California's Abandoned Mines

A Report on the Magnitude and Scope of the Issue in the State
Volume I

Department of Conservation
Office of Mine Reclamation
Abandoned Mine Lands Unit
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EXECUTIVE SUMMARY

Overview

Since the Gold Rush of 1849, tens of thousands of mines have been dug in California. Many of these mines were immediately abandoned when insufficient minerals were found, others were abandoned later when poor economics of the commodity made mining unprofitable, while still others were abandoned in 1942 after the issuance of War Production Board Order L-208. The result is that California's landscape contains tens of thousands of abandoned mine sites, many of which pose health, safety, or environmental hazards. Every year people fall victim to the hazards of abandoned mines. Many sites possess serious physical safety hazards, such as open shafts or adits (mine tunnel). Thousands of sites have the potential to contaminate surface water, groundwater, or air quality. Some are such massive problems as to earn a spot on the Federal Superfund list.

In the interest of environmental and public health and safety, the Department of Conservation (DOC) undertook a three-year effort to determine "the magnitude and scope of the abandoned mine problem in California."[1] An inventory of abandoned mines was accomplished, culminating in this report to the Governor and Legislature. Prior to this effort, the number of abandoned mines reported was based solely on legacy databases and ranged from a low of 7,000 to a high of 20,000 abandoned mines. To get a more accurate picture of the nature and extent of this problem, existing literature and data were collected, input, and spatially analyzed through the implementation of a Geographic Information System (GIS). Data gaps were identified, and a field program was implemented to acquire site specific information. Data were collected at selected abandoned mine sites, by watershed, in various bioregions throughout the state. Significant mine features were photographed and precisely located by differentially corrected Global Positioning System (GPS). A standardized assessment and ranking protocol were applied to potential physical and chemical hazards observed. Field data, in addition to information collected from existing sources, were entered into a relational database and spatially and statistically analyzed for this report[2]. The following itemizes our key findings.

[1] "Magnitude and scope" are the exact words from the FY 97/98 Budget Change Proposal (BCP) that funded the effort. Under this original BCP, the program was to continue at a reduced level beginning in FY 2000/2001. A new FY 2000/2001 BCP continues the funding at near the original level for an additional two years providing that "of the $153,000 appropriated in this item for support of the Abandoned Mine Inventory, no funds shall be expended on or after January 1, 2001, unless and until a statute is enacted authorizing the Department of Conservation to remediate, and complete reclamation of, surface mines operated since January 1, 1976, that have been illegally abandoned and that pose a threat to public health and safety or the environment, but for which no reclamation plan is in effect and for which no financial assurances exist." Chapter 52, Statute of 2000, for Fiscal Year 2000/2001.

[2] A full explanation of the methods and data behind this report are provided in Volume II.

Key Findings [3]

- Based on field investigations and statistical extrapolations, it is estimated that there are approximately 3*9,000* (95% confidence interval from 29,300-69,800) *historic and inactive mine sites* in the state.
- Of these, *4,290 or 11% are estimated to present environmental hazards.*
- Also *32,760 abandoned mines, or 84%, are estimated to present physical safety hazards.*
- There are approximately*128,800 mining features*[4] (95% confidence from 102,700-160,600) in the state.
- Approximately 48,944, or 38%, of these features are hazardous openings[5].
- Our research confirmed that a *field visit to each site is necessary for assessment of physical hazards.*
- Geo-environmental modeling can help prioritize field visits to sites with suspected chemical hazards; however, a field visit is necessary to confirm the existence and magnitude of these hazards.
- An estimated *50% of the abandoned mines are on private lands.*
- Approximately *1.5% of the abandoned mines are on state lands.*
- And *48% are on federal lands,* primarily on Bureau of Land Management and US Forest Service property.

Other State and Federal AML Programs

The following are common themes of other state and federal abandoned mine lands (AML) programs:

- Cooperative arrangements between state and federal agencies leverage limited funds available at both levels of government.
- AML inventory and watershed assessments are done simultaneous with remediation projects.
- Most states have an education component built around the national "Stay-Out, Stay-Alive" slogan.
- The federal program for coal-producing states and the state programs of non-coal producing states such as Nevada and South Dakota, redistribute all or a portion of the costs of environmental clean-up to the active mining industry.

Options

The findings presented in this report lead to three options for addressing California's abandoned mine problem; they are: "no action", short-term, and long-term options. Short-term options are those that require no significant changes in funding or program mandates, whereas long-term options may

[3] The numbers listed in this section are based on statistical modeling and GIS analyses that are more fully explained in Volume II of this document. These numbers are subject to change as the models improve.

[4] Mining "features" include all of the workings, tailings or waste, and processing facilities

[5] Openings include adits, shaft, tunnels and other underground workings that open to the surface.

require significant additional funding, legislation or new programs. All options are more fully detailed later in the document beginning on page 47.

No Action Option (no change in program direction):

- Continue current funding plan. This plan provides a base funding of $250,000 (2.5 person-years) annually for the ongoing Abandoned Mine Inventory. An additional $153,000 (2.1 person-years) is added to this sum for fiscal years 2000/01 and 2001/02 with spending contingent upon the passage of additional legislation for the reclamation of illegally abandoned surface mines that operated after January 1, 1976 (date SMARA was enacted). (See footnote on previous page for budget control language.) This option requires no changes in legislation (beyond that stipulated above), funding or program mandates; and bases policy decisions on the current level of information.

Short-Term Options (redirection within existing DOC or other State Agencies' programs):

- Provide additional staffing and funding to complete the abandoned mine lands inventory in a shorter time frame; expected completion time proportional to funding. For example, 10 staff positions could complete the inventory in approximately 26 years.
- Prioritize high-risk watersheds for inventory and assessment based on enhanced geo-environmental models.
- Prioritize inventory of physical hazards based on enhanced exposure models, and initiate mitigation of hazardous openings under existing laws. (The current laws are punitive to property owners, based on Health and Safety Code as cited in Table 2.)
- Focus the limited remediation resources on watershed-based efforts that address cumulative impacts.
- Study and quantify the impacts of mercury released from historic hydraulic mining.
- Work with other agencies to develop a recycling program to handle the mercury currently being recovered by recreational and small-scale placer mining.
- Develop a mine hazard awareness and education program for the public that is similar to the "Stay-Out, Stay-Alive" programs of other states.
- Direct a portion of the funds collected under the *Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act of 1999* to address the environmental hazards of abandoned mine lands.
- Direct a portion of the funds in the CALFED program towards inventorying, assessing and remediating abandoned mine lands to address the CALFED objectives of habitat restoration, water quality and watershed management.
- Implement an agency CEQA review process that specifically addresses projects on or near hazardous abandoned mines (Currently, no program in DOC or other agency is specifically funded for this task.)

Long-Term Options:

- Fund a public grant program to assist local governments in the remediation of physical hazards.
- Amend SMCRA (Federal) to provide funding for remediation of abandoned mines in states without coal production.
- Amend the Surface Mining and Reclamation Act (SMARA, State) to provide funding for the remediation of abandoned mines.
- Redirect a portion of mine claim maintenance fees (Federal) to states to use for abandoned mine land remediation on federal lands.
- Consider instituting a pollution trading mechanism that would allow active mine operators and others, such as water treatment plants, to receive credits for remediating the environmental hazards of abandoned mines.
- Consider supporting House Resolution 2753, the *Abandoned Mine Restoration Act of 1999*, which establishes the *Restoration of Abandoned Mine Sites* (RAMS) program within the Army Corps of Engineers.
- Consider creating an abandoned mine lands program that parallels California's *Leaking Underground Fuel Tank* program, which places a fee on the industry, as a source of remediation funding.
- Consider supporting "Good Samaritan" provisions within the Clean Water Act (Federal), such as the *Good Samaritan Abandoned or Inactive Mine Waste Remediation Act* (1999) sponsored by Senator Baucus (D-MT).
- Consider supporting changes to the 1872 Mining Law to allow the use of royalties paid by current mining companies to be used to remediate abandoned mines on federal lands.
- Consider supporting changes to the Surface Mining and Reclamation Act of 1975 (SMARA) to ensure that active mines do not become abandoned.

BACKGROUND

California is rich in mineral wealth. In 1998, California ranked second in the nation in production of both gold and non-fuel mineral commodities. The mining of minerals such as gold, silver, copper, lead, zinc, chromium and many others has provided enormous economic wealth to the state, as well as to the nation for over 150 years. In addition, historical mining is part of the rich cultural heritage of California, and is largely the basis for the infrastructure upon which the state was built. Understanding the legacy of historical mining can help us place into perspective what has happened in the past, how that affects the decisions we make in the present, and how we can effectively meet the challenges this mining legacy places on California's future.

In contrast to today's high-tech mining industry, California's historic mining industry was developed in a time of less-sophisticated mining methods and before modern environmental regulations. As a result, California's rich mining legacy has left unreclaimed tens of thousands of abandoned mine sites, many of which are health, safety or environmental hazards (A.1). Thousands of these mines cause surface or ground water quality problems, and several sites have such massive problems as to earn a spot on the National Priorities List (Superfund). These environmental consequences are not limited to the abandoned mines themselves. Contaminated runoff from abandoned mines impacts tens of thousands of acres of land, groundwater, and hundreds of streams, rivers, and lakes throughout the state. Preliminary investigation of existing data revealed that the scope and magnitude of the abandoned mine problem has been previously under-estimated. And because the majority of these sites date back to the 19th century, the individuals or companies responsible for the problem are no longer present to assist with remediation and reclamation.

While some information on a few of our abandoned mine lands (AML) is available from other state, local, or federal agencies, there has not been a statewide clearinghouse for information nor a coordinated statewide effort to address abandoned mine lands in California. A coordinated watershed approach has not been used for decision-making, resulting in the highest profile sites consuming what little remediation dollars have been made available. The low level of knowledge about the location and impacts of abandoned mines is becoming more evident as the state's population moves into high-density abandoned mine lands areas such as the Sierra Nevada foothills.

California is not unique in its attempt to address abandoned mine issues, other western states face similar issues and concerns. In 1993 and 1994 while considering amendments to 1872 General Mining Law[6], funding for AML clean-up was one of several proposed amendments. This law enacted 130 years ago, in conjunction with the Homestead Act, promoted the development and settlement of the west. One requirement for receiving funds from an

[6] The General Mining Law of 1872, as amended, provides private access to hardrock mineral resources on federal lands.

amended General Mining Law, would have been the existence of a statewide abandoned mine inventory, with priorities for remediation[7].

The Department of Conservation's (DOC) Office of Mine Reclamation, which administers the state's reclamation portions of the Surface Mining and Reclamation Act (SMARA 1975), noted that California would not qualify for these remediation funds without the requisite inventory. In fiscal year 1997/98, the new Abandoned Mine Lands Unit (AMLU) was funded in the Office of Mine Reclamation. This program is charged with locating, inventorying, and characterizing the state's historic, inactive, and abandoned mines. As part of their abandoned mine lands (AML) effort, DOC initiated the AML Task Force and entered into Cooperative Agreements or Memoranda of Understanding with the National Park Service and Bureau of Land Management; an agreement with the US Forest Service is still in process.

Over the period from July 1997 to June 2000, the unit was given $450,000 and 4.2 person-years per year to accomplish a statewide inventory and produce a report. Despite unforeseen delays in start-up[8], staff collected and entered data for 778 mine sites and 3,980 features into the AMLU database[9] (A.4).

As in other states around the country, locating, inventorying, and characterizing the state's AML are the first steps in obtaining state, as well as federal, monies to mitigate some of the more serious AML environmental problems and to close dangerous adits and shafts. As part of this information gathering effort, a statewide priority list was proposed to help focus limited resources and reduce competition among stakeholders for remediation dollars (B.1, B.2). Additionally, AMLU digitized the mine symbols from the 2,869 7.5–minute USGS topographic maps that cover California. To date, 50.5% of these have been completed (A.5). The work on this data layer will continue until the state is complete, at which time it will be made available to other agencies and the public.

California's Mining History

California is endowed like no other state with rich geologic diversity. Ranking third in total area, it is also the fourth most mountainous state. There are eleven distinct geomorphic provinces containing equally distinct mineral deposits. As a result, more mineral commodities have been developed in California than in any other area of similar extent and California currently ranks second nationwide in non-fuel mineral production.

Over 700 mineral commodities have been identified in the state, 45 of which only occur here. In recent years, California lead the nation in the production of asbestos, boron, cement, diatomite, mercury, pumice, rare earths, sand, gravel, talc and tungsten. It has been one of the top three states in

[7] The proposed amendments to the 1872 Mining Law addressing funding for AML reclamation have yet to be enacted.

[8] The Chronology given as an appendix in Volume II details the amount of time taken to get the program staffed and outfitted with necessary equipment.

[9] The relational AMLU database is part of an overall Geographical Information System (GIS) that allows for complex spatial analyses. Examples of spatial analyses are included in this volume.

production of bromide, calcium chloride, chromite, feldspar, gold, gypsum, iron ore, platinum, potash, sulfur ore and tin.

The incredible legacy of California mining is that more than any other single source in our first century, it drove our economy, financed our infrastructure, developed our capital, and ultimately gave us early statehood, respect and power. Yet there has been a deferred environmental cost. One that we have largely chosen to defer to future generations. As a result of this legacy, the state is left with environmental hazards such as unstable underground workings, acid rock drainage (ARD), and heavy metal and asbestos contamination.

