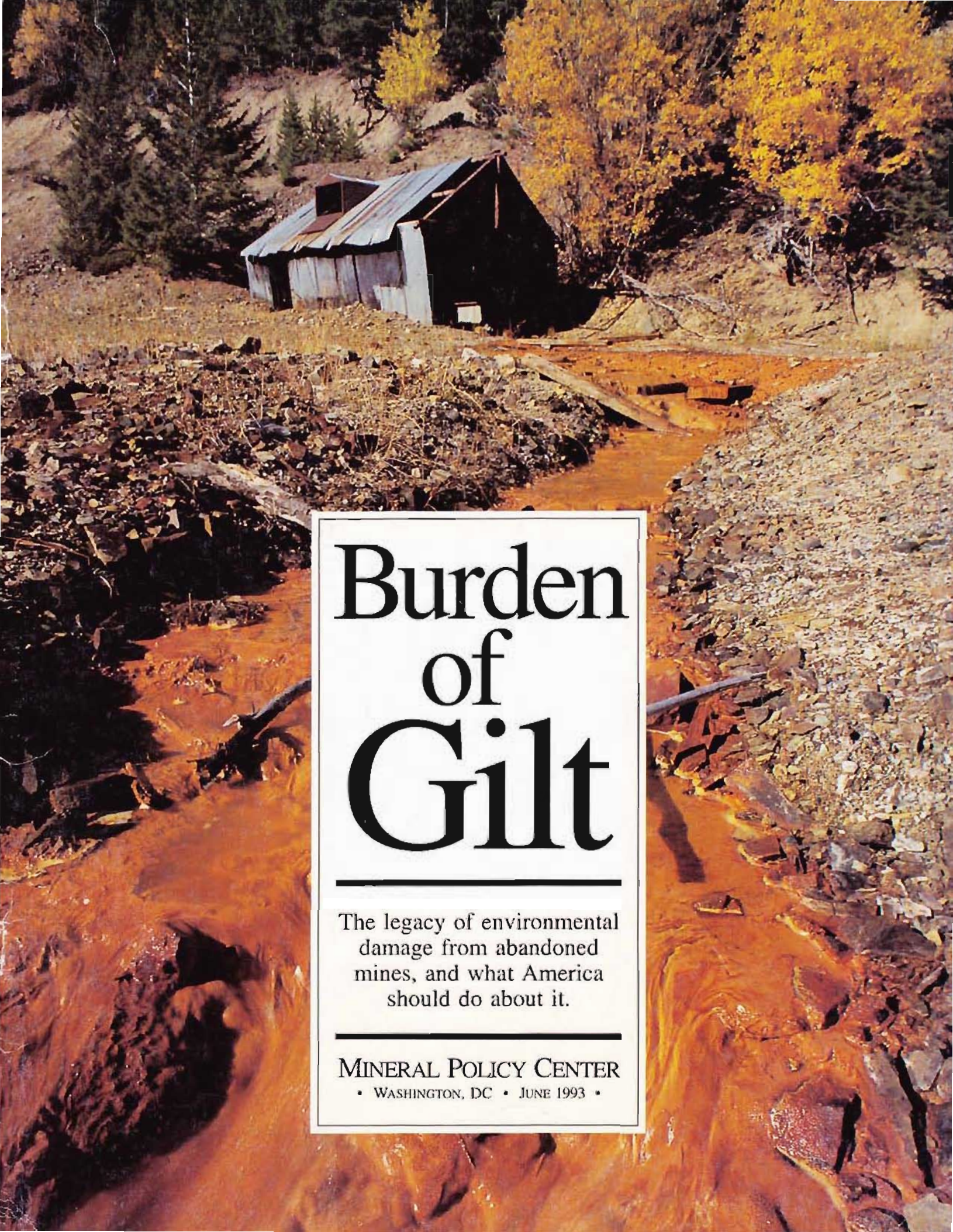

Burden of Gilt

The legacy of environmental damage from abandoned mines, and what America should do about it.

MINERAL POLICY CENTER
• WASHINGTON, DC • JUNE 1993 •

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Thomas J. Hilliard
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COVER PHOTOGRAPH:
Acidic waste from an abandoned mine in Montana leaching into Beartrap Creek, which flows into the fishing waters of the Blackfoot River — scene of Norman Maclean's (and Robert Redford's) 'A River Runs Through It'
PHOTOGRAPH BY BRYAN PETERSON

Burden of Gilt

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Introduction *by Stewart L. Udall*

Burden of Gilt is a singularly apt title for this important report. The phrase succinctly captures just what hardrock mining has done — and is still doing — to America.

