

- Fencing must be used to ensure protection of the public, livestock, and wildlife
- Facilities must be designed to contain the maximum operating water balance in addition to the water from a 100-year, 24-hour storm event; containment ponds must be included in all containment systems
- Leakage detection and recovery systems must be designed for heap and solution containment structures; monitoring of ground and surface water through closure and final reclamation is required
- Cyanide solution and heaps must be neutralized or detoxified.

Although BLM has general management authority for the mineral resources on Federal lands, the Forest Service (FS) also regulates mining activities on Forest Service land, with a similar mandate to minimize adverse environmental impacts. The National Forest Management Act of 1976 provides the Forest Service with authorities and responsibilities similar to those provided to BLM by FLPMA. Like BLM's regulations, they require compliance with the Clean Water Act and other environmental statutes and regulations. FS generally consults with appropriate agencies of the Department of the Interior, including BLM, in reviewing technical aspects of proposed mining operations. FS also conducts environmental assessments of proposed plans and, if necessary, prepares EISs pursuant to the National Environmental Policy Act. FS also specifies standards for reclamation and may require bond posting.

EPA is currently pursuing a Memorandum of Understanding (MOU) with the Department of the Interior to formally coordinate regulatory and enforcement efforts concerning mining operations on Federal lands. Ongoing enforcement efforts are commonly coordinated with BLM State offices, as part of a broader strategy to simplify and coordinate oversight of mining operations at the State and Federal level.

Clean Water Act (CWA)

Under the Clean Water Act, National Pollution Discharge Elimination System (NPDES) permits must be acquired before any pollutant can be discharged from a point source into U.S. waters. EPA has established national technology-based effluent limitation guidelines for ore mining and dressing operations (40 CFR Part 440). These include new source performance standards based on Best Available Demonstrated Technology (BADT). For mine and mill point source discharges, 40 CFR Part 440 establishes the maximum levels of pollutants that can be released daily and monthly. The discharger must not exceed the daily allowance nor the average allowed over an entire month in order to comply with regulations. For most metals, the monthly averages are one-half the daily maximums for metal pollutants.

Contaminated storm water runoff from some mining operations has been documented as causing water quality degradation, according to a Technical Resource Document on extraction and beneficiation of copper by EPA's OSW. In the past, point source storm water discharges have received limited emphasis under the NDPES program. However, EPA has promulgated regulations that specifically address point source discharges of storm water from industrial facilities, including active and inactive/abandoned mine sites (55 FR 47990; November 16, 1990). These regulations require NPDES permits for all discharges of contaminated storm water. The Water Quality Act of 1987 added §402(p)(2)(B), requiring that point source discharges of storm water associated with industrial activity (including active and inactive mining operations) be permitted by October, 1992. This provision includes discharges from "areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water." The storm water permitting regulations address discharges from mine sites that occur as a result of precipitation events where the runoff from those sites is contaminated by exposed overburden, raw material, intermediate products, finished products, byproducts, or waste materials resulting from present or past mining activities.

In the case of active mine sites, the storm water regulations apply to both storm water discharges from mining operations as well as to areas used for the storage and maintenance of material handling equipment, shipping and receiving areas, and haul roads. For inactive or abandoned mines, all point source discharges of contaminated storm water (i.e., storm water that has come into contact with mine facilities, materials or wastes) must be covered under an NPDES storm water permit. Some storm water discharges from mine sites are not subject to NPDES permitting, including storm water that is not contaminated by contact with overburden, raw material, or waste materials located on the site of the operation.

The following exhibit highlights examples of discharges from ore mining and dressing facilities that are subject to 40 CFR Part 440 or to storm water permitting.

Exhibit 26
Mine Discharges Subject to Permitting

Runoff/drainage discharges subject to 40 CFR Part 440 effluent limitation guidelines	**Subject to storm water permitting (not subject to 40 CFR Part 440)**
Land application area Crusher area Spent ore piles, surge piles, ore stockpiles, waste rock/overburden piles Pumped and unpumped drainage and mine water from pits/underground mines Seeps/French drains On-site haul roads, if constructed of waste rock or spent ore or if wastewater subject to mine drainage limits is used for dust control Tailings dams/dikes when constructed of waste rock/tailings Unreclaimed disturbed areas	Topsoil piles Haul roads not on active mining area On-site haul roads not constructed of waste rock or spent ore (unless wastewater subject to mine drainage limits is used for dust control) Tailings dams, dikes when not constructed of waste rock/tailings Concentration/mill building/site (if discharge is storm water only, with no contact with piles) Reclaimed areas released from reclamation bonds prior to 12/17/90 Partially, inadequately reclaimed areas or areas not released from reclamation bond Most ancillary areas (e.g., chemical and explosives storage, power plant, equipment/truck maintenance and wash areas, etc.)

The concentration of pollutants discharged in mine drainage from mines operated to obtain copper bearing ores, lead bearing ores, zinc bearing ores, gold bearing ores, silver bearing ores, or any combination of these ores in open-pit or underground operations other than placer deposits shall not exceed:

Exhibit 27
Mine Discharge Limitations

Effluent Characteristic	Maximum of any 1 day (mg/l)	Average of daily values for 30 days (mg/l)
TSS	30	20
Cu	30	15
Zn	15	7.5
Pb	6	3
Hg	2	1
pH	*	*
***Within the range 6.0 to 9.0**		

Source: *40 CFR 440.102(a).*

Beneficiation is regulated by the same effluent limitation guidelines as extraction processes.

The concentration of pollutants discharged from mills that employ the froth flotation process alone or in conjunction with other processes, for the beneficiation of copper ores, lead ores, zinc ores, gold ores, or silver ores, or any combination of these ores shall not exceed:

Exhibit 28
Mill Discharge Limitations

Effluent Characteristic	Maximum for any 1 day	Average of daily values for 30 consecutive days
TSS	30	20
Cu	30	15
Zn	10	5
Pb	6	3
Hg	0.002	0.001
Cd	10	0.05
pH	*	*
***Within the range 6.0 to 9.0**		

Source: *40 CFR 440.102(b).*

Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act may also apply to mine operations if primary drinking water sources and Class 3 wells are affected by mine wastewater releases. EPA regulates cadmium, lead, and arsenic under its primary drinking water standards (40 CFR 141.11(b)), and regulates copper, iron, manganese, and zinc under its secondary drinking water standards (40 CFR 143.3).

Resource Conservation and Recovery Act (RCRA)

The Bevill Amendment

In 1980, Congress amended RCRA in the Solid Waste Disposal Act Amendments, adopting what has been dubbed the Bevill Amendment, after Representative Tom Bevill of Alabama. The amendment temporarily exempted from Subtitle C regulation solid waste from ore and mineral extraction, beneficiation, and processing. The Amendment directed EPA either to develop Subtitle C regulations for the waste or determine that the exemption should continue, and to present its findings in a report to Congress.

EPA modified its hazardous waste regulations to reflect the Bevill exclusion and issued a preliminary, and quite broad, interpretation of the exclusion's scope. In particular, it interpreted the exclusion as covering "solid waste from the exploration, mining, milling, smelting and refining of ores and minerals." Based on this broad interpretation of the Bevill Amendment, EPA suspended its Subtitle C listing of six hazardous smelter wastes.

In 1985 the U.S. District Court for the District of Columbia awarded judgment to the Environmental Defense Fund and two public interest groups that had sued EPA for failing to submit the required report to Congress and make the regulatory determination by the statutory deadline. The court imposed two schedules, one for completing studies of extraction and beneficiation wastes and submitting them in a report to Congress, and the second for proposing reinterpretation of mineral-processing wastes. In so doing, the court effectively split the wastes that might be eligible for exclusion from regulation into two groups: mineral extraction and beneficiation wastes; and mineral processing wastes.

In December 1985 EPA submitted a report to Congress on mining wastes (*1985 Report to Congress: Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining,* *and Oil Shale*) in which EPA found that some mining wastes exhibit hazardous characteristics, that waste management practices have caused environmental damage, and that the range of risk from mining waste is broad. In July 1986 EPA published a regulatory determination, upheld in subsequent court challenges, that RCRA Subtitle C regulation of extraction and beneficiation wastes was unwarranted because mining wastes tend to be disposed of in arid climates, facilities and wastes are located in sparsely populated areas where human contact is minimal, and waste volumes are high. It also determined that it should develop a risk-based, State-run mining waste program under RCRA Subtitle D.