While the discovery of gold at Sutter's Mill in 1848 is often considered the beginning of California's mining legacy, mining throughout Southern California was already well established on a small-scale. Spanish and Mexican settlers found gold in southern California in 1775, 1812, 1814, 1824 and 1842. There is evidence of mining being done in every major mountain range in southern California during the Mission and Rancho periods.

A major reason for Spanish colonization of California was the search for mineral wealth. Experienced miners from Mexico had discovered a number of the first known deposits of many of the commodities mined today. Although major exploitation did not occur during the Mission Period, after the discovery of gold in Placerita Canyon in the San Fernando Valley in 1842, hundreds of Los Angelenos converged upon the area. Experienced miners from the Mexican State of Sonora were quick to follow. Ultimately they produced over $100,000 in gold that was shipped both to Mexico and the East Coast of the United States for further processing (Wagner 1970).

Yet for most Californians, the benchmark event was the 1848 “rediscovery” of gold in the South Fork of the American River by workers of the Sutter Mexican land grant known as Los Rios de los Americanos. Before the end of the year, every Californian who could do so had traveled up to the foothills in search of the easy to reach “placer” gold.

Meanwhile, as news reached far away places, thousands set out by land and sea on the perilous adventure that in three to four months, perhaps more, would bring them to California. They arrived throughout 1849, immediately heading for the foothills of the Sierra Nevada and covering every major river canyon with multitudes of hastily constituted gold camps.

Between 1848 and 1967, California was the source of more than 106 million ounces of gold. This total, worth over $40 billion dollars by 1999 prices, was far greater than any other state, and represented over 35% of US production (Clark 1966).

During this era in Northern California, quicksilver mines were operating in the Coast Ranges south of San Francisco. They supplied mercury to the gold mines of the Sierra for use as an amalgamator. In fact, the quicksilver mines, more than any other factor, were the origin of development in the San Jose area.

Table 1: Summary of Commodities in MAS/MILS.

Commodity	Frequency	Percentage
Gold	13,994	47.86
Sand and Gravel	2,187	7.48
Stone	1,669	5.71
Copper	1,394	4.77
Unknown	1,363	4.66
Chromium	1,219	4.17
Manganese	917	3.14
Tungsten	749	2.56
Silver	635	2.17
Clay	578	1.98
Mercury	534	1.83
Calcium	410	1.40
Lead	406	1.39
Others	3,184	10.89
	29,239	**100.01**

Metallic Mining

Gold

Placer Mining

For the first few years after 1848, gold was strewn liberally throughout the rivers and was easily had. This was the only time that the individual could strike it rich; later, it would require capital and thus would be the province of corporations. Consequently, for half a decade, gold recovery far exceeded any period following.

At first, all it took was a gold pan, some crevicing tools, and a shovel. Soon, miners learned that a little wooden box with a sluice in the bottom, called a rocker, greatly sped up the process of separating out the gold. In drier climes, like the California deserts, gold seekers dry washed, tossing the sands and gravel up time after time in a blanket until they had separated out the gold.

After having removed the easily obtainable gold by the relatively unsophisticated methods of panning, or shoveling river sands and gravels through a sluice box or rocker, the miners were forced to use more ingenious methods. They diverted miles of river into flumes to get to the normally submerged channel. On occasion, when a river formed a significant bend, like Oxbow on the Middle Fork of the American River, they tunneled through solid rock to reroute the river, thus exposing hundreds of feet of the former bed.

Early pictures show Northern Sierra river canyons completely devoid of any large trees, so demanding was the need for the lumber to build the flumes, dams, large scale sluice boxes, plank roads, bridges, and the hastily constructed habitations. The absence of trees compounded other issues. Major erosion became a problem. The rivers' wildlife diminished with the absence of streamside vegetation, and loss of habitat.

Despite seemingly endless miles of rivers and streams, the thousands of seekers had largely exhausted the easy to reach gold in the river channels within the first three to four years of the 1850s. Miners had limited options at that point, either to locate gold in more remote locales, or seek the gold by other, more sophisticated methods. It is clear by the recorded dates of

settlement of hundreds of Northern California towns that the gold seekers did relocate in every area, as there aren't many locales that did not have, albeit often short, some initial mining activity. So, a miner could continue to operate at a fairly simple level, with pick and shovel, pan and rocker, if he kept moving to more remote areas. (Averill, 1946)

Hydraulic Mining

Hydraulic mining was being perfected simultaneous to the increasingly complex placer methods mentioned above. This type of mining was most prevalent in the region north of the true Mother Lode, in an area sometimes referred to as the "Northern Mines", from El Dorado County in the south to Lassen County in the north.

Hydraulic mining consisted of channeling water into successively narrower, confined pipes, which at the same time rapidly lost elevation, and thus created huge pressure. At the end of the pipe was an ingenious device known as a monitor, which acted like a giant nozzle, blasting the water out in a steam like a cannon.

This original-to-California process was perfected to exploit a tremendous opportunity. In ancient geologic time, several enormous river channels originating hundreds of miles to the east had moved westerly across the state prior to the formation of the Sierra range. When the Sierra was created, the intense upward movement shattered these ancient rivers leaving them as huge segmented beds of gravel as likely to be at the top of a mountain as in a canyon (Lindgren 1911, Lawler 1995).

The ancient gravels when washed down and separated, on a grand scale, could easily be mined for gold. All it took was mercury to separate the gold out, and within a couple hundred miles were the largest mercury reserves in our nation. These gravel beds were discovered and worked throughout the Northern Sierra, and soon after, around the Klamath, Siskiyou, Trinity and Warner Mountains farther north.

As entire mountainsides and whole valleys could be torn apart with relative ease, it wasn't surprising that many syndicates quickly adopted this new technology. One person operating a monitor could do the work of hundreds. Mining Engineer W.S. Keyes reported in an 1867 report that "if wages were $4 a day, the cost of washing one cubic yard with a pan would be $20; with a rocker, $5; but with the hydraulic method, 20 cents".

Hydraulic mining dramatically increased the sediment loads of rivers, leading to raised river bottoms and forcing river towns like Marysville and Sacramento to build miles of costly levees to prevent flooding. Additionally, property values dropped, river boats couldn't reach ports, and the flow from city hydrants became a turgid gruel of mud and water (Kelley 1959). According to University of California, Davis (UC Davis) geochemist Rob Zierenberg, "there is large amount of sediment still moving down [the rivers]" (Rockwell 2000). This sediment has not only been attributed to millions of dollars of property damage from flooding over 150 years, it could be a major factor in the loss of our inland fisheries (Jacobs 1993).

Hydraulic mining was to enjoy a heyday of some thirty years before it was significantly slowed by California's first environmental court decision. In 1884, the Sawyer decision said that the mines were enjoined from placing

mining debris in watercourses that were a tributary to navigable streams. The wording suggested a loophole, and the loophole soon used was that if the mines could construct a debris dam, then they could continue operations. Not surprisingly, that's just what many companies did. These dams worked usually until the next significant flood.[10]

According to the federally appointed special investigator — geologist Grove Gilbert, who engaged in a 14–year study of the extent of the debris — 1,555 million cubic yards were washed into the Sacramento River basin from 1852-1909. This equates to eight times the amount of earth moved to build the Panama Canal. This figure, however, does not include any rivers or streams that are not tributaries to the Sacramento[11] (Gilbert 1917).

With the new restrictions on hydraulic mining, impacted miners had several options. They could build drift tunnels, they could operate clandestinely, or they could devise some way of stopping the sediment from entering the rivers.

Drift tunnels were underground passageways that sought the contact points between the ancient riverbeds and the bedrock below. Drifting involved both economic and actual risk. Much developmental work was needed to prepare the tunnels. And since they ran through partially cemented gravels, the tunnels would often present the danger of caving in on their workers. Miles of drifts and hydraulic tunnels still exist today, presenting a dangerous lure to the increasing numbers of backcountry curiosity seekers.

The Caminetti Act of 1893, resulted in the creation of a California Debris Commission (CDC) to manage the mines and their impact on the rivers. In its first year, the newly founded commission grappled with nearly 100 permits from hydraulic mining companies -— approving 70 (Haygood 1981). By its own records the Debris Commission issued 800 permits from 1893–1935. The Commission was, as well, the enforcing entity of the conditions of the permits. California's Division of Mines issued a 1928 report identifying much of the remaining workable gravels (Root 1928).

The government provided assistance to the industry by allocating monies for four large government built debris dams on the Yuba, Bear, and American Rivers. These dams took years to build, and in fact, only two of the four were completed. But they still bought the industry more time. Ironically, by the time two dams were completed in the early 1940s — on the main stem of the Yuba, and the north fork of the American — most of the hydraulic mining activities had ceased.

There were still 41 active hydraulic mines in 1941, and 23 at the end of the war. During the decade 1945–55, CDC regulated 25 mines. There were 8 reporting in the next decade. Some indications from local histories in the Gold Country suggest a number of smaller mines operated for years surreptitiously

[10] After the 1884 Sawyer Decision ultimately resulted in many of the hydraulic activities diminishing, the intricate system of water conveyances that redirected water to the monitors became the precursor to California's modern day water system. The miners and their contractors had built an elaborate network of dams, flumes and ditches, many of which, still intact, deliver water to foothill communities and valley towns.

[11] Not covered in the CDC figures were the extensive hydraulic mines of the Trinity, Klamath and Scott River basins in Northwest California, as well as the Coast Ranges generally. Nor were sites in Southern California included; thus it does not come close to estimating a total for California.

(Thompson 1998). According to the Debris Commission's issuance of permits, hydraulic mining continued until at least 1965. While most historians wrote that the activity was greatly diminished after Sawyer, few of them take into account that increased technology allowed for more efficient hydraulic equipment in the later period.

California has over 26,000 miles of "blue line streams" (streams delineated with a blue line on the USGS topographic maps), up to half of which may have been impacted by hydraulic mining. The Debris Commission was ultimately concerned with effects downstream in the agricultural valley, not so much the effects above. As the 1990s have been the decade of reflection on our watersheds, a great deal of additional information needs to be compiled about the environmental effects of the historical hydraulic mining.

It is not the sedimentation issue alone, however, that is of such concern regarding these numerous and extensive hydraulic sites. The huge sluices — either on the surface, or in extensive drain tunnels — were liberally laced with mercury to capture the gold washing through. Tons of mercury (a potent neuro-toxin) were used in the mines, and lost to the environment (Knudson 1991). This issue has recently come to light, and is the target of a multi-million dollar study by the USGS.

Hard Rock Mining

Miners discovered that Sierra rivers had cut through a 200-mile long network of quartz veins running north to south in the low foothills of the mountains. They often contained gold concentrations so high that town after town was developed along the so-called Mother Lode to tap the riches. After the easy to get gold on the surface was exhausted, miners went underground to follow the quartz veins.

Thousands of underground ventures began in the areas where gold was found. This proved to be true not only for the Mother Lode but in regions to the north, east, and south of it — along the entire length of the 450-mile mountain range. These underground mines were developed in relationship to the wealth of the minerals discovered, or sometimes, in relationship to the wealth of the investors. Under any circumstances, the hard rock mining operations tended to be far more technical ventures. So, if the gold proved to be of good quantity or quality, the operation became more than a simple tunnel. Vast underground workings were developed, requiring consolidations, cooperation, and capitalization. Some mines alone have hundreds of miles of underground shafts.

Not surprisingly, it is the gold mines that represent the greatest number of abandoned sites in the state today. They constitute almost 50% of the 30,000 mineral locations identified in the former US Bureau of Mines database (MAS/MILS). Of that total, at least half are all or partially underground. These underground mines present one of the most attractive nuisances the West has to offer. Federal public land agencies in California — National Park Service, Bureau of Land Management and Forest Service — have attempted mitigation measures to reduce their liability. California is the only western state to not have a state abandoned mine safety program (WGA 1998).

Whether the method is underground or surface mining, the formations that contained the gold were also often rich in sulfides. Acid rock drainage

(ARD) can occur when sulfide minerals normally confined to below the surface are exposed to air and water as a result of mining activity. A chemical and biological reaction takes place resulting in the creation of sulfuric acid, which dissolves metals and which, in concentrations, can be very harmful to aquatic life. It is the metal-loading that causes a greater environmental concern than the acidity.

Dredging

The later half of the 19th Century was a time of invention, innovation and industrialization. Iron and steel and metal fabrication was perfected to the point where large machines revolutionized mining technology. An invention that added one more dimension to mining was the California gold dredge. The dredges, often the size of a large building, were designed to float on a body of water. As they moved along excavating everything in their way, they created their own ponds underneath them. In this manner of locomotion, they could move along river and stream channels and process the alluvial gravels, separating out the gold as they went.

Many of the rivers in the Central Valley bear the trail of the dredges, where miles of windrows may be found. This unique form of California technology was imported worldwide in the century following its invention. Some of the giant dredges operated on California rivers up until the 1960s. So productive was this form of "low grading" that it constituted the bulk of the gold mining revenues in the 20th Century. Extensive areas on the Feather, Yuba, American and the Tuolumne as well as hundreds of miles of small streams remain in a substantially altered state as a result.