The exploitation and extraction of gold, silver, copper and other hardrock minerals made many men wealthy, built great corporations and caused sprawling cities to spring up in the wilderness. But there has always been a heavy price to pay. Now the bills are coming due.

The hardrock mining industry has traditionally been able to 'externalize' costs, as economists say, simply by abandoning its played-out mines rather than reclaiming them and eliminating all hazards to public health and the environment. Who, then, has to bear these 'externalized costs'— ghost towns, waste piles, valleys contaminated by mine pollution? We do, all of us — and our children and grandchildren.

This ***'burden of gilt'*** is borne by every community whose water supply is contaminated by leaking mine wastes, by every child whose blood shows disturbingly elevated levels of mercury, by every unsuspecting hiker who plunges into an unmarked mine opening and suffers injury or death — all of which happens more often as our population grows and more Americans live in or near what were once remote mining areas.

In a frontier era when hardly anyone worried about the long-term consequences of feverishly cutting, uprooting, digging, blasting, burning and dumping, the mining industry was free to do as it wished. In this respect it was no different from any other industry; all did the same. But finally we have begun saying: Wait. Stop. This cannot continue. We cannot continue to pollute our environment with impunity.

Thirty-three years ago, in *The Quiet Crisis*, I wrote: "America today stands poised on a pinnacle of wealth and power, yet we live in a land of vanishing beauty, of increasing ugliness, of shrinking open space, and of an overall environment that is diminished daily by pollution and noise and blight." During my eight years as Secretary of the Interior under Presidents Kennedy and Johnson, we struggled to set in motion policies that in many areas of our national life have done much to halt the blight and reverse the decline. As for hardrock mining, however, I could have written those same words this morning.

It is true that some hardrock mining companies are now making efforts to operate more responsibly. But their late conversion (which, alas, is by no means industry-wide) leaves us still poised on a pinnacle of waste: more than half a million unreclaimed, deteriorating hardrock mine sites, some of them abandoned decades ago, others abandoned just last week.

There can be no justification for permitting the hardrock mining industry to continue exempting itself from environmental standards applicable to most other industries. The nation must declare that this burden has become intolerable and must shift it where it belongs: to the industry that is responsible for these problems and that must now help bring them under control.

Burden of Gilt is the first attempt by any public or private organization to combine, in one succinct document, an up-to-the-minute assessment of the abandoned mines problem *and* a carefully thought-out proposal to develop and fund an effective nationwide reclamation program. This report represents the first important step in confronting this long-neglected problem and resolving it while there is still time to do so.

Particularly noteworthy, in my opinion, is the report's emphasis on the interconnectedness of the words *environment* and *employment*. Here we have, on the one hand, a backlog of unfinished environmental business, and, on the other, a recession that has been especially hard on basic industries such as mining. If these be lemons, let us make lemonade.

We have a huge cleanup job to do, and we have a reservoir of unemployed men and women, many of them skilled veterans of the industry that once wanted them to dig its mines but no longer needs them. What could be more logical than to call upon their skills to restore our bruised and battered land to the condition in which our forebears found it — and to which future generations are entitled?

We must address this challenge now or face intolerable consequences. ***Burden of Gilt*** tells us how to get the job done without bankrupting either the mining industry or the Treasury. I urgently recommend this report to anyone who has a stake in the future well-being of the nation, and I urge the President and our elected representatives in Washington to incorporate its recommendations in the mining reform legislation now pending before the Congress.

Chairman,
Mineral Policy Center
June 1993

Executive Summary

Overview

Hardrock mining has been a major industry in the United States for more than a century. But the industry has habitually failed to clean up after itself. As a result, more than half a million abandoned hardrock mines are scattered across the American landscape.

While the mining companies have been reaping the vast fortunes that hardrock mining has long bestowed, the ***'burden of gilt'*** — the degrading unreclaimed land abandoned by the mine operators — has been left to the public to deal with.

Abandoned mines are silent killers, threatening public safety and health and creating long-lasting environmental hazards. Toxic mine wastes endanger people downwind, destroy aquatic life downstream, and contaminate vital groundwater resources. Abandoned mines constitute an intolerable threat to the nation's future.

The time has come to attack this problem head-on. The nation needs a comprehensive national program to regulate currently active hardrock mines and prevent new abuses — and, to heal old wounds, the nation needs a ***Hardrock Abandoned Mines Reclamation (HAMR)*** program, administered jointly by the federal government and the states and funded by fees on hardrock minerals extraction nationwide.