In keeping with its court-ordered directive to reinterpret the Mining Waste exclusion for mineral processing wastes, EPA proposed to narrow the scope of the exclusion for mineral-processing wastes to include only a few specific waste streams. Unable to articulate criteria for selecting these wastes, EPA later withdrew this proposal and was subsequently sued by the Environmental Defense Fund. The courts ruled against EPA, holding that the Agency's interpretation of Bevill exclusions was overbroad. The court ordered EPA to restrict the scope of the exclusion as it applied to mineral-processing wastes to include only "large volume, low hazard" wastes.

In a series of rulemaking notices, EPA reinterpreted the exclusion for mineral-processing wastes and defined which mineral-processing wastes met the high-volume, low-hazard criteria. The vast majority of mineral-processing wastes did not meet both criteria. EPA published its final regulatory determination in 1991, in compliance with a court-ordered deadline. The final rule permanently retains the Bevill exemption for 20 mineral-processing wastes. EPA determined that regulation under RCRA Subtitle C was inappropriate for these wastes because of the extremely high cost to industry and the technical infeasibility of managing them under Subtitle C requirements; 18 of the wastes are subject to applicable State requirements, while the remaining two (phosphogypsum and phosphoric acid process waste water) are currently being evaluated by EPA.

Wastes from the extraction and beneficiation of ores and minerals remain exempt from Subtitle C requirements, irrespective of their chemical characteristics; EPA may, in the future, evaluate the appropriateness of regulating these wastes under RCRA Subtitle D as an industrial waste. Wastes from mineral processing, however, are not exempt from Subtitle C unless they are one of the 20 specific wastes identified in EPA's final ruling.

In addition, only wastes that are uniquely associated with the extraction and beneficiation of ores and minerals (or one of the 20 listed mineral processing wastes) are excluded from hazardous waste regulation. Non-uniquely associated wastes are typically generated as a result of maintaining mining machinery or as a result of other facility activities, and continue to be subject to Subtitle C regulation. These non-uniquely associated wastes may include used oil, polychlorinated biphenyls, discarded commercial chemicals, cleaning solvents, filters, empty drums, laboratory wastes, and general refuse.

Determining how and under what circumstances the Bevill Amendment exclusions should be interpreted in regulating mining wastes continues to be a subject of discussion and study, at least in part because many beneficiation terms are used to describe activities common to a wide range of nonexempt industries and to describe mineral-processing operations that occur at the same location as the beneficiation operations. Beneficiation and mineral-processing operations are often closely linked; in order to apply Subtitle C regulations at a mine site, a regulator often must prove that the waste is not a beneficiation waste. Because a variety of regulators, at both Federal and State levels, are independently interpreting the Bevill rules, the potential for inconsistent interpretations is significant. Staff in EPA's OSW have suggested the following guidelines for regulators and the regulated community in distinguishing between exempt and nonexempt wastes at mines and mineral-processing sites:

- Determine whether the material is considered a solid waste under RCRA.
- Determine whether the facility is using a primary ore or mineral to produce a final or intermediate product and also whether 50 percent of the feedstocks are from secondary sources.
- Establish whether the material and the operation that generates it are uniquely associated with mineral production.
- Determine where in the sequence of operations beneficiation ends and mineral processing begins.
- If the material is a mineral-processing waste, determine whether it is one of the 20 special wastes from mineral processing.

This sequence will result in one of three determinations: 1) the material is not a solid waste and therefore not subject to RCRA; 2) the material is a solid waste but is exempt from RCRA Subtitle C because of the Mining Waste Exclusion; or 3) the material is a solid waste that is not exempt from RCRA Subtitle C and is subject to regulation.

Comprehensive Response Compensation and Liability Act (CERCLA)

Although Bevill wastes are excluded from regulation under RCRA Subtitle C, they can be addressed under CERCLA. Mining companies may be liable under CERCLA for the release or threat of release of hazardous substances, covering releases to air, surface water, groundwater and soils. Many mines, where practices did not incorporate the safeguards now required under the CWA, allowed runoff from mine and tailings sites to flow into nearby streams and lakes. Even newer mines, which have been subject to CWA regulations, have been targeted for CERCLA enforcement. Some of these mines, such as Colorado's Summitville Mine, have been listed on the National Priorities List (NPL). Mine owners may also be liable for damages to natural resources as a result of mining activity.

Clean Air Act (CAA)

Under §111 of CAA, New Source Performance Standards (NSPS) applicable to metallic mineral-processing plants have been established (40 CFR 60 Subpart LL). These standards regulate emissions of particulate matter in metal mining operations in crushers, conveyor belt transfer points, thermal dryers, product packaging stations, storage bins, truck loading and unloading stations, and rail car loading and unloading. Although all underground mining facilities are exempt from these provisions, fugitive dust emissions from mining activities may be regulated (usually by requiring dust suppression management activities) through State permit programs established to meet Federal NAAQSs.

National Environmental Policy Act (NEPA)

NEPA requires that all Federal agencies prepare detailed statements assessing the environmental impact of, and alternatives to, major Federal actions that may "significantly affect" the environment. An environmental impact statement (EIS) must provide a fair and full discussion of significant environmental impacts and inform decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts on the environment; EISs must explore and evaluate all reasonable alternatives, even if they are not within the authority of the lead agency. NEPA authorities are solely procedural; NEPA cannot compel selection of the environmentally preferred alternative.

Federal actions specifically related to mining that may require EISs include Federal land management agency (e.g. BLM and Forest Service) approval of plans of operations for hardrock mining on Federally-managed lands. All effected media (e.g., air, water, soil, geologic, cultural, economic resources, etc.) must be addressed. The EIS provides the basis for the permit decision; for example, an NPDES permit may be issued or denied based on EPA's review of the overall impacts, not just discharge-related impacts, of the proposed project and alternatives. Issues may include the potential for acid rock drainage, aquatic and terrestrial habitat value and losses, sediment production, mitigation, and reclamation.

<u>Endangered Species Act (ESA)</u>

The ESA provides a means to protect threatened or endangered species and the ecosystems that support them. It requires Federal agencies to ensure that activities undertaken on either Federal or non-Federal property do not have adverse impacts on threatened or endangered species or their habitat. In a June 1995 ruling, the U.S. Supreme Court upheld interpretations of the Act that allow agencies to consider impact on habitat as a potential form of prohibited "harm" to endangered species. Agencies undertaking a Federal action (such as a BLM review of proposed mining operations) must consult with the U.S. Fish and Wildlife Service (USFWS); an EIS must be prepared if "any major part of a new source will have significant adverse effect on the habitat" of a Federally or State-listed threatened or endangered species.

State Statutes

In addition to Federal laws, State and common laws also affect waste generation from mining activities. State law generally requires that permits be obtained prior to commencement of mining activities; permits may require design, performance, closure, and reclamation standards, and may impose monitoring requirements. Under common law, a mine owner may be liable for trespassing if wastes migrate into and damage another's property, or if the waste impacts the community as a whole, a miner may be liable for creating a public nuisance. Over the last five years several States have substantially altered their mining regulations to prevent the damage caused by past mining operations. Considerable disagreement remains, however, between mining industry groups and the environmental community regarding the effectiveness of these State regulations in preventing damage to the environment.

Many Western States require mining operations to obtain reclamation bonds and mining permits that are designed to regulate and monitor mining activity. States that require bonding and/or permitting include Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming. To regulate mining activity in the State of Colorado, for example, the State requires mining operations to obtain: 1) a performance bond, 2) a reclamation bond, and 3) a permit. The performance bond outlines what the mining operation intends to do on the land, and is simply a promise from the mining operation that it will reclaim the land. This bond gives Colorado the authority to pursue reclamation costs from mining operations that fail to properly reclaim the land. The reclamation bond, also known as a financial warranty, equals the cost the State would incur if it were to hire someone to reclaim the site should the mining operation fail to do so. Although performance bonds are updated periodically, the bonds have not always been adequate to cover closure costs.

VI.C. Pending and Proposed Regulatory Requirements

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

The Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA) Section 313 mandates that owners and operators of facilities that manufacture, process, or otherwise use a listed chemical report to EPA their annual releases of these chemicals to any environmental medium. EPA makes this information available to the public in the form of the Toxics Release Inventory (TRI). TRI currently requires reporting from facilities in SIC codes 20-39 that meet various threshold requirements.