The Modern Era

Two events were largely responsible for the decline of the traditional mines and methods. One was the government order in World War II to close down the gold mines because they were not considered an essential war time industry. The other was declining gold prices, which beset the industry in the early 1950s. The low prices, coupled with the considerable expense to dewater and rehabilitate the mines after the order was lifted, closed down even some of the longest running operations.

Today some mines wait for the gold price to go back up; others continue minimal exploration, hoping for another pay streak. More importantly the technology of recovery has completely changed things again. Large open pit operations, employing cyanide heap leach recovery, dominate the industry.

Silver and The Comstock Lode

Ten years after the Gold Rush of '49, when many individual miners were out of work, a miraculous discovery was made on the eastern edge of California. A vast body of high-grade silver was found at Virginia City, Nevada. This started another rush, in this case mainly of California miners and capitalists, over to the eastern side of the Sierra.

While not occurring in California, the impacts were felt as much here as in Nevada. The supplies, equipment, manpower and transportation were all mainly from California. "The Sierra was devastated for a length of nearly 100 miles to provide the 600 million board feet of lumber that went into the Comstock Mines, and 2 million cords of firewood were consumed by mines and mills by 1880", reported mining attorney Grant H. Smith after witnessing the

scene 110 years ago (Brechin 1998). The Comstock discovery rekindled a desire by California miners to explore further. As a result many new finds of all types of commodities were made east of the Sierra Nevada down to the Colorado and Mojave deserts. Miners that were involved in exploration and development at Virginia City went on to locate productive silver mines in Southern California, particularly in Inyo and San Bernardino Counties.

In 1878 new legislation requiring government silver purchases made silver paramount to gold, and often, the metal of choice by miners throughout the West. In the remaining decades of the 19th Century, advances in mining technology made it possible for the mines to exploit deep lodes and still profit.

Many of the larger operations were forced to close and never reopened after the Panic of 1893 when silver prices collapsed. Yet, silver continued to be an important mineral mined in California up until the 1950s. It still is often recovered and processed as a byproduct of gold production in California.

Silver mining boomtowns in California's past include Calico, Randsburg, and Cerro Gordo. Often the results with these largely underground operations have been mountains laced with tunnels, much like the labyrinth of gold mining districts. As silver has tended to be found in drier areas, the tunnels tend to be intact and not flooded with water, thus, often accessible. To an inquisitive explorer today, a significant number of these mines offer extensive, dangerous subterranean passageways often lined with very unstable ceilings.

Copper

While California is not thought of as a big copper producing state, the total value of the mineral with respect to other metallic commodities mined here rank it second behind gold (Jenkins 1957). Often mined as a byproduct of zinc and tungsten mining in the state, copper has been extracted from mines in at least 12 California counties.

There exists a California copper-belt running northwest to southeast from the Oregon border along the Sierra foothill region almost to the bottom of the San Joaquin Valley. Records from the former Bureau of Mines show there to be nearly 1,400 copper mines or prospect locations mainly along this zone, although there were some exploited copper deposits in the Mojave Desert as well. Some of California's larger historic copper mines are now Superfund sites. Notably, mines like Iron Mountain, Penn, and Walker are all well known to the EPA as they present challenging and expensive clean-ups.

Some copper-laden areas, particularly in Shasta County were mined more for the concentrations of related sulfides, which were used for silver ore processing. These sulfides, when exposed to air and water, create sulfuric acid that then puts metals into solution. These heavy metals at high concentrations — typically silver, chromium, cobalt, copper, nickel, mercury and zinc — cause environmental damage to aquatic ecosystems, and impact water supplies.

Mercury

Around 90% of the mercury mined in the United States has been mined in California. The country's two largest mines have been the New Almaden in Santa Clara County, and the New Idria in San Benito County. Production has almost entirely come from the Coast Range, with the greatest concentration of mercury mines in Lake County. In general, mercury was mined in the Coast Range and imported for use in the Sierra Nevada gold fields.

Mercury readily binds to gold, a property that allows miners to easily extract gold from slurries. Since mercury was relatively inexpensive, and so plentiful in California, large amounts of it were used in this state for gold processing. By design or by mistake, much of it escaped into the environment. According to UC Davis research toxicologist Darell Slotton, "at least 7.6 million pounds of mercury were lost in the Sierra during the gold rush" (Knudson 1991). Since mercury continued to be used in nearly every gold extraction process up until the 1950s closures, it is conceivable that the amount lost is considerably higher (Buel 1998).

Mercury has been recognized for centuries as a highly toxic substance. Because of its capacity to bio-accumulate in various organisms, some species of sport fish are so impacted by mercury that they are considered to be above safe limits for consumption in some parts of the state, most notably, the Delta and San Francisco Bay.

So, the mercury problem is threefold. First, is the challenge for clean-up of various forms of mercury in the coastal mountains where it was extracted. Second, the location and clean up of the area where the elemental mercury was used, the gold mining belt along the western slope of the Sierra. Third, the challenge presented by the extensive deposition of mercury in hundreds of miles of rivers and streams, and the San Francisco Bay-Delta.

Tungsten

California has been the leading U.S. producer of tungsten since its discovery in 1905. Most of the precious metal has been mined on the eastside of the Sierra in Inyo County at high elevations. There are also numerous old mines and prospects throughout the California desert. Its principal uses are as a hardener in metal alloys (especially in tools), for welding, and for filaments in lights (DMG 1966). As is the situation with other potentially strategic minerals, production in this country has diminished in favor of less expensive foreign sources; in this case, China. But reserves do exist in California, should the need for them ever arise.

The remnant, abandoned tungsten mines in California tend to be large, very deep underground systems, most often occurring in drier climates, all of which contributes to the hazard to the public posed by indiscriminant entry.

Chromium

The mineral chromite contains another strategic element essential to the strength of steel, chromium, often a component of this state's abundant serpentine rock areas. Between 1869 and 1940, California supplied the bulk of the U.S. domestic supply.

It was during the world wars that the demand for this metal created an intense amount of mining, mainly in the Coast Ranges. There is also a prominent serpentine ledge throughout the Sierra foothills, with a number of historic mines there as well. The US Bureau of Mines reported over 1,200 chromium mines in California in the 1950s (MAS/MILS).

Like most of the metals mined in California, the method of mining was determined by the character of the ore which was worked and thus could have been open pit or underground. Chromium, another of the heavy metals becomes a concern only when changed into its hexavalent form. Hexavalent

chrome is a carcinogen and is found under certain environmental conditions in wetlands and water bodies.

Manganese

Manganese bearing rocks exist throughout the state. There are over 700 known deposits in 44 counties, although most of the mining has occurred along the coastal zones. This strategic mineral's fortunes too, have been dependent on government induced demand, most notably during the world wars. Manganese is one of a number of minerals that the U.S. Government deemed to be "strategic"; and thus it has been subsidized and stockpiled during certain periods. When this program ended in 1959, all California manganese mines closed (DMG 1966).

Manganese, too, is considered a "heavy metal", and as such can pose an environmental hazard if accumulations are present in water travelling through manganese mine sites.

Lead

Lead mining in California has been significant, although not dominating the market as has been the case with other mineral commodities. The MAS/MILS database indicates a total of 406 lead mines or prospects in California. Often lead mining occurs in concert with another mineral, mainly gold or silver. The Inyo Mountains on the East Side of the Owens River Valley has been the most productive area. The Cerro Gordo and Darwin Districts had particularly high production. One mine at Cerro Gordo has over 15 miles of underground workings.

Lead is considered highly toxic to all living organisms and is known to effect growth, learning, development, behavior, reproduction and metabolism (Eisler 1988).

Zinc

Another mineral historically associated with vast underground workings is zinc, for which California ranked fourth nationally in total tonnage extracted. Zinc appears in the desert regions, in the Sierra foothills, and in Shasta County.

As with many of the previously mentioned metals, production has followed U.S. Government related needs. The price for zinc for the most part, has not justified mining in California since World War II. There are nearly 100 abandoned zinc sites statewide.

Some of the zinc mine sites were found to have exceptional physical hazards, some pose chemical hazards, and a few present both. According to Environmental Protection Agency (EPA) spokesman Fraser Felter, until expensive mitigation measures were undertaken in the 1990s, the Iron Mountain Mine in Shasta County contributed 1,400 pounds of zinc daily into the Upper Sacramento River (Martin 1992).

Zinc plays a complex role in living organisms and is regarded as both an essential nutrient and a toxin. Aquatic systems are most susceptible when elevated zinc levels are associated with low pH, low alkalinity, low dissolved oxygen and eleveted temperatures. This report can not adequately address the peculiar role of zinc, so the reader may refer to (Eisler 1988) for more information.

Non-Metallic Mining

Coal

Many Californians are surprised to hear of the state's early and relatively brief coal mining history. While there are small, scattered deposits in 43 counties, only 12 counties have had mining. Only five areas saw any extended mining: Alberhill in Riverside County, Ione in Amador, Stone Canyon in Monterey, Corral Hollow in Alameda, and the Mount Diablo District in Contra Costa. The mines of Contra Costa yielded over 60% of the total tonnage (Jenkins 1957).

The coal mining period really only lasted a little more than two decades on a large scale, largely between 1887 and 1907. In the early 1900s, when the infrastructure became sufficient, California imported cheaper coal from the eastern US.

Issues associated with coal mining are well documented and include extensive underground workings; and low pH waste that can contaminate water and may also carry heavy metals.

It is ironic that coal mining revenues fund the abandoned mine mitigation programs in most western (and eastern) states and that California, which has no active coal mines, does not qualify for the Surface Mining Control and Reclamation Act (SMCRA) monies.

Boron

Boron deserves mention because California contains the world's largest known reserves, supplies the bulk of the boron produced, and in terms of total historic dollar value, boron passed gold as the greatest non-fuel commodity.

As most of the boron is simply extracted off ancient lakebeds, the past mining has not been very problematic. Management of boron particulate at the older, abandoned sites can sometimes be an air quality concern.

Asbestos

Serpentine, the principal host rocks for asbestos deposits in California, and the state's official rock, is abundant. This resilient fibrous material became a backbone of the construction industry in the 1960s, although it had been mined in California since 1887. There are over 170 mines that have produced asbestos, all but a fraction are currently inactive. A large mass northwest of Coalinga constitutes one of the largest asbestos deposits in the world.

Long term exposure to ambient airborne asbestos fibers has been linked to chronic respiratory illnesses and lung cancer. Unresolved are the hazards from ingested asbestos fibers. Although naturally occurring, and therefore released, the asbestos being transported in certain coastal streams poses another concern for state health officials (EPA 2000).

Atlas Mine, in San Benito County, with exposed asbestos wastes spread over a 200-acre area, was considered a major human health hazard prior to its delisting as a Federal Superfund site in 1998.

Uranium

California has been a uranium mining state, with nearly 300 sites, now mostly inactive in California. While the desert sites were plentiful, the deposits have

never been economically viable in the long term. Most of those sites were only active during the great boom in post-war California.

Uranium mining exposes radioactive wastes, allowing them to come into contact with air and water. Proper disposal of the wastes can be problematic. Monitoring and sometimes treatment is necessary (Ripley et al 1996).

The Abandoned Mine Lands Task Force

As the previous section discussed, California is rich in geologic diversity and mining history. To assist in the development of a consistent, statewide policy regarding the diversity of abandoned mine issues, DOC initiated the AML Task Force. The first meeting was held on July 9, 1997; meetings continue to be held approximately quarterly. Membership was originally limited to state government departments whose regulatory responsibilities have potential application to abandoned mine issues. Since the original meeting, membership has been expanded to include federal agencies with responsibilities, as well. Representatives from industry and environmental groups were also invited.

Members and frequent participants in the Abandoned Mine Lands Task Force include representatives from:

State Government
Department of Conservation
Department of Fish and Game
State Water Resources Control Board
Department of Toxic Substances Control
Department of Parks and Recreation
State Lands Commission
State Mining and Geology Board

Others
California Mining Association
Mining Companies
Consulting Companies
Interested Individuals

Federal Government
Forest Service
Bureau of Land Management
National Park Service
Environmental Protection Agency
Army Corps of Engineers
Geological Survey

Intergovernmental
CALFED Bay-Delta Program

The goals for the Task Force were stated by the group as:

- To advise DOC in the production of a single, state-wide inventory of abandoned mine sites for California that would be officially recognized by state government departments, local and federal agencies, the mining industry and environmental organizations;
- To agree upon a state-wide definition for abandoned mine;
- To support the Western Governors' Association/National Mining Association joint efforts relating to abandoned mine issues; and
- To position California to compete for federal dollars that might be forthcoming for abandoned mine reclamation.

Definition of Abandoned Mine

The Task Force agreed on the initial need to define the term "abandoned mine". The Surface Mining and Reclamation Act (SMARA) defines abandoned surface

mined area as mined lands that meet all of the following requirements (Section 2796 (b)(2)(A)(ii)):

I. Mining operations have ceased for a period of one year or more.

II. There are no approved financial assurances that are adequate to perform reclamation in accordance with this chapter.

III. The mined lands are adversely affected by past mineral mining, other than mining for coal, oil, and gas, and mineral material mining.

The Abandoned Mine Lands Task Force refined the definition (though it was never codified) on March 27, 1998, as follows:

> **Abandoned Mine**: The location of any mineral extraction, exploration or borrow operation that may include, but is not limited to, shafts and adits, buildings and workings, open pits, stockpiles, roads, processing areas, waste disposal areas, or tailing piles and ponds, and which meet all of the following conditions:
>
> (a) Mining operations have ceased for a period of one year or more;
>
> (b) There is no interim management plan in effect; and
>
> (c) There are no approved financial assurances that are adequate to perform reclamation.
>
> This definition is not intended to apply to operations developed to extract oil, natural gas or geothermal resources.

In practice, these two definitions do not differ significantly. For the purposes of this project, both definitions were applied to the choice of sites for sampling purposes. The issue of mined lands associated with oil extraction is discussed below.

Petroleum Mines

The issue of petroleum mines has seeped between the cracks of abandoned mine inventories. Petroleum mining has historically been accomplished by excavation and quarrying. Native Californians gathered tar from seeps for thousands of years for decoration, tool binding, and waterproofing for boats and baskets. The difference with the mining conducted by European immigrants was entirely one of scale (Hodgson 1987, Clark 1999, Magoon et. al. 2000). Large asphaltum quarry operations were active in the 1880s and continued to be developed for road-base materials throughout the state until the 1950s (Hallmark 1984). It is evident that the methods of excavation and quarrying used in historical petroleum mining are not significantly different from those used in non-petroleum mineral mining.

Non-petroleum mineral production has conventionally been considered the purview of the mining industry, while petroleum-mineral production has been considered the responsibility of the oil and gas industry. Government

agencies have similarly divided these responsibilities. For example, SMARA specifically excludes "mining for coal, oil, and gas" in its definition of abandoned mines. Correspondingly, the Abandoned Mine Lands Task Force definition "is not intended to apply to operations developed to extract oil, natural gas or geothermal resources". However, governmental agencies associated with the oil and gas industry have defined their responsibilities to only include *drilled* oil and gas wells. Abandoned petroleum mines were considered to be excavations and not wells, so their location and condition were never inventoried. The result is that abandoned petroleum mines have been excluded from any inventory — inclusive of this current volume.

Regulations, Authorities, And Responsibilities

By its very nature, the AML Task Force acknowledges that reclamation of abandoned mines falls under multiple agencies' jurisdiction. Federal and state statutes, governmental regulations, and common law provide the legal framework in California for abating hazards caused by abandoned mine lands (AML). However, most of the laws require that the cost be borne by the property owner or a local lead agency, which often do not have the financial resources. Tens of thousands of AML hazards continue to go unmitigated in California, and remediation of environmental hazards is not coordinated by watershed or across agencies. Programs within the regulatory agencies could be enhanced to address some of the current shortcomings of statewide remediation strategies. But in general, the existing authorities and funding mechanisms are inadequate to address this huge statewide issue. Table 4 lists many of the AML remedial actions in the state that have occurred under current laws.

Local Lead Agencies

Lead agencies have authority over abandoned mines within their jurisdiction through nuisance laws and during the review of new developments. Lead agencies are required to comply with the California Environmental Quality Act of 1970 (CEQA) when permitting projects within their jurisdiction. CEQA is a disclosure statute; therefore, the presence of an AML site at the site of a proposed project should be adequately disclosed during the process. The disclosed information should include the potential for the existence of physical or chemical hazards on the site. If hazardous substances that are known to the state to cause cancer or to be a reproductive toxicant are found during the initial study phase, a Proposition 65 notice should be filed. CEQA also has provisions that require consultation with the appropriate agencies. For AML sites, usually the appropriate agencies include the State Water Resources Control Board or the Regional Boards, the Department of Toxic Substances Control, and the County Public Health Department. If the proposed project would result in a significant effect or exposure of the public or environment to an AML hazard, then the effect should be mitigated as part of the proposed project (i.e., accomplished by the project proponent). The potential for the project to adversely affect natural or cultural resources would also need to be disclosed and mitigated.

State Agencies

State agencies that have jurisdiction, authority, or responsibility for AML sites include the State Water Resources Control Board (SWRCB), the Department of Toxic Substances Control (DTSC), the Department of Fish and Game (CDFG), and the Department of Conservation (DOC).

The SWRCB and the Regional Water Quality Control Boards are given authority over abandoned mines through the provisions of the Toxic Pits Cleanup Act, the Porter-Cologne Water Quality Act, and Section 13304 of the Water Code which deals with the discharge of hazardous materials into surface or groundwater. Section 13260 of the Water Code requires all persons discharging waste that could affect the quality of the waters of the state to file a report of the discharge to the appropriate regional board. The report shall include information on the physical and chemical characteristics of the discharge and its potential to cause pollution or contamination, including the acid-generating potential of the mining waste over the long term. Any person failing to furnish a report when requested by the regional board is guilty of a misdemeanor and may be liable civilly.

DTSC regulates hazardous wastes (as defined by Title 22, Section 66261.3) and the cleanup of hazardous substance releases (Health and Safety Code, Division 20, Chapter 6.5 and 6.8). Section 25369 of the Health and Safety Code required DTSC to establish an abandoned site program (inclusive of abandoned mines), with screening criteria and established priorities as to potential hazard to public health or the environment. DTSC has a voluntary clean-up program, or can take action under the Health and Safety Code.

DOC has expertise in geology, mineralogy, and mine reclamation. While this agency does not have regulatory authority of AML sites, it is the state's depository of AML information. CDFG is charged with protecting fish and wildlife, where such resources are affected by AML sites.

Federal Agencies

US Environmental Protection Agency (US EPA) regulates AML sites via the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and the Clean Water Act. Actions taken by federal landowners, US Forest Service and Bureau of Land Management, are taken as a property owner or under one of the federal laws listed previously.

Landowners

Ultimately, landowners (including public entities) have responsibility for hazards on their property. Under common law, landowners have a legal obligation (liability) to keep their land safe for people who enter the property. California Health and Safety Code Section 115700(a) provides that a landowner who permits the existence of an abandoned mine excavation and who fails to secure the excavation is guilty of a misdemeanor; however, this law is limited to excavations less than ½ acre in surface area and is rarely used. Section 115705 of the Health and Safety Code permits Boards of Supervisors to order the covering or fencing of abandoned mine excavations on unoccupied public lands; however, this also is rarely used. Section 115710 requires Boards of Supervisors to order the covering or fencing of abandoned excavations on

unoccupied land whenever it appears that the excavation is dangerous to man or beast; this section is also never used. Section 50231 of the California Government Code permits local legislative bodies to declare as public nuisances and abate all abandoned excavations located upon private property. The cost of the action is a special assessment against the parcel in question and can be recorded as a lien.

Table 2: Major State Laws Effecting Abandoned Mine Reclamation in California (Anon 1972, CMA 1999).

Law	Primary Requirements	Enforcement Summary
Surface Mining and Reclamation Act of 1975 (PRC D2 C9 Sec. 2710 et seq.)	Requires new and existing mines to have an approved reclamation plan and financial assurances sufficient to cover the estimated cost of reclamation. (Intended to prevent abandonment of mines, and to reclaim mined-lands to a beneficial end-use.)	Mines without an approved reclamation plan or financial assurances are prohibited from operating. Financial assurances may be used by lead agencies to reclaim mines should operators fail to.
Porter-Cologne Water Quality Control Act, Water Code 13000 et seq.	Discharges of "waste" that could affect waters of the state subject to Waste Discharge Requirements (WDRs), or waiver, by Regional Board	Administrative and civil penalties and/or injunction.
	Discharges of "pollutants" from point sources to surface waters require NPDES permit issued by Regional Board in Form of WDRs under USEPA delegation.	Administrative and civil penalties and/or injunction, as well as criminal penalties. Can apply to discharges from clean up (e.g., Penn Mine).
	Storm water discharge permits for storm water contaminated by contact with overburden, raw materials, intermediate products, finished products, and by products, issued by State Board under USEPA delegation.	
	Discharges of "waste" that create or threaten to create a condition of pollution or nuisance subject to Regional Board cleanup or abatement order.	Administrative and civil penalties for violation. Injunction to comply. Regional Board may itself expend funds to remediate, which constitute a lien on the property.
Fish and Game Code Section 5650	Illegal to permit to pass to waters of the state any substance deleterious to fish, plant or bird life, unless authorized by Regional Board WDRs or a federal permit for which CWA Section 401 state certification issued.	Civil penalties, damages for injury to wildlife and habitat, clean-up costs, and/or injunction. Also misdemeanor fines and incarceration.
California Endangered Species Act, Code Section 2050 et seq.	Illegal to take state-listed endangered, threatened, or candidate species, except as authorized by CDFG.	Misdemeanor prosecution: Fines and incarceration.

Law	Primary Requirements	Enforcement Summary
Fish and Game Code Sections 3511, 4700, 5050, 5515, among others.	Take of any fully-protected species prohibited under all circumstances. Species include, but not limited to: American peregrine falcon, bighorn sheep, wolverine, blunt-nosed leopard lizard, limestone salamander, unarmored threespine stickleback, among many others.	Misdemeanor prosecution; fines and incarceration.
Proposition 65	Prohibits certain persons, in course of doing business, from knowingly discharging a chemical known to the state to cause cancer or reproductive toxicity into a source of drinking water, or unto land where it passes or probably will pass into water.	Civil penalties. Third party law suits. May apply to "Good Samaritan" doing cleanup.
Toxic Pits Cleanup Act of 1984, Health & Safety Code 25208 et seq.	Addresses the regulation of "surface impoundments" containing hazardous liquids or hazardous wastes containing free liquids. Grants specific authorities to the State Water Resources Control Board and Regional Boards in order to protect the waters of the state from contamination. (see RCRA, 42 U.S.C. Sec. 6901 et seq.)	SWRCB shall impose fees upon persons discharging into a "surface impoundment", shall assess penalties for non-compliance up to 100 percent of the original fee, shall issue cease and desist orders and remedial action for surface impoundments that do, or threaten to, contaminate the waters of the state.
Hazardous Substances Account Act (California Superfund), Health & Safety Code 25301 et seq.	Requires "potentially responsible parties" (PRPs) to remove and/or remediate actual and threatened releases of hazardous substances to the environment.	DTSC order to remove and/or remediate. Civil penalties for violation of DTSC orders. Triple damages if fail to comply with order based on finding of imminent and substantial endangerment to public health or welfare, and DTSC expends state funds. Cost recovery for DTSC expenditures of funds. Also injunctions.
California Health and Safety Code Section 115700(a)	Provides that a landowner must secure an abandoned mine excavation; however, this law is limited to excavations less than 1/2 acre in surface area and is rarely used.	Landowner guilty of a misdemeanor if fails to secure the excavation; rarely used.
California Health and Safety Code Section 115705	Permits Boards of Supervisors to order the covering or fencing of abandoned mine excavations on unoccupied public lands. Rarely used	None.

Law	Primary Requirements	Enforcement Summary
California Health and Safety Code Section 115710	Requires Boards of Supervisors to order the covering or fencing of abandoned excavations on unoccupied land whenever it appears that the excavation is dangerous to man or beast. Rarely used.	None.
California Government Code Section 50231	Permits local legislative bodies to declare as public nuisances and abate all abandoned excavations located upon private property.	The cost of the action is a special assessment against the parcel in question and can be recorded as a lien.

In addition, to the state laws listed above, two other state laws deserve mention. The California Coastal Act of 1976 (PRC 30000 et seq.) provides policy and directions for state and local review of developments within the state's Coastal Zone, including federal lands. CEQA (PRC 20000 et seq. and its guidelines CCR 15000 et seq.) provides a process for the disclosure and review of environmental impacts. In the review of projects under either or both of these laws, mitigation (remediation) of an abandoned mine may be accomplished. Much the same could be said for both the National Environmental Policy Act (NEPA) and the Federal Land Policy and Management Act (FLPMA), which were not included in the following table.

Table 3: Major Federal Laws Effecting Abandoned Mine Reclamation in California (Anon 1972, CMA 1999)

Law	Primary Requirements	Enforcement Summary
Clean Water Act (CWA), 33 U.S.C. 1251 et seq.	NPDES permits for discharges of pollutants from point sources to surface waters and storm water discharge permits. (See Porter-Cologne above).	Administrative and civil penalties and/or injunction, as well as criminal penalties. Third party suits.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, and (Superfund) 42 U.S.C. 9601 et seq.	EPA may perform removal and/or remedial actions for releases of hazardous substances itself and seek reimbursement for potentially responsible parties (PRPs), or compel PRPs to clean up through administrative or judicial proceedings. Liability is strict, can be joint and several, and held to be retroactive.	EPA abatement and/or cost recovery actions. Administrative Orders. Civil penalties for violation, with potential triple damages. Third party suits. Damages for injuries to natural resources, by trustee agencies including CDFG and federal agencies.
Endangered Species Action, 16 U.S.C. 1531 et seq.	Illegal to take species listed as endangered or threatened by US Fish and Wildlife Service, except as authorized, including degradation of habitat that actually harms individuals of species.	Substantial civil penalties. Injunction. Third party suits. Criminal penalties.