EPCRA Section 313 gives EPA discretionary authority to modify the coverage of facilities required to report to EPA for inclusion in the TRI. EPA is considering expanding the TRI through the development of reporting requirements for additional facilities. These additional facilities include a list of 25 SIC codes that contribute 99 percent of the non-manufacturing TRI chemical loadings to the environment. SIC code 10 is among these 25 SIC codes. EPA anticipates publication of a proposed rule in late 1995 or early 1996 requiring additional facilities to report the use, release, and transfer of TRI chemicals.

Clean Water Act (CWA)

A comprehensive bill was introduced in Congress in 1995 to reauthorize the Clean Water Act. The bill may affect EPA's authority to require changes in production processes, products, or raw materials to control emissions of toxins; may require risk assessments for water quality standards, effluent limitations or other regulatory requirements; and may require social, economic, and environmental benefits to be weighed in establishing regulations. Potentially large sectors of the mining industry could be affected by this legislation.

Clean Air Act (CAA)

EPA continues to prepare rules for industry sources subject to hazardous air pollutant standards under the CAA, as amended. The sources are those that emit one or more of the 189 substances defined as hazardous air pollutants (HAPs) under the CAA. The EPA published a list of these sources in 1992 and has begun to define Maximum Achievable Control Standards that will apply to them. Although the timetable for issuing regulatory controls varies, proposed standards for most mineral industries are due by November 15, 1997.

EPA is also reviewing and updating national ambient air quality standards (NAAQS) for particulate matter, ozone, and sulfur dioxide to incorporate new scientific and technical information that has become available since the last reviews. Based on these revised data, EPA will determine whether revisions to the standards are appropriate. The metal mining sector will be affected by any revisions to these standards.

Resource Conservation and Recovery Act (RCRA)

The Hazardous and Solid Waste Amendments of 1984 require EPA to promulgate regulations establishing treatment standards that must be met before hazardous waste may be disposed on land. An announcement of new proposed rulemaking was made on October 24, 1991 in 56 CFR 55160. The proposed rulemaking established treatment standards for certain mineral processing waste and toxicity characteristic metals. Proposed rulemaking is expected mid-1995 and final action is expected mid-1996.

In a July 1986 Regulatory Determination, EPA stated that it was not appropriate to regulate the extraction and beneficiation wastes covered in the 1985 *Report to Congress: Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale.* Among the reasons cited by EPA for the special treatment of mining wastes were: 1) mining waste is generated in much larger volumes than industrial wastes (the average mining waste facility produces 3,000,000 metric tons of waste annually, while the average

RCRA Subtitle C regulated waste producer produces 50,000 metric tons annually); 2) mining waste sites are usually much larger than traditional waste producers. The average tailings pile covers 494 acres and the average mining waste piles cover 126 acres, while the average Subtitle C hazardous waste impoundment of landfill is six to ten acres; 3) mining waste streams are believed to have lower human exposure and risk potential.

As a result, EPA determined that RCRA Subtitle C controls may be neither technically nor economically feasible, nor at times necessary to protect human health and the environment. EPA recommended development of a primarily State-implemented, site-specific, and risk-based regulatory approach under Subtitle D of RCRA. The result was the preparation of *Strawman I* and *II* proposals, which would regulate material uniquely associated with mining that the regulatory authority determines could pose a threat to human health and the environment, including mill tailings, stockpiled ores, leaching solutions, and water that may accumulate hazardous constituents.

While the Strawman proposals no longer represent a viable and current Agency approach to the mining industry, EPA may in the future evaluate the appropriateness of regulating mining waste under RCRA Subtitle D as an industrial waste.

VII. COMPLIANCE AND ENFORCEMENT PROFILE

Background

To date, EPA has focused much of its attention on measuring compliance with specific environmental statutes. This approach allows the Agency to track compliance with the Clean Air Act, the Resource Conservation and Recovery Act, the Clean Water Act, and other environmental statutes. Within the last several years, the Agency has begun to supplement single-media compliance indicators with facility-specific, multi-media indicators of compliance. In doing so, EPA is in a better position to track compliance with all statutes at the facility level, and within specific industrial sectors.

A major step in building the capacity to compile multimedia data for industrial sectors was the creation of EPA's Integrated Data for Enforcement Analysis (IDEA) system. IDEA has the capacity to "read into" the Agency's single-media databases, extract compliance records, and match the records to individual facilities. The IDEA system can match Air, Water, Waste, Toxics/Pesticides/EPCRA, TRI, and Enforcement Docket records for a given facility, and generate a list of historical permit, inspection, and enforcement activity. IDEA also has the capability to analyze data by geographic area and corporate holder. As the capacity to generate multimedia compliance data improves, EPA will make available more in-depth compliance and enforcement information. Additionally, sector-specific measures of success for compliance assistance efforts are under development.

Compliance and Enforcement Profile Description

Using inspection, violation, and enforcement data from the IDEA system, this section provides information regarding the historical compliance and enforcement activity of this sector. In order to mirror the facility universe reported in the Toxic Chemical Profile, the data reported within this section consist only of records from the TRI reporting universe. With this decision, the selection criteria are consistent across sectors with certain exceptions. For the sectors that do not normally report to the TRI program, data have been provided from EPA's Facility Indexing System (FINDS), which tracks facilities in all media databases. Please note that in this section EPA does not attempt to define the actual number of facilities that fall within each sector. Instead, the section portrays the records of a subset of facilities within the sector that are well-defined within EPA databases.

As a check on the relative size of the full sector universe, most notebooks contain an estimated number of facilities within the sector according to the Bureau of Census (See Section II). With sectors dominated by small businesses, such as metal finishers and printers, the reporting universe within EPA databases may be small compared to Census data. However, the group selected for inclusion in this data analysis section should be consistent with this sector's general make-up.

Following this introduction is a list defining each data column presented within this section. These values represent a retrospective summary of inspections and enforcement actions, and solely reflect EPA, State, and local compliance assurance activities that have been entered into EPA databases. To identify any changes in trends, the EPA ran two data queries, one for the past five calendar years (August 10, 1990 to August 9, 1995) and the other for the most recent twelve-month period (August 10, 1994 to August 9, 1995). The five-year analysis gives an average level of activity for that period for comparison to the more recent activity.

Because most inspections focus on single-media requirements, the data queries presented in this section are taken from single-media databases. These databases do not provide data on whether inspections are State/local or EPA-led. However, the table breaking down the universe of violations does give the reader a crude measurement of the EPA's and States' efforts within each media program. The presented data illustrate the variations across regions for certain sectors.[1] This variation may be attributable to State/local data entry variations, specific geographic concentrations, proximity to population centers, sensitive ecosystems, highly toxic chemicals used in production, or historical noncompliance. Hence, the exhibited data do not rank regional performance or necessarily reflect which regions have the most compliance problems.

Compliance and Enforcement Data Definitions

General Definitions

Facility Indexing System (FINDS) -- this system assigns a common facility number to EPA single-media permit records. The FINDS

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[1] EPA Regions include the following States: I (CT, MA, ME, RI, NH, VT); II (NJ, NY, PR, VI); III (DC, DE, MD, PA, VA, WV); IV (AL, FL, GA, KY, MS, NC, SC, TN); V (IL, IN, MI, MN, OH, WI); VI (AR, LA, NM, OK, TX); VII (IA, KS, MO, NE); VIII (CO, MT, ND, SD, UT, WY); IX (AZ, CA, HI, NV, Pacific Trust Territories); X (AK, ID, OR, WA).

identification number allows EPA to compile and review all permit, compliance, enforcement, and pollutant release data for any given regulated facility.

Integrated Data for Enforcement Analysis (IDEA) -- is a data integration system that can retrieve information from the major EPA program office databases. IDEA uses the FINDS identification number to "glue together" separate data records from EPA's databases. This is done to create a "master list" of data records for any given facility. Some of the data systems accessible through IDEA are: AIRS (Air Facility Indexing and Retrieval System, Office of Air and Radiation), PCS (Permit Compliance System, Office of Water), RCRIS (Resource Conservation and Recovery Information System, Office of Solid Waste), NCDB (National Compliance Data Base, Office of Prevention, Pesticides, and Toxic Substances), CERCLIS (Comprehensive Environmental and Liability Information System, Superfund), and TRIS (Toxic Release Inventory System). IDEA also contains information from outside sources, such as Dun and Bradstreet and the Occupational Safety and Health Administration (OSHA). Most data queries displayed in notebook Section VII were conducted using IDEA.

Data Table Column Heading Definitions

Facilities in Search -- are based on the universe of TRI reporters within the listed SIC code range. For industries not covered under TRI reporting requirements, the notebook uses the FINDS universe for executing data queries. The SIC code range selected for each search is defined by each notebook's selected SIC code coverage described in Section II.

Facilities Inspected -- indicates the level of EPA and State agency facility inspections for the facilities in this data search. These values show what percentage of the facility universe is inspected in a 12 or 60 month period. This column does not count non-inspectional compliance activities such as the review of facility-reported discharge reports.

Number of Inspections -- measures the total number of inspections conducted in this sector. An inspection event is counted each time it is entered into a single media database.

Average Time Between Inspections -- provides an average length of time, expressed in months, that a compliance inspection occurs at a facility within the defined universe.

Facilities with One or More Enforcement Actions -- expresses the number of facilities that were party to at least one enforcement action within the defined time period. This category is broken down further into Federal and State actions. Data are obtained for administrative, civil/judicial, and criminal enforcement actions. Administrative actions include Notices of Violation (NOVs). A facility with multiple enforcement actions is only counted once in this column (facility with 3 enforcement actions counts as 1). All percentages that appear are referenced to the number of facilities inspected.

Total Enforcement Actions -- describes the total number of enforcement actions identified for an industrial sector across all environmental statutes. A facility with multiple enforcement actions is counted multiple times (a facility with 3 enforcement actions counts as 3).

State Lead Actions -- shows what percentage of the total enforcement actions are taken by State and local environmental agencies. Varying levels of use by States of EPA data systems may limit the volume of actions accorded State enforcement activity. Some States extensively report enforcement activities into EPA data systems, while other States may use their own data systems.

Federal Lead Actions -- shows what percentage of the total enforcement actions are taken by the U.S. EPA. This value includes referrals from State agencies. Many of these actions result from coordinated or joint State/Federal efforts.

Enforcement to Inspection Rate -- expresses how often enforcement actions result from inspections. This value is a ratio of enforcement actions to inspections, and is presented for comparative purposes only. This measure is a rough indicator of the relationship between inspections and enforcement. This measure simply indicates historically how many enforcement actions can be attributed to inspection activity. Related inspections and enforcement actions under the Clean Water Act (PCS), the Clean Air Act (AFS) and the Resource Conservation and Recovery Act (RCRA) are included in this ratio. Inspections and actions from the TSCA/FIFRA/EPCRA database are not factored into this ratio because most of the actions taken under these programs are not the result of facility inspections. This ratio does not account for enforcement actions arising from non-inspection compliance monitoring activities (e.g., self-reported water discharges) that can result in enforcement action within the CAA, CWA and RCRA.

Facilities with One or More Violations Identified -- indicates the number and percentage of inspected facilities having a violation identified in one of the following data categories: In Violation or Significant Violation Status (CAA); Reportable Noncompliance, Current Year Noncompliance, Significant Noncompliance (CWA); Noncompliance and Significant Noncompliance (FIFRA, TSCA, and EPCRA); Unresolved Violation and Unresolved High Priority Violation (RCRA). The values presented for this column reflect the extent of noncompliance within the measured time frame, but do not distinguish between the severity of the noncompliance. Percentages within this column can exceed 100 percent because facilities can be in violation status without being inspected. Violation status may be a precursor to an enforcement action, but does not necessarily indicate that an enforcement action will occur.

Media Breakdown of Enforcement Actions and Inspections -- four columns identify the proportion of total inspections and enforcement actions within EPA Air, Water, Waste, and TSCA/FIFRA/EPCRA databases. Each column is a percentage of either the "Total Inspections," or the "Total Actions" column.

VII.A. Metal Mining Compliance History

The following exhibit provides a summary of five-year enforcement and compliance data for the metal mining industry. Consistent with information presented in previous sections, the greatest concentration of metal mining activity occurs in the Western States, where the greatest number of inspections and enforcement actions also occur.

Exhibit 29
Five-Year Enforcement and Compliance Summary for the Metal Mining Industry

A	B	C	D	E	F	G	H	I	J
Metal Mining SIC 10	Facilities in Search	Facilities Inspected	Number of Inspections	Average Number of Months Between Inspections	Facilities w/One or More Enforcement Actions	Total Enforcement Actions	State Lead Actions	Federal Lead Actions	Enforcement to Inspection Rate
Region I	2	1	1	120	1	1	0%	100%	1.00
Region II	15	11	74	12	2	14	100%	0%	0.19
Region III	9	8	47	11	1	1	100%	0%	0.02
Region IV	28	20	209	8	5	7	86%	14%	0.03
Region V	27	17	129	13	5	15	67%	33%	0.12
Region VI	40	14	56	43	6	17	0%	100%	0.30
Region VII	14	10	91	9	4	12	42%	58%	0.13
Region VIII	135	62	284	29	13	32	100%	0%	0.11
Region IX	54	42	346	9	11	13	31%	69%	0.04
Region X	549	154	282	117	19	43	2%	98%	0.15
Total/Average	873	339	1,519	34	67	155	47%	53%	0.10

VII.B. Comparison of Enforcement Activity Between Selected Industries

Exhibit 30 highlights enforcement and compliance information across selected industries. The metal mining industry had one of the lowest numbers of inspections among those industries represented, as well as the highest average number of months between inspections.

Exhibit 31 provides enforcement and compliance summary data for one year for selected industries. Over half of the facilities inspected were cited for a violation. The metal mining industry also represented the greatest percentage of facilities with enforcement actions taken, at 19 percent.

Exhibit 32 presents inspection and enforcement data by statute for selected industries. As discussed previously, water pollution represents the most common problem associated with the metal mining industry, followed by air. Thirty-four percent of total enforcement actions taken were under the Clean Water Act, while 11 percent were under the Clean Air Act.

Exhibit 33 provides a one-year summary of inspection and enforcement data by statute for selected industries. Again emphasizing the weight given to water pollution in the metal mining industry, inspections under the Clean Water Act represented over 50 percent of total metal mining inspections.

Exhibit 30
Five-Year Enforcement and Compliance Summary for Selected Industries

A	B	C	D	E	F	G	H	I	J
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Average Number of Months Between Inspections	Facilities w/One or More Enforcement Actions	Total Enforcement Actions	State Lead Actions	Federal Lead Actions	Enforcement to Inspection Rate
Metal Mining	873	339	1,519	34	67	155	47%	53%	0.10
Non-metallic Mineral Mining	1,143	631	3,422	20	84	192	76%	24%	0.06
Lumber and Wood	464	301	1,891	15	78	232	79%	21%	0.12
Furniture	293	213	1,534	11	34	91	91%	9%	0.06
Rubber and Plastic	1,665	739	3,386	30	146	391	78%	22%	0.12
Stone, Clay, and Glass	468	268	2,475	11	73	301	70%	30%	0.12
Nonferrous Metals	844	474	3,097	16	145	470	76%	24%	0.15
Fabricated Metal	2,346	1,340	5,509	26	280	840	80%	20%	0.15
Electronics/Computers	405	222	777	31	68	212	79%	21%	0.27
Motor Vehicle Assembly	598	390	2,216	16	81	240	80%	20%	0.11
Pulp and Paper	306	265	3,766	5	115	502	78%	22%	0.13
Printing	4,106	1,035	4,723	52	176	514	85%	15%	0.11
Inorganic Chemicals	548	298	3,034	11	99	402	76%	24%	0.13
Organic Chemicals	412	316	3,864	6	152	726	66%	34%	0.19
Petroleum Refining	156	145	3,257	3	110	797	66%	34%	0.25
Iron and Steel	374	275	3,555	6	115	499	72%	28%	0.14
Dry Cleaning	933	245	633	88	29	103	99%	1%	0.16

Exhibit 31
One-Year Enforcement and Compliance Summary for Selected Industries

A	B	C	D	E		F		G	H
Industry Sector	Facilities in Search	Facilities Inspected	Number of Inspections	Facilities w/One or More Violations		Facilities w/One or More Enforcement Actions		Total Enforcement Actions	Enforcement to Inspection Rate
				Number	Percent*	Number	Percent*		
Metal Mining	873	114	194	82	72%	16	14%	24	0.13
Non-metallic Mineral Mining	1,143	253	425	75	30%	28	11%	54	0.13
Lumber and Wood	464	142	268	109	77%	18	13%	42	0.15
Furniture	293	160	113	66	41%	3	2%	5	0.04
Rubber and Plastic	1,665	271	435	289	107%	19	7%	59	0.14
Stone, Clay, and Glass	468	146	330	116	79%	20	14%	66	0.20
Nonferrous Metals	844	202	402	282	140%	22	11%	72	0.18
Fabricated Metal	2,346	477	746	525	110%	46	10%	114	0.15
Electronics/Computers	405	60	87	80	133%	8	13%	21	0.24
Motor Vehicle Assembly	598	169	284	162	96%	14	8%	28	0.10
Pulp and Paper	306	189	576	162	86%	28	15%	88	0.15
Printing	4,106	397	676	251	63%	25	6%	72	0.11
Inorganic Chemicals	548	158	427	167	106%	19	12%	49	0.12
Organic Chemicals	412	195	545	197	101%	39	20%	118	0.22
Petroleum Refining	156	109	437	109	100%	39	36%	114	0.26
Iron and Steel	374	167	488	165	99%	20	12%	46	0.09
Dry Cleaning	933	80	111	21	26%	5	6%	11	0.10

*Percentages in Columns E and F are based on the number of facilities inspected (Column C). Percentages can exceed 100% because violations and actions can occur without a facility inspection.