Law	Primary Requirements	Enforcement Summary
Resource Conserv-ation and Recovery Act (RCRA) of 1976. 7 USC 1010 et seq, 40 CFR 280 and 281	Provides regulatory authority to USEPA for environmental remediation of sites containing, or suspected of containing, hazardous waste. May effect AML properties associated with active sites.	Includes orders to correct any violation; civil and criminal penalties; fines, and/or imprisonment.
Clean Air Act of 1970, Amended 1990 42 USC 7401-7671q et seq.	USEPA sets limits on airborne pollutants. Allows individual states to have stronger pollution controls. States develop State Implementation Plans (SIPs), used to target generators and clean up polluted areas.	Fee assessments; court injunctions and or civil penalty of not more than $25,000 per day for each violation. Criminal penalties include fines up to $1 million and imprisonment up to fifteen years.
Air Quality Act of 1967 42 USC 7401	EPA sets limits on airborne pollutants. Allows individual states to have stronger pollution controls. States develop State Implementation Plans (SIPs), used to clean up polluted areas. Predecessor to Clean Air Act.	Administrative penalties to states for lack of enforcement; orders issued requiring compliance; civil and criminal penalties; fines, and/or imprisonment. Enforced under Clean Air Act of 1990.
National Historic Preservation Act of 1966 16 U.S.C. 470 et seq.	Provides process for registration of properties significant in national, state, and local history on National Register of Historic Places. Ensures planning considerations and recognizes state historic preservation initiatives and laws.	Environmental review may be required under CEQA if property is threatened by a project.

Table 4 lists the approximate dollars spent addressing abandoned mine sites under various state and federal laws. This list was compiled by OMR staff with figures reported by various agencies and does not represent all of the sites in the state for which funds have been spent. For example, three sites that were remediated by active mining operations and for which we were unable to obtain information, are not included. In addition, the reported costs often do not include monies spent on administration, site investigations, characterization, or post-remediation monitoring.

Table 4: Estimated dollars spent as of January, 2000 to address abandoned mine sites under existing State and Federal Laws.

Law	Mine Site	Approx. Cost ($ millions)	Remediating Entity[12]
CERCLA	Iron Mountain, Shasta County	150+	EPA,PRP
CWA	Penn, Calaveras County	10	EBMUD, CVRWQCB
CERCLA	Sulphur Bank, Lake County	10	EPA,DTSC
CERCLA	Celtor Chemical (Copper Bluff), Humboldt County	9	EPA
CERCLA (Emergency Response); Porter-Cologne	Leviathan, Alpine County	7	LRWQCB, PRP
CERCLA	Coalinga Asbestos, Fresno County	5.5	EPA,DTSC, PRP
CERCLA (Emergency Response)	Mesa Del Oro (Central Eureka), Amador County	5	EPA, DTSC
CERCLA	Atlas Asbestos, Fresno County	5	EPA,DTSC,BLM, PRP
CWA	Mammoth Mine Complex (Balaklala, Shasta King, Early Bird, Keystone, Mammoth, and Stowell), Shasta County	4.8	PRP
CWA (Emergency Response); Porter Cologne	Gambonini, Marin County	3	EPA, SFRWQCB
CERCLA	Walker Mine an Tailings, Plumas County	3	USFS,PRP, SWRCB
CERCLA,CWA (Emergency Response)	Lava Cap, Nevada County	2	EPA,DTSC
CERCLA, (Emergency Response)	Grey Eagle Tailings, Siskiyou County	1.9	EPA
Toxic Pit Act	Spenceville, Nevada County	0.7	CDFG
In consideration of CWA	Primera, San Luis Obispo County	0.45	CNG
CERCLA, CWA, General Liability	Gilbralter, Santa Barbara	0.4	USFS
California Superfund	Argonaut, Amador County	0.3	DTSC
CWA	Buena Vista & Klau, San Luis Obispo County	0.3	PRP
CERCLA	El Portal Barite, Mariposa County	0.25	USFS,NPS

[12] CDFG: California Department of Fish and Game; CNG: California National Guard; CVRWQCB: Central Valley Regional Water Quality Control Board; DTSC: Department of Toxic Substances Control; EBMUD: East Bay Municipal Utilities District; EPA: U.S. Environmental Protection Agency; LRWQCB: Lahontan Regional Water Quality Control Board; NPS: U.S. National Park Service; PRP: Potentially Responsible Party; SFRWQCB: San Francisco Regional Water Quality Control Board; USFS: U.S. Forest Service

Reclamation Under Federal Jurisdiction

Because of a lack of specific AML funding, the US Forest Service, National Park Service, and Bureau of Land Management have been very creative in redirecting funds to close hazardous openings, mitigate hazards, and remediate abandoned mine sites in California. Unfortunately, there has not always been a standardized mechanism for either funding or reporting these reclamation efforts. This is beginning to change as more funds are becoming available for the conduct of AML inventories. Federal agencies have begun to develop the means to record and track the progress on closures, mitigations, and remediation efforts.

A survey of the reclamation efforts by different federal agencies with jurisdictions in California was conducted by AMLU staff for this report. In some cases, key staff could not be contacted, or the information was not available. As such, information about the reclamation activities of individual forest districts, parks, and field offices may not be current or complete. Some records reviewed indicated efforts only for a select few years, while others indicated every effort completed to date. In addition, many activities are in progress. Because some information was not available or up-to-date, this report may not provide an absolutely accurate accounting of the number and type of reclamation activities on federal lands. However, in keeping with the theme of this report, an indication of the magnitude and scope of federal reclamation efforts in California can be presented.

Federal staff have made extraordinary efforts to secure abandoned mine sites on lands within their jurisdictions in California. However, based on the estimate that half of all hazardous openings in the state are on federal lands; less than 2 percent of these AML hazards have been mitigated to any degree, and less than 1 percent have been closed or remediated.

Table 5: Reclamation by Federal Agencies.

Agency	C	M	R	S	Agency ($)	EPA ($)	Total ($)
BLM							
Bishop	0						
Barstow		3					
Caliente		7					
All/Others		109					
BLM Sub Total	*0*	*119*					
US Forest Service							
Angeles							
Cleveland	6	6	5		28,000		28,000
El Dorado	10	5	5	1	25,000		25,000
Inyo	1	2		5	25,000	80,000	105,000
Klamath	8	3	1	3	40,000	4,000,000	4,040,000
Lassen*							
Los Padres	0						
Mendocino	0						
Modoc*							
Plumas	0						
San Bernardino		2	1				
Sequoia*							

Agency	C	M	R	S	Agency ($)	EPA ($)	Total ($)
Shasta-Trinity	0			2			
Sierra*							
Six Rivers		7			49,000		49,000
Stanislaus	5						
Tahoe		38					
All/Others					2,033,000		2,033,000
USFS Sub Total	*30*	*63*	*12*	*11*	*2,200,000*	*4,080,000*	*6,280,000*
National Park Service							
Death Valley	4	346			500,000		500,000
Golden Gate							
Joshua Tree	5	29			200,000		200,000
Lava Beds							
Lassen Volcano							
Mojave				1	350,000		350,000
Pinnacles		2					
Point Reyes							
Redwood			13		57,000		57,000
Sequoia/Kings Canyon							
Whiskeytown	11				30,000		30,000
Yosemite							
NPS Sub Total	*20*	*377*	*13*		*1,137,000*		*1,137,000*
Totals	***50***	***559***	***25***	***11***	***3,337,000***	***4,080,000***	***7,417,000***

Key: C – Closures; M – Mitigations; R – Remediations; S – CERCLA Sites;
* – No Response for Information

CLEAN WATER, THE ENVIRONMENT AND PUBLIC AT RISK

Abandoned mine lands present two general types of hazards, physical and chemical. Physical hazards include the workings themselves, derelict structures and other equipment. Much of the time, these hazards are easy for an observant person to recognize. An open shaft descending hundreds of feet often, though not always, presents a recognizable danger. However, many people are less aware of the potential hazards of highwalls or adits (mine tunnels). Collapse of underground abandoned mine workings can happen at any time. If the workings are near enough to the ground surface, a subsidence may result. The potential for this type of physical hazard can be more difficult to predict. Several instances of subsidence have occurred in recent years, turning once valuable property into a liability (see page 37 for examples). As California's growing population moves into former mine lands the risk for injury increases (see A.6 for a map depicting population growth rates and areas of high historical mining activity).

The other type of hazard presented by abandoned mine lands may be labeled chemical or environmental. These hazards can further be subdivided into acute and chronic. Acute environmental hazards are presented by old explosives, drums of chemicals or direct exposure to highly toxic tailings, for instance. Poisonous gases or low oxygen environments can develop in underground workings; the adventurous spelunker may be caught unaware and asphyxiate. More often, abandoned mines may present chronic exposure hazards that may effect the environment miles away. Often the pathway to exposure is through our waters. Mines in areas of high-sulphide rock may create acid-generating conditions. Low-pH (acidic) waters may carry high levels of heavy metals which present a health hazard both to humans and wildlife. The other chronic exposure pathway is our air. Asbestos is of high concern, and is the subject of on-going studies. Dusts or sediment may contain naturally-occurring contaminants such as arsenic or chromium, which have become exposed because of mining activities.

The Abandoned Mine Lands Unit, in partnership with other agencies, is in the process of gathering environmental information as it pertains to abandoned mine lands to better quantify the magnitude and scope of the problem and to better inform our decision makers. The following presents AMLU's findings based on current information and selected examples of physical and chemical hazards.

Findings[13]

The current estimate by California's Abandoned Mine Lands Unit, is that there are approximately 39,000 historic and inactive mine sites in the state (95% confidence limits are from 29,300-69,800).

Of these, 4,290 or 11% may present environmental hazards. The most common environmental hazards are: heavy metals associated with acid-rock

[13] The numbers listed in this section are based on statistical modeling and GIS analyses that are more fully explained in Volume II of this document. These numbers are subject to change as the models improve.

drainage (ARD); methyl mercury from mercury-contaminated sediments; other forms of mercury from mercury mines; arsenic; asbestos; and chromium. Appendix B.1 lists the 130 mine sites that fall into the "4,290 group" for which we have data. Map A.7 provides a projection of the watersheds that likely contain the majority of abandoned mines in this "4,290 group". These data were collected by AMLU, or provided by the State Water Resources Control Board, the Department of Toxic Substances Control, or the US Forest Service. Sites are grouped by rank, with a rank of 5 having the highest potential for an environmental hazard.

Also, an estimated 32,760 mines, or 84%, may present physical safety hazards. The most common physical hazards are: highwalls; open shafts; open adits; and collapsing structures. Appendix B.2 lists the top 159 of the sites that present physical hazards for which we currently have data. These data were collected by AMLU or US Forest Service; such information has not been compiled by other agencies. Sites are grouped by rank, with a rank of 5 having the highest level of physical safety hazards.

Our research confirmed that a field visit is necessary for assessment of physical hazards; however, with results from statistical modeling and geo-environmental models, the potential for chemical hazards can be predicted with some accuracy. A site visit is still necessary to confirm the hazard, but the modeling can aid in prioritizing field resources on the areas that may contain the highest level of hazard.

The total number of mining features (shafts, adits, waste piles, tailings, etc.) in the state is estimated to be 128,800 (95% confidence limits area 102,700-160,600). This estimate is based on counting mine features shown on 7.5-minute (1:24,000 scale) topographic maps and field estimates of the numbers of features on sites that are not shown on the maps (Map A.5). Approximately 48,944, or 38%, of these features are either hazardous shafts or adits. The location for approximately one-third of the shafts and adits in the state are depicted on topographical maps; however, a field visit is necessary to determine whether or not the feature is hazardous.

It is estimated that 50% of the abandoned mines are on private lands, 1.5% are on state lands, and 48% are on federal lands, largely Bureau of Land Management and US Forest Service maps (Map A.3). There may be a significant level of inaccuracy in the estimate of the number of mines on federal lands. These percentages were determined through GIS analysis where the GIS ownership layer has a minimum mapping unit of 10 acres. That is, small in-holdings or patented lands less than 10 acres would show as being in federal ownership, rather than private.

The cost for mitigating physical hazards, inclusive of adits and shafts, and of remediating the sites that present chemical (environmental) hazards at a level of Category 3 (moderate potential for a chemical risk) or above is on the order of $4.1 billion (excluding Iron Mountain, which has already cost approximately $150 million and is not fully remediated; see Table 6). Nationally, it has been estimated by the Mineral Policy Center that the cost of clean-up will range from $32.7 billion to $71.5 billion (Lyon 1993). The US Bureau of Mines estimated that the cost of clean-up for "non-coal, non construction, non-Superfund" sites for the surveyed 13 states (not including California) "is on the order of $3 billion" (USBOM and CCEM 1994).

Table 6: Estimated Costs To Mitigate or Remediate the Physical and Chemical Hazards of Abandoned Mine Lands in California (excluding Iron Mountain) (calculated per Dolzani et. al. 1994, Smit 1995, USEPA 1997).