Exhibit 32
Five-Year Enforcement and Compliance Summary by Statute for Selected Industries

Industry Sector	Number of Facilities Inspected	Total Inspections	Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/ EPCRA/Other*	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Metal Mining	339	1,519	155	35%	17%	57%	60%	6%	14%	1%	9%
Non-metallic Mineral Mining	631	3,422	192	65%	46%	31%	24%	3%	27%	<1%	4%
Lumber and Wood	301	1,891	232	31%	21%	8%	7%	59%	67%	2%	5%
Furniture	293	1,534	91	52%	27%	1%	1%	45%	64%	1%	8%
Rubber and Plastic	739	3,386	391	39%	15%	13%	7%	44%	68%	3%	10%
Stone, Clay and Glass	268	2,475	301	45%	39%	15%	5%	39%	51%	2%	5%
Nonferrous Metals	474	3,097	470	36%	22%	22%	13%	38%	54%	4%	10%
Fabricated Metal	1,340	5,509	840	25%	11%	15%	6%	56%	76%	4%	7%
Electronics/ Computers	222	777	212	16%	2%	14%	3%	66%	90%	3%	5%
Motor Vehicle Assembly	390	2,216	240	35%	15%	9%	4%	54%	75%	2%	6%
Pulp and Paper	265	3,766	502	51%	48%	38%	30%	9%	18%	2%	3%
Printing	1,035	4,723	514	49%	31%	6%	3%	43%	62%	2%	4%
Inorganic Chemicals	302	3,034	402	29%	26%	29%	17%	39%	53%	3%	4%
Organic Chemicals	316	3,864	726	33%	30%	16%	21%	46%	44%	5%	5%
Petroleum Refining	145	3,237	797	44%	32%	19%	12%	35%	52%	2%	5%
Iron and Steel	275	3,555	499	32%	20%	30%	18%	37%	58%	2%	5%
Dry Cleaning	245	633	103	15%	1%	3%	4%	83%	93%	<1%	1%

* Actions taken to enforce the Federal Insecticide, Fungicide, and Rodenticide Act; the Toxic Substances and Control Act, and the Emergency Planning and Community Right-to-Know Act as well as other Federal environmental laws.

Exhibit 33
One-Year Inspection and Enforcement Summary for Selected Industries

Industry Sector	Number of Facilities Inspected	Total Inspections	Enforcement Actions	Clean Air Act		Clean Water Act		Resource Conservation and Recovery Act		FIFRA/TSCA/ EPCRA/Other	
				% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions	% of Total Inspections	% of Total Actions
Metal Mining	114	194	24	47%	42%	43%	34%	10%	6%	<1%	19%
Non-metallic Mineral Mining	253	425	54	69%	58%	26%	16%	5%	16%	<1%	11%
Lumber and Wood	142	268	42	29%	20%	8%	13%	63%	61%	<1%	6%
Furniture	293	160	5	58%	67%	1%	10%	41%	10%	<1%	13%
Rubber and Plastic	271	435	59	39%	14%	14%	4%	46%	71%	1%	11%
Stone, Clay, and Glass	146	330	66	45%	52%	18%	8%	38%	37%	<1%	3%
Nonferrous Metals	202	402	72	33%	24%	21%	3%	44%	69%	1%	4%
Fabricated Metal	477	746	114	25%	14%	14%	8%	61%	77%	<1%	2%
Electronics/ Computers	60	87	21	17%	2%	14%	7%	69%	87%	<1%	4%
Motor Vehicle Assembly	169	284	28	34%	16%	10%	9%	56%	69%	1%	6%
Pulp and Paper	189	576	88	56%	69%	35%	21%	10%	7%	<1%	3%
Printing	397	676	72	50%	27%	5%	3%	44%	66%	<1%	4%
Inorganic Chemicals	158	427	49	26%	38%	29%	21%	45%	36%	<1%	6%
Organic Chemicals	195	545	118	36%	34%	13%	16%	50%	49%	1%	1%
Petroleum Refining	109	439	114	50%	31%	19%	16%	30%	47%	1%	6%
Iron and Steel	167	488	46	29%	18%	35%	26%	36%	50%	<1%	6%
Dry Cleaning	80	111	11	21%	4%	1%	22%	78%	67%	<1%	7%

* Actions taken to enforce the Federal Insecticide, Fungicide, and Rodenticide Act; the Toxic Substances and Control Act, and the Emergency Planning and Community Right-to-Know Act as well as other Federal environmental laws.

VII.C. Review of Major Legal Actions

This section provides a listing of major legal cases and supplemental enforcement projects that pertain to the Metal Mining Industry. Information in this section is provided by EPA's *Enforcement Accomplishments Reports FY 1991, FY 1992, FY 1993* and the Office of Enforcement and Compliance Assurance. As indicated in the EPA's *Enforcement Accomplishments Report*, publications, nine significant enforcement actions were resolved between 1991 and 1993 for the metal mining industry. CERCLA violations comprised three of these actions, the most of any statute. The remaining cases were distributed fairly evenly with CWA and RCRA cited twice, and CAA, EPCRA, and TSCA each cited once.

Two of the cases involved cyanide contamination from heap leaching of gold ores. Each of the settlements, one under CERCLA and one under the CAA, resulted in monetary penalties. The CERCLA settlement provided for company reimbursement of the Superfund for $250,000 in past response costs. Two other CERCLA settlements resulted in penalties: a penalty for failure to notify authorities of a release resulted in a $75,000 fine; a judgment in U.S. vs. Smuggler-Durant Mining Corporation resulted in a $3.4 million award in favor of the EPA.

Both of the CWA actions cited Section 404 for destruction of wetlands. Both instances involved placer mining and resulted in monetary penalties; one of the actions involved a Supplemental Environmental Project (SEP) requiring stream/wetland restoration. Another SEP involved a TSCA violation by Kennecott Utah Copper. In addition to a monetary penalty, Kennecott agreed to upgrade an emergency computer system at an estimated cost of $70,000.

VII.C.1. Supplemental Environmental Projects

This section provides a list of Supplementary Environmental Projects (SEPs). SEPs are compliance agreements that reduce a facility's stipulated penalty in return for an environmental project that exceeds the value of the reduction. Often, these projects fund pollution prevention activities that can significantly reduce the future pollutant loadings of a facility.

In December, 1993, the Regions were asked by EPA's Office of Enforcement and Compliance Assurance to provide information on the number and type of SEPs entered into by the Regions. The following chart contains a representative sample of the Regional responses addressing the metal mining industry. The information contained in the chart is not comprehensive and provides only a sample of the types of SEPs developed for the metal mining industry. (See Exhibit 34)

Exhibit 34
Supplemental Environmental Projects

Case Name	EPA Region	Statute/ Type of Action	Type of SEP	Estimated Cost to Company	Expected Environmental Benefits	Final Assessed Penalty	Final Penalty After Mitigation
Sunshine Precious Metals, Inc. Kellogg, ID	X	TSCA	Pollution Reductio n	$6,588	Early disposal of PCB equipment.	$6,588	$3,294

VII.D. EPA Hardrock Mining Framework

EPA is currently developing a multi-media, multi-statute hardrock mining strategy for existing EPA authorities, resources, and expertise in order to address the environmental problems posed by mining activities in the U.S., in concert with other Federal, State, tribal and local agencies. Some of the driving issues behind the strategy's development are concerns about overlapping and poorly coordinated regulatory authorities and actions; liability under CERCLA and other statutes, which may create a recurring barrier to voluntary remediation of mine sites; and rapid changes in mining practices that are leading to new environmental challenges.

The strategy establishes **environmental goals**, to protect human health and ecological resources through pollution prevention, control, and remediation at active, inactive, and/or abandoned mine sites on both Federal and non-Federal lands; **administrative goals**, to use available resources and authorities most efficiently and to focus on the highest priority concerns; and **fiscal responsibility goals**, to promote inter- and intra-governmental efficiency and fiscal responsibility in control of mining sites, as well as to prevent future unfunded public burdens.

Several objectives have been defined in support of these goals, including the following:

- Facilitate coordination with co-regulators: employ a range of approaches to ensure coordination and communication
- Use innovative approaches to foster efficiency: wherever possible, innovative tools (particularly non-regulatory) will be employed to help achieve efficient and timely action

- Consolidate priority-setting: establish multi-agency priorities to maximize scarce resources, help ensure benefits for costs incurred, and address the most problematic sites first

- Promote fiscal / personal responsibility: promote responsibility to help owners reflect true costs of activities and to avoid incurring unnecessary and unfunded environmental and financial burdens for the public

- Enhance capabilities of existing tools: use current administrative authorities to improve environmental problem-solving capabilities

- Be proactive and preventative: ensure that environmental performance standards are quantified to the maximum extent, and that assumptions, risks, and uncertainties are identified

- Promote protective closure standards and adequate financial assurances: establish closure performance standards and bonding requirements that will ensure mines are properly closed and that adequate post-closure care is performed

- Perform timely and environmentally sound clean-up of abandoned mines: ensure that priority inactive and abandoned mines are cleaned up in a timely manner, addressing worst sites first, while avoiding costly efforts addressing mines with little or no environmental effects.

In compliance and enforcement issues, the strategy promotes multi-agency compliance approaches, developing a ranking system for determining inspection priorities, and developing a multi-media inspection protocol for mine sites. Other compliance and enforcement measures include:

- Promoting use of environmental audits within the regulated community

- Conducting an enforcement initiative to target mine owners and operators who violate requirements to obtain and comply with storm water permits

- Compiling and circulating within EPA brief descriptions of successful mining-related enforcement actions brought by the Agency

- Prioritizing action based on the extent of actual human health and environmental impacts; the potential for additional impacts; the likely success, technical feasibility, and cost effectiveness of response actions; and the availability of staff, equipment, and funding

- Developing enforcement MOAs with other Federal agencies to facilitate consultations and joint actions
- Improving consultation between EPA and the States to determine whether violations of Federal and State law warrant joint enforcement action.

As noted above, however, EPA seeks to strengthen its use of non-regulatory tools to encourage environmental compliance and clean-up at mining sites. These tools are intended to complement existing regulatory programs in addressing mining impacts. Common themes of most non-regulatory approaches include: active participation by principal stakeholders, creative use of funding resources, site-specific flexibility, prioritization of clean-up projects, and regulatory discretion to promote creative problem-solving and early implementation of clean-up projects.

Most non-regulatory approaches have one or more of the following characteristics:

- **Financial** - Financial support often comes from a variety of sources when non-regulatory approaches are used; funds are often leveraged and budgets are typically tight. Other Federal agency funds are often used to supplement EPA funds; State/local partnerships can fill financial holes; and voluntary efforts by private parties can contribute significantly to clean-up of inactive or abandoned mine sites.
- **Institutional** - Interagency Agreements (MOUs, MOAs, and IAGs) are tools that can be used to streamline the mining permitting and regulatory processes; more informally, interagency groups are often used to focus attention on certain projects or issues. Agreements to encourage consistent Federal positions are particularly important for siting criteria, operating criteria, and reclamation and bonding standards.
- **Technical Assistance and Outreach** - Forms of technical assistance vary and may include dedicating either EPA staff or contractor hours to directly help a stakeholder; developing analytic methodologies, such as monitoring and testing standards;

providing education and training; and providing materials to small business assistance centers.

EPA has identified several examples of existing approaches to using non-regulatory tools. Site-specific examples include the Coeur D'Alene Basin Restoration Project, the Clear Creek Watershed Project, and the Arizona Copper Mine Initiative. Non-site specific examples include the CWA non-point source funding approaches; RCRA Subtitle D Strawman guidelines; Mining Headwaters Initiative; technology demonstration programs; and the Western Governors' Association Mine Waste Task Force.

As part of its hardrock mining strategy, EPA is developing detailed guidance for regulatory personnel who must apply various regulatory tools to specific mine sites. This matrix will highlight areas of overlap, gaps, unused but available authorities, and synergy among the various regulatory authorities. Envisioned is a document that will present various sources of pollution, a range of possible associated problems/concerns/threats, and a short description of the tools applicable to each situation.

VIII. COMPLIANCE ASSURANCE ACTIVITIES AND INITIATIVES

This section highlights the activities undertaken by this industry sector and public agencies to voluntarily improve the sector's environmental performance. These activities include those independently initiated by industrial trade associations. In this section, the notebook also contains a listing and description of national and regional trade associations.

VIII.A. Sector-related Environmental Programs and Activities

Compliance Projects

Region VIII has introduced "The Mining Initiative," whose goal is to obtain compliance with the Clean Water Act at active metal mines and metal mining exploration sites. The Regional NPDES program is in the process of determining the compliance status of the active metal mines located in the Region. Most of the mines (98 percent) are located in Colorado, Montana, and Utah. The States are trying to achieve deterrence through high profile enforcement actions which remove the economic advantage of noncompliance by assessing financial penalties.

The Region VIII Water Division is taking an active role in monitoring State enforcement actions against mining facilities and State-issued NPDES permits for mines, encouraging States to apply consistent requirements to all metal mining facilities. EPA has requested that each State appoint a contact to work with EPA on this initiative.

The Bureau of Mines Waste Research Program

In 1988 the debate over the Bevill exclusion wastes and other environmental issues led the Bureau of Mines to initiate a new, comprehensive research program to investigate the environmental problems posed by the mining and minerals processing industry in managing waste. The new research program was named the "Environmental Technology Program" and was established to develop mining technologies that would ameliorate environmental damage caused by mining activities.

The program's main elements are "Control of Mine Drainage and Liquid Wastes" and "Solid Waste Management and Subsidence." Control of Mine Drainage and Liquid Wastes examines acid mine drainage and migration of toxic waters from mines and waste disposal piles that threaten the quality of surface and groundwater. The Solid Waste Management and

Subsidence program has two objectives: to investigate management and disposal methods for the solid waste produced by mining and minerals processing; and to develop new technology to mitigate the effects of subsidence and other environmental hazards caused by underground mining. Under ETP, National Mine Land Reclamation Centers have also been established in several regions to investigate the surface effects of mining and the problems associated with reclaiming abandoned, as well as active, mine lands. An important element of the program is cooperation with universities, industry, labor, State and Federal government agencies, and international institutions.

The Bureau of Mines has also established an Environmental Health Research Program to focus on monitoring and controlling airborne dusts and emissions from diesel engines that are inhaled deep into the lungs, and which can cause respiratory diseases. Under this program, a dust monitor is being developed that will continuously evaluate dust conditions during the mineral ore extraction process and will alert workers to hazardous dust concentrations. Dust control techniques are primarily directed at reducing concentrations through use of water sprays, more effective use of ventilation, and modification of mining machine operations. Current Federal regulatory efforts for mining operations seek to limit the amount of diesel soot in the mine environment, while researchers are developing instruments that will allow diesel soot particulate to be sampled and measured in the underground atmosphere. The Bureau of Mines is also conducting research to reduce diesel soot emissions by filtration, ventilation, fuel modifications, and catalytic conversion techniques. Because of the confined, dusty, humid, and often hot conditions in the mine environment, this research will be widely applicable to the most difficult industrial and environmental dust problems.

Mine Safety and Health Administration (MSHA) Mines Initiative

Electrical transformers or capacitors containing polychlorinated biphenyls (PCBs) are often used as power sources in underground mines. This equipment is regulated by EPA to prevent environmental release of PCBs, chemicals classified as probable human carcinogens. Abandoned mines often fill with groundwater, which can cause PCB-containing equipment, if left in place, to corrode and leak chemicals into the water; EPA regulations currently require removal of this equipment prior to mine closure.