Type	Number[14]	Cost in Millions ($)
Physical		
Hazardous Openings	48,944	394
Hazards, other	32,760	134
Chemical		
Category 5	390	1,400
Category 4	1,170	1,110
Category 3	2,730	1,040
		4,098

At Risk Areas For Chemical (Environmental) Hazards

AMLU has developed a suite of geo-environmental models that aid in identifying areas of the state that, by virtue of their mineralogy and climatic conditions, have a higher *potential* for mining-induced environmental degradation from abandoned mines. Currently, the models focus on those geologic settings that are conducive to environmental degradation from arsenic (As), mercury (Hg), acid-rock drainage (ARD), and processing mercury released from historic hydraulic mining. Areas of potential environmental degradation have been modeled using:

commodity
ore-deposit type
ore mineralogy
host rock mineralogy
geologic structure
historic operational data
local climate & meteorology

Geologic and mineralogy data were derived from spatial analysis of the California Geologic Map (Jennings 1977), Mineral Resource Data System (Frank 1999), Minerals Availability System-Mineral Industry Location System (Causey 1998), original data developed by AMLU, and standard mineralogical and geochemical texts. Data on climatic and meteorological conditions are available from the State Meteorologist and the National Oceanograhic and Atmosphereic Administration.

In California, metals (such as arsenic, nickel, aluminum, copper, zinc, etc.) usually accompany ARD. It is these metals that can be toxic in sufficient concentrations and, hence, are of greater concern than the acidity itself (see Maps A.8, A.9, A.10). Geo-environmental models developed by AMLU are attached, and are the basis for, determining watersheds at the greatest risk from ARD and heavy metals. In addition, AMLU identified watersheds that may contain mercury left over from mercury mining (Map A.11) and released into the environment as part of historic hydraulic and placer mining (A.12). These models can be used to set watershed priorities for focused inventories, followed by watershed remediation, as displayed in Table 7. Future analyses could look at projected impacts to receiving waters (such as the Bay-Delta) from these priority watersheds.

[14] The estimates for the numbers and types of physical and chemical hazards are based on statistical modeling done by AMLU.

Table 7: Watersheds with the highest potential for impacts by ARD, arsenic (As) or mercury from mercury mines (Hg) or from Placer and Hydraulic mines (Placer). The frequency of mines is given under the columns for the potential contaminant. Only the top two categories for each contaminant are shown. Data for ARD, As, and Placer derived from MRDS; data for Hg derived from DMG Mercury File.

Watershed	Bioregion	ARD	Hg	As	Placer	Totals
Middle Klamath River	Northwestern California	26	1	1	137	**164**
North Yuba	Sierra Nevada	23	0	9	108	**140**
Middle Trinity River	Northwestern California	7	0	3	121	**131**
Upper Trinity River	Northwestern California	21	1	5	92	**119**
Salmon River	Northwestern California	16	0	0	92	**108**
Scott River	Northwestern California	39	0	2	62	**103**
Middle Yuba	Sierra Nevada	35	0	22	41	**98**
East Branch N. Fork Feather	Sierra Nevada	10	0	2	70	**82**
South Yuba	Sierra Nevada	48	0	2	29	**79**
Lower Trinity River	Northwestern California	10	2	2	63	**75**
Upper Bear	Sierra Nevada	32	0	3	22	**57**
Copperopolis	Sierra Nevada	37	3	5	15	**57**
Buckhorn Peak	Sierra Nevada	43	0	2	6	**51**
North Fork Merced	Sierra Nevada	38	0	1	8	**47**
Mariposa	Sierra Nevada	32	0	3	10	**45**
South Fork Calaveras	Sierra Nevada	36	0	1	5	**42**
Clear Creek	Northwestern California	15	0	4	14	**33**
Bear Creek	Northwestern California	0	42	0	0	**42**
Middle Russian River	Central Western California	0	13	0	0	**13**
Upper Putah Creek	Northwestern California	2	21	0	1	**24**
Ciervo Hills	Central Western California	0	17	0	0	**17**
Guadalupe River	Central Western California	0	14	0	0	**14**
TOTALS		**470**	**115**	**67**	**896**	***1548***

Examples Of Recently Reported Abandoned Mine Hazards

Abandoned mines can present a wide range of hazards. The following section illustrates the scope and character of the hazards by summarizing recently reported stories from the popular media.

Physical Hazards

Fresno County (5/90): Rescuers recovered the body of an Orosi man who was killed after falling 160 feet down an abandoned mine shaft located in the foothills 15 miles northeast of Orosi in Fresno County. (Modesto Bee)

San Bernardino County (6/97): Two men were rescued after one fell 20 feet and another fell 100 feet down an abandoned mine shaft they were exploring and climbing near Parker Dam. One of the men sustained serious injuries in the fall, and had to be air-lifted to Loma Linda Medical Center near San

Bernandino. The two men later sued the BLM for damages, and won an out-of-court settlement for $750,000. (Today's News-Herald) (The BLM reports that they sealed the entrance after the accident; within weeks, vandals had the entrance reopened—personal communication with AMLU staff.)

Butte County (3/98): A four-foot wide by thirty-foot deep shaft suddenly caved-in under the carport of a home in a downtown, residential area of Oroville. This shaft is a remnant of potentially extensive undocumented underground workings in gravels that have caused several publicized cases of subsidence in Oroville over the past few years. (KCRA 3 TV Sacramento-Stockton)

Calaveras County (4/98): An off-road ATV rider left his vehicle and a companion to go exploring at night in a remote area and fell 75 feet down an air shaft into an abandoned gold mine. The victim laid injured with a broken back at the bottom of the shaft for more than 12 hours, and was rescued only after the last shot fired from his handgun alerted rescuers to his location. (Modesto Bee)

Nevada County (5/98): A 30-foot wide by 30-foot deep pit caved-in without warning under a recently constructed custom home in a residential development where the abandoned main shaft of the Old Brunswick Mine is located. The home, located near Grass Valley, is a total loss. And the home's septic tank has fallen deeper into the old underground workings where it may impact groundwater quality. (Sacramento Bee)

Riverside County (4/98): An injured 51-year old man was rescued from an abandoned mine after he fell down a 200 foot shaft while on an amateur

spelunking adventure with his son in a remote part of the high-desert. (LA Times)

Chemical (Environmental) Hazards

San Luis Obispo County (1/00): Contaminated soil from an abandoned mercury mine near Cambria led state agencies to embargo all crops from a nearby organic farm which cultivated lettuce and spinach on toxic-laden tailings. Worried consumers flooded County Health Agency with calls. (San Luis Obispo Telegram-Tribune)

Marin County (1/00): After years of contaminating Tomales Bay, toxic runoff from an abandoned mercury mine (Gambonini Mine) on Walker Creek was reduced to background levels following a $3 million dollar EPA cleanup. Scientists studying waterfowl in the bay report finding twice the mercury levels of those from neighboring bays, and shellfish contaminated above state alert levels. (San Fransisco Examiner)

(Photo courtesy of Dyan Whyte, SFRWQCB)

Nevada County (12/99): Arsenic-laden tailings piled four-to-seven feet deep line the Little Clipper Creek following the failure of the log containment–dam in 1997 at the abandoned Lava Cap Mine. Now a Superfund clean-up site, federal officials warned local residents of the risk of exposure to the tailings and recommended "catch and release" of fish caught at nearby Lost Lake because of arsenic levels above the federal drinking water standards. (Nevada Union)

When this log tailings dam at the Lava Cap Mine failed in 1997, it released arsenic laden tailings into Clipper Creek.

Here, a child plays in the arsenic-laden tailings released when the tailings dam above failed.

(Photo courtesy of Dan Ziarkowski, DTSC).

Amador County (4/98): The 64 residents of the Mesa Del Oro residential subdivision reached a $2 million settlement with the owner and developer of the housing project built atop arsenic-laden tailings on the former site of the Central Eureka Mine. (Sacramento Bee)

Shasta County (9/99): Since it was made a federal Superfund site in 1983, interim remedial measures at the Iron Mountain Mine have cost over $150 million. Despite reducing 95% of the acidic, heavy-metal laden drainage, seeps continue to pollute the Sacramento River, contaminating fish and shellfish as far away as San Francisco Bay. (Redding Record-Searchlight)

Alpine County (3/00): Thousands to millions of gallons of acidic, toxic runoff from the abandoned Leviathan Mine threatens to overflow from the retention ponds and pollute creeks feeding the Carson River. The creeks are already so polluted, they cannot support aquatic life. The site is on the USEPA National Priorities List (Superfund, 5/11/2000). (Tahoe Tribune)

Fresno County (2/00): Sampling by USEPA conducted at the abandoned Atlas Asbestos Mine near Coalinga, revealed that both surface water and air contained elevated levels of asbestos. The EPA designated the Atlas Mine a superfund clean-up site because airborne emissions of asbestos posed a serious threat to neighboring residents. (www.epa.gov/superfund)

Lake County (01/00): The abandoned Sulphur Bank Mercury Mine, on the shore of Clear Lake, was one of the largest producers of mercury in California. The site consists mainly of tailings and a flooded 150-foot deep mine pit (Herman Impoundment), and in addition, has more than 1000 feet of tailings extending into the lake along the shoreline. Sampling indicates that mercury is present in the tailings and has impacted the lake, which is a major recreational area. There is a state advisory against consumption of the fish from the lake due to high levels of mercury. Sulphur Bank is also on the USEPA NPL list. (UC Davis Magazine).

(Photo courtesy of the Lake County Public Library Archives)

Preservation and Conservation of Abandoned Mine Lands

Another perspective on abandoned mines needs to be addressed, their conservation. Abandoned mines are part of California's rich heritage, as such, their natural or cultural value needs to be considered prior to management decisions. Many of the mines that present physical and environmental hazards also provide unique interpretive opportunities and wildlife habitat. Historic mine lands attract visitors, and their preservation makes economic sense for communities by creating jobs and stimulating the local economy.

Historical and Cultural Resources

Many abandoned mines have significant historical value and should be protected from destruction, vandalism, and theft. Not all abandoned mines qualify as historic, nor do they warrant preservation just because they have been abandoned for many years. The National Historic Preservation Act established the National Register of Historic Places (NRHP) as a federal listing of cultural resources worthy of preservation. The NHRP is maintained by the National Park Service, and to be eligible for listing, abandoned mine lands must be demonstrated to have significance to American history, architecture, engineering, or culture. The NHRP nomination process uses additional criteria

to determine the historic significance of sites, buildings, structures, and objects. Besides meeting one or more of the NHRP criteria, a mine site generally must also be at least 50 years old (with possible exceptions), and have integrity of location, design, setting, materials, workmanship, feeling, and association in order to be eligible for inclusion. If a site has been compromised by significant alterations, it may not be eligible.

The California Register of Historical Resources Program recognizes and protects resources of architectural, historical, archeological and cultural significance, identifies historical resources for state and local planning purposes, and determines eligibility for grants. The California Historical Landmark registry includes sites, buildings, features, or events that are of statewide significance; and which have anthropological, cultural, military, political, architectural, economic, scientific or technical, religious, experimental, or other values. The California Point of Historical Interest Program is a registration that recognizes resources that are only of local or countywide importance. All three of the California programs offer limited protection under CEQA.

Wildlife Habitat

Abandoned mines provide critical habitat for a wide range of plant and animal life, including some rare, threatened, or endangered species. Several species of endangered plants have been found on disturbed mining areas. Large mammals such as bears and mountain lions may use old adits as dens, and for winter hibernation. Other species such as the desert tortoise, rodents, owls, snakes, and salamanders also rely on mines for shelter. Bat species play a critical role in insect-control and pollination. Many bat species are threatened and endangered because uninformed development is destroying their habitat. Fourteen species of bats are known to use mines for roosts, winter hibernation, and nurseries in California. Ten of these are species of concern. Closure of mine openings without first conducting a biological survey could wipe out an entire colony of bats, and destroy the only habitat available for hundreds of miles. The preservation of abandoned mines as wildlife habitat may be crucial to the survival of certain species, so it is imperative that some effort be made to protect these unique and irreplaceable habitats, while protecting the public. Bat Conservation International provides a wealth of information on bat-friendly mine closures.

EXAMPLES FROM OTHER STATE AND FEDERAL AML PROGRAMS

The following examples of other state and federal AML programs have four recurring themes:

- Cooperative arrangements between state and federal agencies leverage limited funds available at both levels of government.
- AML inventory and watershed assessments are done simultaneous with remediation projects.
- Most states have an education component built around the national "Stay-Out, Stay-Alive" slogan.
- The federal program for coal-producing states and the state programs of non-coal producing states such as Nevada and South Dakota, redistribute all or a portion of the costs of environmental clean-up to the active mining industry.

SMCRA States

The Federal *Surface Mining Control and Reclamation Act of 1977* (SMCRA) is the primary funding source for most western (and for that matter, national) abandoned mine reclamation programs. Income to the fund comes from a royalty/reclamation fee imposed on active coal mining operations. This federal law assesses a fee of 35 cents per ton for surface-mined coal and 15 cents per ton for coal mined underground. The fund distributes money back to the 24 states and 3 tribes proportionate to the amount generated in each entity. Those monies are used for administration of state abandoned mine land programs (including a mandatory "Stay-Out, Stay-Alive" program). Remediation dollars are distributed back to the states and tribes on a project basis. The first task of these programs is to inventory and remediate abandoned coal mines; the second task is to inventory and remediate non-coal mines. Through fiscal year 1998, the SMCRA AML fund has received $5.1 billion in taxes on coal production. Of that, Congress has allocated $3.7 billion to the states and tribes for AML remediation.