EPA and MSHA launched a joint effort in early 1993 to identify all underground mines using electrical transformers or capacitors that contain PCBs. During 1993, MSHA inspectors conducted PCB surveys to identify mines using PCB- or other liquid-filled equipment underground. Inspectors also identified any violations of EPA regulations governing PCB use, marking, storage, or disposal. A total of 85 underground mines that may use PCB-containing equipment were identified. EPA has since used the PCB surveys in its enforcement efforts, resulting in four mining companies being cited for PCB mismanagement and facing Federal penalties of up to $317,575. EPA has settled one of these cases, while filing three additional complaints.

Mine Waste Technology Program (MWTP)

In 1991 Congress allocated $3.5 million to establish a pilot program for treating mine wastes in Butte, Montana. Both bench-scale research and field demonstrations are conducted through the MWTP. Sponsored by EPA's Risk Reduction Engineering Laboratory and the Department of Energy (DOE), the program is implemented by DOE's Western Environmental Technology Office (WETO) contractor, MSE, and the University of Montana's Montana Tech. MWTP program goals include the following:

- Identify mine waste problems that are most severely affecting human health and the environment
- Evaluate engineering and economic factors for selected technologies
- Prioritize the most promising mine waste treatment technologies based on their engineering and economic value
- Demonstrate, test, and evaluate the most promising mine waste treatment technologies
- Accelerate the commercialization of selected mine waste treatment technologies
- Transfer knowledge gained from the above through systematic training of user communities, and the use of workshops, short courses, video outreach, and graduate study support.

The program focuses on developing and proving technologies that offer solutions to the remedial problems facing abandoned mines and the ongoing compliance problems associated with active mines. Other Federal agencies, such as USBM, BLM, and the Forest Service, are also participating in various phases of the research. Within EPA, the Butte program is coordinated and teamed with the Superfund Innovative Technology Evaluation (SITE) program, and is coordinated with the DOIT (Demonstration of Innovative Technologies) Committee of the Western Governor's Association to assist in technology outreach and coordination among the States most affected by mining activities.

The priority areas for research are:

1) *Source controls, including in situ treatments and predictive techniques.* Such at-source control technologies as sulfate-reducing bacteria, biocyanide oxidation, transport control/pathway interruption techniques, and AMD production prediction techniques will help generate permanent solutions to mining waste problems.

2) *Treatment technologies.* Technologies such as unique reagent utilization and use of natural and enhanced wetlands are high priorities for research to protect the environment from immediate damage until long-range solutions can be developed.

3) *Resource recovery*. Much of the mining wastes represent a potential resource, since they contain significant quantities of heavy metals. Membrane technologies, ion exchange systems, electrochemical separation processes, selective precipitation, enhanced magnetic separation, biological treatment/recovery schemes, and advanced metallurgical processes are techniques that might provide effective and efficient separation and recovery of the metal values in both liquid and solid waste streams.

In addition to those cited previously in the profile, specific MWTP projects include the following:

- *Nitrate Removal Demonstration Project* focuses on developing innovative technologies to remove nitrates from effluent and drinking water through ion exchange, biological denitrification, and electrochemical ion exchange.

- *Neutral Chelating Polymers Research Project* focuses on treating acid mine wastewater by using chelates (chemical substances with more than one binding site on the molecule) to remove metal ions from wastewater.

- *Photoassisted Electron Transfer Reactions Research Project* focuses on treating mine wastewaters by using dissolved and solid photocatalysts to remove toxic cyanide and nitrate anions.

- *Science and Technology Information Retrieval System (STIRS)* facilitates centralized access to various databases developed by EPA, DOE, Bureau of Mines, and others, including CD ROM databases.

- *Remote Mine Site Demonstration Project* seeks to operate a water-powered remote treatment facility for acidic metal-laden mine wastewater, using the Crystal Mine near Basin, Montana. The facility treats 10-25 gallons of wastewater per minute, using a series of rip-rap channels, water wheel-powered feeders, and settling ponds to conduct oxidation, adjust pH levels, and separate solids and liquids for ultimate disposal.

- *Biocyanide Demonstration Project* focuses on using bacteria to degrade cyanide and cyanide complexes in mining wastewater.

Western Governors' Association

Over the past few years, EPA has enlisted the assistance of the States in developing an approach to regulating mining activities under RCRA. In order to facilitate the States' involvement in this effort, EPA has provided funding to the Western Governors' Association (WGA), an independent non-partisan organization of 21 member governors. In 1988, WGA formed a Mine Waste Task Force to coordinate the views of member States and to work with the EPA, the mining industry, the environmental community, and the public to develop workable mine waste management programs.

Kansas State University

Kansas State University's Hazardous Substance Research Center (HSRC) is an EPA-funded center that provides research and technology transfer services for pollution prevention and other waste management techniques, including mining waste. HSRC programs include outreach for industry, assistance to government, education materials, and workshops on pollution prevention and hazardous waste remediation.

VIII.B. EPA Voluntary Programs

EPA sponsors a variety of programs aimed at waste reduction and pollution prevention. Some research-oriented programs, such as the Mining Waste Technology Program, are funded through other Federal and State agencies and are described in previous sections of this profile. Other programs that may serve the metal mining industry are highlighted below.

Environmental Leadership Program

The Environmental Leadership Program (ELP) is a national initiative piloted by EPA and State agencies in which facilities have volunteered to demonstrate innovative approaches to environmental management and compliance. EPA has selected 12 pilot projects at industrial facilities and Federal installations to demonstrate the ELP program principles. These principles include: environmental management systems, multi-media compliance assurance, third-party verification of compliance, public measures of accountability, community involvement, and mentoring programs. In exchange for participating, pilot participants receive public recognition and are given a period of time to correct any violations discovered during these experimental projects. (Contact: Tai-ming Chang, ELP Director, 202-564-5081 or Robert Fentress, 202-564-7023)

Project XL

Project XL was initiated in March 1995 as a part of President Clinton's *Reinventing Environmental Regulation* initiative. The projects seek to achieve cost effective environmental benefits by allowing participants to replace or modify existing regulatory requirements on the condition that they produce greater environmental benefits. EPA and program participants will negotiate and sign a Final Project Agreement, detailing specific objectives that the regulated entity shall satisfy. In exchange, EPA will allow the participant a certain degree of regulatory flexibility and may seek change in underlying regulations or statutes. Participants are encouraged to seek stakeholder support from local governments, businesses, and environmental groups. EPA hopes to implement fifty pilot projects in four categories including facilities, sectors, communities, and government agencies regulated by EPA. Applications will be accepted on a rolling basis and projects will move to implementation within six months of their selection. For additional information regarding XL Projects, including application procedures and criteria, see the May 23, 1995 Federal Register Notice, or contact Jon Kessler at EPA's Office of Policy Analysis (202) 260-4034.

NICE[3]

DOE and EPA's Office of Pollution Prevention are jointly administering a grant program called the "National Industrial Competitiveness through Energy, Environment, and Economics" (NICE[3]). By providing grants of up to 50 percent of total project cost, the program encourages industry to reduce industrial waste at its source and to become more energy-efficient and cost-competitive through waste minimization efforts. Grants are used by industry to design, test, demonstrate, and assess the feasibility of new processes and/or equipment with the potential to reduce pollution and increase energy efficiency. The program is open to all industries, however priority is given to proposals from participants in the pulp and paper, chemicals, primary metals, and petroleum and coal products sectors. (Contact: DOE's Golden Field Office, 303-275-4729)

VIII.C. Trade Association Activity

The metal mining industry's many associations have been active participants in exploring new avenues of pollution prevention. As noted above, some are participating in Bureau of Mines or MSHA research. A description of various industry associations is provided in the following section.

The trade and professional organizations serving the metal mining industries are primarily organized according to commodity. In light of the controversy over mining law and the possible legislative reform of current mining practices, there are also several associations whose sole intent is to influence the reform process.

National Mining Association 1130 17th St. Washington, D.C. 20036 Phone: (202) 861-2800 Fax: (202) 861-7535	Members: 400 Contact: Richard Lawson

Founded in 1995 with the merger between the American Mining Congress and the National Coal Association, the National Mining Association represents producers of domestic coal, metals, and industrial and agricultural minerals; manufacturers of mining and mineral processing machinery, equipment, and supplies; engineering/consulting firms; and financial institutions that serve the mining industry. The Association also offers tax, communications, and technical workshops.

Coalition for Responsible Mining Law c/o Coeur D'Alene Mines Corp. PO Box 1 Coeur D'Alene, ID 83816-0316 Phone: (208) 667-3511 Fax: (208) 667-2213	Members: 300 Staff: Budget: Contact: Justin Rice

The Coalition for Responsible Mining Law (CRML) comprises mining company executives, exploration geologists, small miners, and others interested in mining laws, organized as a means of coalescing Western mining interests behind a proposal to preserve the basic provisions of the National Mining Law (Mining Law of 1872). The coalition seeks to raise awareness about the law within the mineral industry, Congress, and the general public through specialized education. Publications include a periodic newsletter.