As an example of a SMCRA program, the State of Colorado began their AML program and inventory efforts in 1980. Through their inventory efforts, they estimate that there are 23,000 abandoned mines in the state; approximately 4,000 of those sites have been remediated (at a cost of $26.8 million) by their SMCRA program.

Non-SMCRA States

In the western US, Arizona (except on tribal lands), California, Idaho, Nevada, and South Dakota all have abandoned mine hazards and lack a stable source of federal funding to address the issue. Each of these same states generate more than 10 million tons of mine waste per year from hardrock mines (excludes sand, gravel, and limestone mines), but have no active coal operations to provide funding back to the state under SMCRA. Of these states, Arizona,

Nevada, Idaho, and California all have extensive abandoned mine sites. Arizona and Nevada took the lead and were the first of these states to institute an active state AML program. Table 6 provides a comparison of expenditures by states' AML programs for remediation of hazards.

Nevada

Funding for the abandoned mine safety program stems from an industry fee, imposed by legislation which was supported by the mining industry. Active mining claims and new mines on public lands are assessed a relatively small amount to cover costs for program administration, hazard mitigation and public education. Nevada, a state with limited rainfall, has found most of its AML problems are associated with hazardous openings; only 0.05% of the total number of inactive and abandoned mine sites are estimated to be of concern regarding ARD. (Acid rock drainage requires the presence of sulfides, air, and water.) To date, Nevada has secured over 70% of the estimated 7,520 abandoned mine sites that it had deemed hazardous. The state program aids claimants and property owners in securing hazardous openings and provides "Stay-Out, Stay-Alive" warning signs upon request. (Paper signs are free; metal ones cost $4.)

Arizona

After a tragic incident in Arizona ten years ago, the Arizona Legislature appropriated money for an abandoned mine inventory. The bill that appropriated the funds also addressed vandalism of fences and signs around hazardous openings, by raising the crime from a misdemeanor to a felony. This fund also allows private contributions not only for fencing but also for permanent filling or bat gating. By 1999, Arizona had identified 1,149 mines posing significant public hazards on state lands alone. Arizona, like Nevada, has limited rainfall, and has found that only 3.3% of their sites pose environmental problems, while 13.1% pose significant physical hazards. Due to a population growth rate that nearly approaches California's, Arizona has promulgated an abandoned mine fencing program. Arizona has also received significant funding from the Bureau of Land Management and National Park Service for inventory of federal lands within the state. Such cooperative arrangements between state and federal agencies are also a recurring theme for a funding mechanism throughout the non-coal states.

Table 8: Expenditures By a Sampling of States' AML Programs On Non-Coal Mines In One Year (WGA 1998)

State	Number Of Mines	Remediation Dollars In 1997		Total Remediation Dollars In 1997
Non-SMCRA States		**State**	**SMCRA**	
California	52,700	0	[2]N.A.	0
Arizona	[1]100,000	30,000	N.A.	30,000
Nevada	50,000	38,000	N.A.	38,000
SMCRA States				
Montana	6,000	300,000	4,381,164	4,681,164
Colorado	22,000	110,000	1,500,000	1,610,000
New Mexico	20,000	0	175,000	175,000
Wyoming	2,649	0	22,000,000	22,000,000

1 Estimate based on counting features, not on mine sites. 2 Not Applicable.

South Dakota

While the South Dakota legislature did not actually create an abandoned mine program, it did initiate a system for prioritizing the abandoned mines should further funding become available. Recently the Department of Environment and Natural Resources completed a state-mandated inventory, funded by fees levied on active gold mines (a cyanide tax). Approximately 900 non-coal mine sites were identified by this inventory. In addition, about 65 inactive mine sites, mostly on private lands, have been voluntarily reclaimed by the active mining industry on properties that they own or control.

Pacific Northwest

Oregon and Idaho are not active coal mining states and have no SMCRA funding, but they desired to engage in a cost-effective clean-up effort. These two states formed a partnership with Washington, which has two active coal mines, and, therefore, receives extremely limited SMCRA funds. This three-way partnership entered into a compact with the US EPA, known as the Tri-State Agreement, not only to accomplish priority reclamation projects, but also to inventory abandoned mine sites as well.

Federal Efforts

During fiscal years 1993 through 1995, the Bureau of Land Management (BLM) inventoried approximately 7.4 million acres nationwide (less than 3% of BLM lands), and identified approximately 7,000 sites, which constituted 24,600 mine features. The BLM identified public safety hazards at over 6,600 locations and environmental hazards at 890 locations. This effort was done in cooperation with many state agencies (excluding California, which had no AML program at the time). Funding was provided by the Watershed Clean-up Initiative and other federal funds. In their final report it was noted that state support and participation greatly aided their efforts and that *"the State of California lacks a coordinated effort focused on the identification and remediation of potentially hazardous AML sites. As such, BLM has not been able to establish a strong Federal/State partnership in this effort."* (USBOM and CCEM 1994)

In 1995, the Interdepartmental AML Watershed Clean-up Initiative was born. This initiative brought together the resources of the US Forest Service, Bureau of Land Management, US Environmental Protection Agency, US Geologic Survey, National Park Service, and the now defunct US Bureau of Mines. Together, they developed a coordinated strategy for the cleanup of environmental contamination from abandoned hardrock mine sites associated with federal lands. The strategy was based on a watershed approach to characterize and remediate contamination. Two watersheds were identified for pilot reclamation programs, the upper Animas River in Colorado, and the Boulder River in Montana. Choice of the watersheds was based on water quality impacts, metal loading, and recognition of the strong state programs.

Noting the limited funding for clean-up, US Forest Service efforts (outside of the Watershed Initiative) have focused on those sites that have the potential to be CERCLA (the Comprehensive Environmental Response, Compensation, and Liability Act) sites. These are sites that impact the environment (produce ARD, heavy metal loading, etc.) and for which there is a potential responsible

party which can bear the cost of remediation. The Forest Service estimates that about 1,700 of its sites nationwide qualify for reclamation under CERCLA criteria; those in California were included in Tables 4 and 5.

PROGRAM OPTIONS

The long-term continuation of the AMLU program, beyond the baseline 2.5 staff positions allocated, could take many different shapes. The current level and manner of inventories could continue or a different inventory scheme could be employed. Watershed assessments coupled with remediation priorities could be accomplished in high-risk watersheds. Physical hazards could be abated. Mercury issues in our watersheds could be quantified and remediated. A public education program, under the slogan "Stay-Out, Stay-Alive" could be developed. And a CEQA review program for projects in, on or near abandoned mine sites could be implemented. The following list is not intended to be all inclusive, but offers some options for addressing this complex issue.

Inventory

Various options for future AML inventories include:

- continue the random sampling program to further refine the estimates of the magnitude and scope of the AML problem in California,
- use a watershed approach to concentrate inventories in the watersheds most at risk for environmental impact by ARD and heavy metals, arsenic, or mercury,
- use exposure models to concentrate inventories in the areas where the public are most likely to come in contact with physical hazards,
- or any combination of the above options.

Watershed Assessments and Remediation

A watershed-based assessment and remediation program has many advantages over the classic site-by-site assessment and remediation strategy. A watershed approach would concentrate inventories in the watersheds most at risk for environmental impacts by ARD and heavy metals, mercury, or arsenic, for example. Spatial queries based on municipal water supplies, recreational water use (boating, swimming, fishing), and impacts to endangered species (such as salmonids) could further aid in setting assessment and remediation priorities.

Once watersheds are identified for assessment, staff could inventory, characterize and remediate the contaminated sites that have the potential for the most positive improvements in water and ecosystem quality within the watershed. Such an approach would require interagency cooperation and the continuance of the Abandoned Mine Task Force and existing Memoranda of Understanding.

The watershed approach has many benefits:

- focuses resources on actions likely to improve water and ecosystem quality significantly,
- bases impact analyses on cumulative effects of multiple non-point sources of contamination,
- reduces the costs of remediation, when compared to a site-by-site approach,

- leverages remediation costs among a group of sites which may have different revenue sources (such as potentially responsible party and US EPA Emergency Response monies),
- provides a setting that reduces costs because of mobilization and economy-of-scale issues,
- fosters cooperation among federal, state, and local governments and the watershed stakeholder groups, and
- complies with the 1998 Federal Clean Water Action Plan, under the Clean Water Act.

Physical Hazard Remediation

In addition to impacts to water quality, abandoned mine shafts, adits, collapsing structures, and quarry highwalls present grave physical hazards. Though AMLU is currently cataloging these hazards, at present there is no state program or funding mechanism for remediation of physical hazards (chemical hazards can be remediated through actions by potentially responsible parties through CERCLA or CWA actions). A grants program to provide assistance in the preparation of mitigation/closure plans, remediation costing, and contract management, administration, and support for physical hazard remediation on abandoned mines could be initiated.

Ziebright Adit, Nevada County — A popular recreation area.

Afterthought Mine, Shasta County — Example of a Derelict Structure.
(Photo courtesy of Phil Woodward, Central Valley Regional Water Quality Control Board)

Hydraulic Mine Sites

Millions of pounds of elemental mercury were discharged into the environment during the hydraulic gold-mining era. In today's environment, some of this mercury has become bio-available and may be impacting human and environmental health, potentially causing fish consumption advisories.

Some of these historic hydraulic sites have been inventoried by AMLU; however, the limitations of our current program do not allow AMLU to determine the location and full extent of the historic hydraulic gold mines in Plumas, Placer, Nevada, Sierra, El Dorado, and Trinity counties, in a timely manner. If the sites were fully researched and inventoried, and their ground sluices and tunnels mapped, the total amount of mercury released to the environment could then be estimated more accurately, as well as the probable location of that mercury.

Mercury Recycling

During AMLU's initial investigations, the historic mercury loading of watersheds within the Sierra Foothills became apparent. There is currently no state (or federal) program for appropriate handling of mercury recovered during recreational mining. DOC, in cooperation with other state agencies, could begin

a program to facilitate the proper management of mercury (a hazardous substance) from recreational and small-scale placer mining, by arranging for the pickup, transport, and recycling of recovered mercury through cooperative programs with the private sector, local, state, and federal entities.

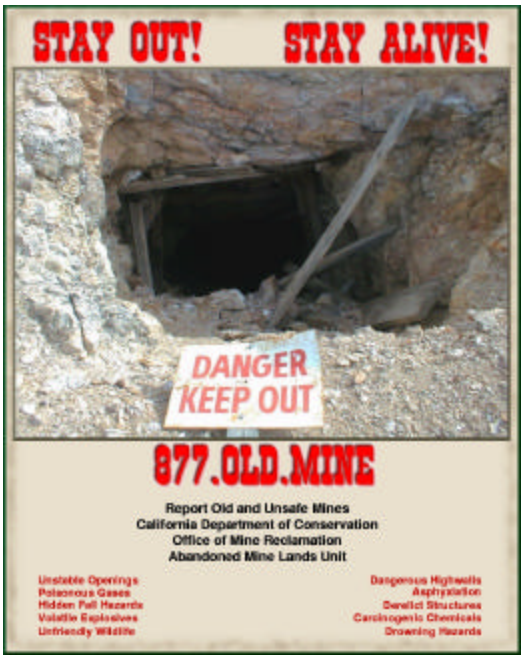
Malakoff Diggins—Now a State Historic Park

Mercury Facts[15]

From 1848 to 1976, 17 to 22 million pounds of mercury were used in California

Mercury losses in the Sierra Nevada are estimated at 6 to 11 million pounds.

Public Education: "Stay-Out, Stay-Alive"



The majority of chemical and physical hazards present at abandoned mines in California are not likely to be eliminated in the foreseeable future. Because of this, some effort should be made to educate and inform the public of specific hazards to their health and safety. Many mines may also provide irreplaceable habitat for threatened and endangered species animals and plants. Educating the public about the need to preserve the unique habitat created by abandoned mines is necessary in order to protect these species. In addition, potentially significant historic and cultural sites have been destroyed by uninformed development, theft, and vandalism.

Although AMLU has documented abandoned mine hazards throughout the state, resources are not currently available to effectively educate the public. There may be a potential liability for the state if additional resources are not made available to inform the public about these documented mine hazards. Consequently, the state should make a reasonable effort to provide this knowledge to the public. To be effective, this effort should have the following goals:

- Educate the public about the dangers of abandoned mines.

[15] Photo and mercury loss data courtesy of the Division of Mines and Geology.

- Educate the public about historical and cultural preservation to protect mines and structures from destruction, theft, vandalism, and illegal dumping.
- Provide a toll-free number for reporting hazards.
- Educate property owners about appropriate remediation and mitigation practices and prevent further site degradation.

Other states provide public outreach and education through participation in the nationwide mine hazard awareness campaign known as, "Stay Out, Stay Alive". This initiative is sponsored by the Federal Mine Safety and Health Administration (MSHA), and 30 other mining states. This program is a cooperative venture between governmental and private organizations to provide educational materials about the hazards of abandoned mines to schools and the public through print, radio, television, and the World Wide Web. By supporting and participating in an abandoned mine hazard education and outreach program modeled after "Stay Out, Stay Alive", California would benefit from the information and coordination provided by MSHA and the other mining states.