Interstate Mining Compact Commission 459B Carlisle Dr. Herndon, VA 22070 Phone: (703) 709-8654 Fax: (703) 709-8655	Members: 17 Staff: 2 Budget: $150,000 Contact: Gregory E. Conrad

The Interstate Mining Compact Commission (IMCC) is comprised of States engaged in surface mining operations. The commission's purpose is to bring together State officials to discuss mining problems of national scope and significance. An effort is made to promote cooperation between States, private mining groups, and the Federal government, and to discuss, encourage, endorse, or sponsor activities, programs, and legislation to advance mined land reclamation. The IMCC publishes the *NASL Newsletter* quarterly.

Gold

Gold Institute 1112 16th St. NW, Ste. 240 Washington, DC 20036 Phone: (202) 835-0185 Fax: (202) 835-0155	Members: 66 Staff: 10 Budget: Contact: John Lutley

The institute represents gold mining and refining companies, manufacturers of products containing gold, and others who hold and supply gold. The institute advances the gold industry's interests by "developing information from worldwide sources on gold uses, research, technology, markets, and reference data," and encourages the development and use of gold and gold products. Publications include the bi-monthly *Gold News.*

Lead

Lead Industries Association 295 Madison Ave. New York, NY 10017 Phone: (212) 578-4750 Fax: (212) 684-7714	Members: 70 Staff: 4 Budget: Contact: Jerome Smith

The Lead Industries Association consists of mining companies, smelters, refiners, and manufacturers of lead products. The association provides technical information to consumers, maintains a library, and gathers statistics. Its primary semi-annual publication is LEAD.

Iron and Steel

American Iron and Steel Institute 1101 17th St. NW, Suite 1300 Washington, DC 20036-4700 Phone: (202) 452-7100 Fax: (202) 463-6573	Members: 1200 Staff: 44 Budget: Contact: Andrew G. Sharkey III

Members of the American Iron and Steel Institute operate steel mills, blast furnaces, finishing mills, and iron ore mines. The Institute conducts extensive research programs on manufacturing technology, basic materials, environmental quality control, energy, and fuels consumption. In addition to technical manuals and pamphlets, the Institute also publishes the *American Iron and Steel Institute-Annual Statistical Report.*

American Iron Ore Association 614 Superior Ave, W Cleveland, OH 44113-1383 Phone: (216) 241-8261 Fax: (216) 241-8262	Members: 12 Staff: Budget: $260,000 Contact: George Ryan

The American Iron Ore Association represents iron ore producing companies in the U.S. and Canada. The organization's goals are to compile and disseminate statistics concerning the iron ore industry, and to provide a forum for discussing industry problems. The Association publishes a variety of documents, among them annual and monthly reports that detail significant occurrences in the industry.

Aluminum

Aluminum Association 900 19th St. NW, Ste. 300 Washington, DC 20006 Phone: (202) 862-5100 Fax: (202) 862-5164	Members: 86 Staff: 27 Budget: $4,300,000 Contact: David Parker

The Aluminum Association consists of producers of aluminum and manufactures of semi-fabricated aluminum products. The association represents members' interests in legislative activity and conducts seminars and workshops. In addition, the Association maintains a library and publishes various documents, including a monthly *Aluminum Situation.*

Copper

American Copper Council 2 South End Ave., No. 4C New York, NY 10280 Phone: (212) 945-4990	Members: 175 Staff: 2 Budget: $300,000 Contact: Mary Boland

The American Copper Council consists of producers, fabricators, merchants, consumers, and traders of copper. The council provides a forum for exchanging news and opinions between copper industry executives and government officials. In addition, the council maintains a relationship with the metal trade press and contributes data and background information related to copper industry events. A newsletter is published quarterly.

Zinc

American Zinc Association 1112 16th St., NW, Suite 240 Washington, DC 20036 Phone: (202) 835-0164 Fax: (202) 835-0155	Contact: George Vary

The AZA is an international association that represents primary and secondary producers of zinc metal, oxide, and dust from the U.S., Canada, Mexico, Australia, Finland, Norway, and Spain, who sell in the U.S. market -- the largest single-country zinc market in the world. The association's primary goal is to promote awareness of and to educate the public about zinc and its many uses; *Zinc Essentials* is the association's newsletter.

IX. CONTACTS/ACKNOWLEDGMENTS/RESOURCE MATERIALS/BIBLIOGRAPHY

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U.S. Industrial Outlook 1994, Department of Commerce.

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SIC Code Profile 10, Metal Mining, September 1994 U.S. EPA, Office of Pollution Prevention and Toxics.

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Acid Mine Drainage from Mines in National Forests, a Management Challenge, Program Aid 1505, 1993, USDA Forest Service.

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The Scope of the Bevill Exclusion for Mining Wastes, Van Housman, Environmental Law Reporter, November 1994.

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Hardrock Mining Framework, Draft, March 1995, U.S. EPA.

Unified Agenda, 59 Federal Register, April 1994.

Process Descriptions

Annual Report: Copper, 1992, U.S. Bureau of Mines.

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Mining's Future: Meeting the Environmental Challenge, Connolly, R.E., Battelle Press, 1990.

Mining: Technical Support Document, Internal Training Workshop Principles of Environmental Enforcement, Draft April 1994 U.S. EPA.

The Use of Constructed Wetlands in the Treatment of Acid Mine Drainage, Perry, Allen, Cambridge University Press, 1991.

Contacts*

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John Roach	U.S. Bureau of the Census	301-703-7066
Roger Wilmoth	U.S. EPA Office of Research and Development	513-569-7509
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* Many of the contacts listed above have provided valuable background information and comments during the development of this document. EPA appreciates this support and acknowledges that the individuals listed do not necessarily endorse all statements made within this notebook.

Name	Office Organization	Telephone
Melanie Pallman	U.S. EPA Region VIII (inspector)	303-293-1626
Dan Tangerone	U.S. EPA Region X (inspector)	206-553-1630
Ron Clawson	U.S. EPA Region IX (inspector)	415-744-1888
General Information	U.S. Bureau of Mines	202-501-9650
Division of Mineral Commodities	U.S. Bureau of Mines	202-501-9448
Division of Regulatory and Policy Analysis	U.S. Bureau of Mines	202-501-9732
Division of Environmental Technology	U.S. Bureau of Mines	202-501-9271

EPA Document Availability

Per the March 1, 1995 Federal Register, the following technical documents concerning wastes from non-coal extraction and beneficiation, were issued by the U.S. EPA, and are available at the RCRA docket, EPA Headquarters, Washington, D.C., and all EPA Regional Libraries. Copies of most documents may be purchased from the National Technical Information Service at (800) 553-NTIS. Most documents are also available electronically on the Internet System, through the EPA Public Access Gopher Server.

The following technical resource documents (TRDs) have been peer reviewed by State representatives, Federal land management agencies, mining companies, and public interest groups:

TRD Vol.1: Lead-Zinc (NTIS PB94-170248)
TRD Vol.2: Gold (NTIS PB94-170305)
TRD Vol.3: Iron (NTIS PB94-195203)
TRD Vol.4: Copper (NTIS PB94-200979)
TRD Vol.5: Uranium (NTIS PB94-200987)
TRD Vol.6: Gold Placer (NTIS PB94-201811)
TRD Vol.7: Phosphate & Molybdenum (NTIS PB94-201001)

The documents listed below discuss current mining waste management and engineering practices, and have been peer reviewed by State representatives, Federal land management agencies, mining companies, and public interest groups:

Innovative Methods of Managing Environmental Releases at Mine Sites (NTIS PB94-170255)

Design and Evaluation of Tailings Dams (NTIS PB94-201845)
Treatment of Cyanide Heap Leaches & Tailings (NTIS PB94-201837)
Acid Mine Drainage Prediction (NTIS PB94-201829)
WASTE: An Information Retrieval System for Mill Tailings References (not at NTIS; available electronically or at RCRA docket)

The following documents provide historical context for EPA's mine waste activities:

- Report to Congress on Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale (NTIS PB88-162631)
- Strawman II (NTIS PB91-178418)
- U.S. EPA Mine Waste Policy Dialogue Committee Meeting Summaries and Supporting Material (NTIS PB95-122529).