CEQA Review Program

In 1970, the state legislature adopted the California Environmental Quality Act (CEQA), which was further broadened in 1972. CEQA establishes the environmental policy for the State of California, and is designed to disclose potential environmental impacts and to require decision-makers to consider the environmental implications of their actions in order to avoid or reduce impacts, if feasible. The act is applicable to public projects and to private projects where an agency is involved via permitting, funding, or approval. The environmental review process provides an important opportunity for public participation in the decision-making process. The heart of the law is the recognition of potential environmental impacts that may result from proposed development and the involvement of public agencies and members of the public in a debate about those impacts and development of mitigation measures to minimize them. The process begins with an Initial Study, completed by the lead agency, which reviews a number of factors related to the project.

The issues included in a CEQA document (e.g., Negative Declaration or Environmental Impact Report) that can relate to abandoned mines are usually addressed in one of the following sections: Hazards and Hazardous Materials, Mineral Resources, Cultural Resources (archeological and historical), or Geology /Soils. The CEQA document is circulated publicly and to various public agencies, inclusive of DOC. DOC, while currently not funded for abandoned mine CEQA review, has received numerous requests for input on such documents where projects are proposed on top of, or adjacent to abandoned mines. Review of published and unpublished literature to determine the level of abandoned mine hazards on a particular development—and, where warranted, onsite field assessments to determine/verify the hazards on a site--could become part of the CEQA record.

Funding and Liability

In order to mitigate or remediate abandoned mine lands, funding mechanisms will need to be developed. Some possibilities have already been mentioned. Other possible sources of funding are identified below. Private individuals or corporations may wish to remediate sites, but have failed to take action in the past for fear of being identified as a responsible party under the Clean Water Acts and CERCLA. Removing such disincentives may further the goal of remediating abandoned mine lands. Finally, the potential liability to the state is addressed; as such, the state may need to consider direct appropriations for specific sites or watersheds.

Amend SMCRA

The National Governor's Association NR-23 (Abandoned Mine Reclamation Financing) speaks to the abandoned mine land programs funded under the Surface Mining Control and Reclamation Act (SMCRA). It has been suggested that NGA NR-23 be amended to include language recommending the federal government provide funding for remediation of environmental problems associated with abandoned mine lands in states without a current SMCRA program.

Amend the 1872 Mining Law

One possible funding mechanism for this program (which has been suggested previously) is a federal royalty on non-coal mineral production from public lands. However, a federal royalty would involve mining law reform and previous efforts to accomplish reform have not been successful in Congress.

Return Claim Fees To States

Another possibility for funding is the annual $100 per claim maintenance fee collected by the federal government on every unpatented mining claim not subject to the small miner exemption. This fee was enacted in 1993 and replaced the requirement to perform $100 per year assessment work on unpatented mining claims. The fee currently generates approximately $35 million annually, the bulk coming from non-SMCRA states (California, Nevada, and Arizona). Today, California has approximately 40,000 active claims on federal lands. The fee is currently used to fund the administrative law function of the non-coal mining program within the BLM and the USFS. Redirection of a portion of the claim maintenance fee could follow the same logic as the allocation of SMCRA funds, that is, it could be returned to the states for abandoned mine clean-up in proportion to the amount generated in that state.

California's "Water Bond"

The Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act of 1999 provides opportunities for addressing abandoned mine lands that present environmental hazards. Abandoned mines could qualify under both the Watershed Protection Program and the Non-point Source Program. A total of $280 million in grants and loans are to be distributed to districts, local agencies, non-profit organizations, and local watershed groups under these two programs.

CALFED

The information collected and analyzed by AMLU specifically addresses CALFED's multiple objectives of habitat restoration, water quality, and watershed management. Abandoned mine remediation would include actions relating to the reduction of metals loading, sediment loading, and the restoration of aquatic, wetland, and riparian habitats. Funding provided by CALFED could allow for enhanced and accelerated watershed assessments that meet CALFED's goals and priorities. The long-term system-wide benefits of such a project would be the remediation of the mine sites that are contributing the most to the impaired water quality of the Bay-Delta.

Pollution Trading

Pollution trading is a regulatory process that allows pollution dischargers to remediate other sources of discharge to achieve pollutant reductions over an entire watershed. With respect to AML, such a program would allow a discharger, such as a wastewater treatment plant, to get "credit" for cleaning up a polluting abandoned mine.

The USEPA promotes the use of pollution trading as an innovative way for industry, regulatory agencies, and the public to implement practical solutions to water quality problems at the watershed level. The states of Idaho, Colorado, and Minnesota have already instituted a regulatory process for pollution trading. Participating dischargers earn pollution discharge credits for reductions made in water quality impacts. New or increased discharges of pollutants which impact water quality may be allowed if the total pollutant load remains constant or decreases within the watershed. Dischargers who exceed the remediation requirements of their plan are then allowed to sell or trade credits to other dischargers who would be required to invest more to achieve the same amount of pollution reduction.

The US Army Corps of Engineers' RAMS Program

House Resolution 2753, the "Abandoned Mine Restoration Act of 1999" sponsored by Congressman Jim Gibbons of Nevada, would establish a new program (RAMS: "Restoration of Abandoned Mine Sites") and fund it at the level of $45 million dollars a year. This resolution would authorize the Secretary of the Army to assist federal and state agencies to address the serious environmental and water quality problems caused by drainage and related impacts from abandoned and inactive mines throughout the western United States. California would need to enter into a Memorandum of Understanding with the Corps prior to the beginning of any RAMS projects in the state. Projects under the RAMS program require matching funds from the affected state; therefore, a state source of funding would need to be identified in order to work with the Corps under this program.

Create AML Program Parallel to "LUFT" Program

California's Leaking Underground Fuel Tank (LUFT) program can be viewed as an analogy to a conceptual abandoned mine remediation program. Both involve abandoned or orphaned sites, small-scale ("mom and pop") owner/operator with little or no capital resources, and a lack of environmental liability insurance to cover the costs of environmental remediation. In response to

these realities and in view of the mounting environmental degradation associated with LUFT, the legislature created the Underground Storage Tank Cleanup Trust Fund (1990). The fund is capitalized by a 1.2¢ per gallon storage fee on petroleum products placed in underground storage tanks. Issues of third party liabilities and injuries are dealt with on a separate track while environmental remediation is completed. A similar fee on the mining industry could be a viable mechanism to address California's abandoned mine lands.

CERCLA And CWA Liability

Liability concerns continue to be a disincentive to the cleanup of abandoned mine sites. The Clean Water Act (CWA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as currently written, are major stumbling blocks to progress on this issue. While CERCLA has a provision for the "innocent landowner", CWA does not. Questions of liability have impeded, many "Good Samaritan" efforts involving voluntary cleanups or re-mining by industry.

The Western Governor's Association (WGA) has asked Congress to amend the Clean Water Act to provide a "Good Samaritan" exemption from liability for states which clean up old, abandoned mine sites. In October 1999, Senator Max Baucus (D-MT) introduced the *Good Samaritan Abandoned or Inactive Mine Waste Remediation Act* together with co-sponsors Sen. Ben Nighthorse Campbell (R-CO) and Sen. Tom Daschle (D-SD). California could support "Good Samaritan" exemptions to remove this disincentive for remediation.

Possible State Liability and Existing AML Hazards

The state has knowledge about physical hazards on state, local, and private lands, yet there is no program or financing to address these issues. The state owns lands, such as Malakoff Diggins State Historic Park (ARD, mercury, hazardous openings), Empire Mine State Historic Park (openings, subsidence, and collapses), Spenceville Wildlife Area (ARD, toxic lake, and open adit), and Carnegie State Vehicular Recreation Area (many unstable openings, collapses), all with unmitigated AML hazards. At sites owned by State Parks, substantial fencing and signing is used to warn and protect the public from hazards, while retaining the historical integrity of the site. Three examples of state and federal liabilities are provided; however, most such cases are settled out-of-court and are not reported (unlike the following examples):

- In 1992, a teenager died while exploring an abandoned mine shaft on private lands in Oklahoma. The state's Conservation Commission was found "50% negligent for not finding the shaft and for not filling it." (The jury declared that the boy bore the other 50% of the negligence.)[16].
- In June 1997, two men were rescued after one fell 20 feet and another fell 100 feet down an abandoned mine shaft they were exploring in California near Parker Dam. One of the men sustained serious injuries in the fall, and had to be air-lifted to Loma Linda Medical Center in the San Bernardino area. The two men later sued the BLM for damages, and won an out-of-court settlement for $750,000.

[16] Reif v. State of Oklahoma, C-92-564, In the District Court in and for LeFlore County, State of Oklahoma 1994.

- In September 1994, a man died in an abandoned mine on private land. At trial, the jury found that even though the site was on private land the State of Arizona was 67% at fault for the death. A Forest Service worker claimed that he had reported the mine to the state several months to a year prior to the death. While the state had no record of this report, the jury believed that the state had knowledge of the mine. They found the deceased 18% at fault and the landowner only 14% at fault. The jury awarded the widow $1.4million. With reductions, the State of Arizona's portion totaled about $700,000.[17]

[17] Wagenknecht vs. Arizona State Mine Inspector and Marvin Harrison. The case was filed in Gila County Superior Court in 1995 and went to trial in April 2000.

CONCLUSION

California has between 29,300 and 69,800 abandoned mines with an estimated mean of 39,000. But what do these numbers mean? They suffer from the apple and orange paradigm. A mine site may be represented by one five-foot square shaft, presenting only a safety hazard; or a site may include 42 shafts, three waste piles, two tailings dams and a processing area, all encompassing in excess of 200 acres and presenting both safety hazards and environmental hazards. Yet in the total 39,000 AML number, the implication is that they are all equal. In other words, a better question would be to ask how many hazardous features are there in the state, how many have the potential to impact the environment, and where are they. A complete answer should encompass an estimate of the hazardous openings and structures; an estimate of the acreage of mine waste and tailings and their composition; and an estimate of the size and type of processing areas. And to provide useful data that can be spatially analyzed for land-use decisions, all these features need to be accurately located using modern GPS technology. This was AMLU's aim.

Over the 2.75 years of this study, field data for 2% of these mines (778 sites, with 3,980 features) were collected, inclusive of accurate locations. A subset of these sites were part of the stratified, random sampling of mines used to make the statistical extrapolations contained in this report. Notably, the extrapolations show that while most of these abandoned mines present physical safety hazards to the populace, only about 11% pose clearly significant environmental hazards. Much more field verification of sites and features is still needed.

Common physical hazards that were documented include subsidence, open (and inviting) shafts and adits, collapsing structures, and highwalls. Currently, the most accurate statewide locations for hazardous openings are those shown on the USGS topographic maps; and AMLU is in the process of digitizing these symbols. Based on the estimate of 48,944 hazardous openings, perhaps a public education program should be the first step in protecting people. A nationwide "Stay Out, Stay Alive" program already exists, and California could become part of this effort. Simultaneously, a state program to provide information, and perhaps even funding, to aid property owners with proper closures and signage may be advisable.

Environmental hazards from abandoned mines occur because of processing chemicals used on the site (e.g. cyanide and mercury) or because of the indigenous geochemical make-up of the ore body or host rock combined with mining activity. Common environmental issues associated with California's abandoned mines include the release of asbestos, arsenic, mercury, aluminum, chromium, nickel, copper, zinc, lead, or other metals, the release of acidic waters, and sedimentation. These hazards are often transported via our waterways at long distances from their sources. The state, through actions in Cal-EPA, CDFG as a trustee, and federal agencies are already addressing many of the most important abandoned mines on a site-by-site basis. A greater benefit to water quality and the environment could be attained if abandoned mine sites were addressed on a watershed basis. The geo-environmental

models and priorities set forth in this report are the beginning for watershed assessments, followed by watershed remediation programs.

The current regulatory environment would seem to indicate that there is adequate regulation to cause the remediation and closure of all abandoned mines. But this is misleading. The laws and regulations that address hazardous excavations put the cost of closure solely on the current property owner. The two most commonly used laws that address environmental impacts, CERCLA and the CWA, put the cost of remediation on current landowners and any potentially responsible parties (PRPs) that can be located and are financially viable. Most of these current landowners had nothing to do with the historic mining, unlike the PRPs, and the clean-up costs can be daunting. These mines, by in large, were developed 50 to 150 years ago when safety and environmental consequences were either unknown or not a consideration. The 1872 General Mining Law was enacted to settle the west, to create an infrastructure for the people, and yes, to extract minerals. The legacy of historical mining in California is the inheritance of all.

Of the states with abandoned mines, the State of California is one of the last states to address abandoned mines systematically, which means that we are in the position to borrow ideas from the many excellent AML programs in other states. The state is presented with the opportunity to take advantage of the initiative and progress made by the AMLU Inventory. The Abandoned Mine Task Force is already in place and is the appropriate vehicle for continuing the coordinated effort on statewide AML issues. This coordinated effort includes the investigation, research, compilation, and dissemination of information about mine hazards with other federal, state, and local agencies. A relational database of abandoned mines, linked with data collected from other agencies, has been developed and implemented. Additionally, an abandoned mine GIS has been developed and implemented which allows the spatial and statistical analyses necessary to prioritize abandoned mine sites and watersheds for remediation. Staff — uniquely trained and experienced in locating, assessing, documenting, prioritizing, and remediating mine hazards — are already in place. All that is necessary to make progress in the identification, prioritization, and remediation of abandoned mine lands is a legislative mandate and the resources to accomplish the task.

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