Mineral Policy Center estimates that there are 557,650 hardrock abandoned mine sites nationwide and that the cost of cleaning them up will range from $32.7 billion to $71.5 billion. *HAMR* represents an opportunity to restore long-neglected mining lands and to create up to 10,000 jobs in communities suffering from the effects of the mining industry's shrinking employment base.

HAMR will have an immediate impact on the environmental and economic well-being of more than two dozen states that have been severely scarred by hardrock mining — and, in the long run, ***HAMR*** will benefit every American who breathes air and drinks water. ■

Executive Summary

Abandoned Mines: A Nationwide Problem

The map of the United States is pockmarked with abandoned hardrock mining* sites — an estimated 557,650 in 32 states. At least 50 billion tons of untreated, unreclaimed mining wastes currently cover public and private lands in the United States.

Mine wastes can contain many life-threatening contaminants — arsenic, asbestos, cadmium, copper, cyanide, iron, lead, mercury, sulfur, and zinc, among others. Mine wastes can also be soluble and mobile. Wind and rain can erode waste piles, liberating toxic wastes as airborne pollutants and as acid runoff that migrates to nearby (and sometimes distant) waterways. Mine effluents have already polluted 12,000 miles of the nation's waterways and 180,000 acres of our lakes and reservoirs and are a growing threat to underground aquifers.

Abandoned hardrock mines can pose many kinds of hazards to public safety and health as well as to the environment. For example:

▸ ***Colorado:*** *A father and son were riding their motorbikes cross-country when they plunged into an unmarked abandoned mine. The son was killed. A few months later a two-year-old boy fell to his death in an unsealed mine shaft near his home in Central City. Abandoned mine sites have caused at least 22 fatalities in Colorado in recent years.*

▸ ***Arizona:*** *A 45-unit mobile-home park built near Globe on a backfilled site containing untreated mine wastes had to be evacuated — and was later condemned — after ambient air samples were found to contain potentially lethal levels of carcinogenic asbestos fibers.*

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* **Hardrock mining** is generally defined as the extraction of metals (e.g., copper, gold, iron, lead, magnesium, silver, uranium, zinc) and nonfuel minerals (e.g., asbestos, gypsum, phosphate rock, sulfur) by surface or underground mining methods. The principal hardrock mining states (i.e., those where total material handled exceeds 1 million tons per year) are *Alaska*, *Arizona*, *California*, *Colorado*, *Florida*, Georgia, *Idaho*, Indiana, Iowa, Kansas, Kentucky, *Michigan*, *Minnesota*, *Missouri*, Mississippi, *Montana*, *Nevada*, *New Mexico*, New York, *North Carolina*, Ohio, Oklahoma, Pennsylvania, South Carolina, *South Dakota*, *Tennessee*, Texas, *Utah*, Vermont, Virginia, Washington, *Wyoming*. Italics denote states producing more than 10 million tons of mining waste per year. (Source: U.S. Bureau of Mines)

The scope of this study excludes the examination of non-hardrock mineral abandoned mine sites such as sand, gravel, and limestone, which together with hardrock abandoned sites exist in all 50 states.

▸ ***Florida:*** *The aquifer that supplies drinking water to 90 percent of the state's residents is being contaminated by heavy metals leaching from mine sites. State officials have warned that unless the problem is brought under control soon, the aquifer could require decontamination treatment — at enormous cost — for the next half-century.*

▸ ***Nevada:*** *Long-abandoned Comstock Lode gold and silver mines are leaching heavy metals into the Carson River, not far from Lake Tahoe. Because the river now contains dangerously high levels of mercury — which can cause irreversible central nervous system disorders and other health problems — valley residents have been warned not to eat fish or waterfowl from the river.*

▸ ***Vermont:*** *A mine that was closed in 1958 and left unreclaimed continues to leach acid mine wastes into a tributary of the Ompompanoosuc River near Montpelier, acidifying the stream, eliminating aquatic life and degrading groundwater. After 35 years, vegetation has not yet taken hold at the orphaned mine site.*

▸ ***North Carolina:*** *Erosion and sedimentation from abandoned hardrock mines is a major long-term threat to water quality in the western part of the state. Aquatic life along more than 100 miles of stream has been destroyed and a major reservoir has been polluted.*

▸ ***Colorado:*** *A newly abandoned mine at Summitville, in the southwestern part of the state, is generating acid-bearing materials and toxic pollutants. The Environmental Protection Agency, which has been spending $38,000 daily treating the mine wastes on an emergency basis, has warned of possibly massive toxic spills into the Alamosa River — which irrigates many farms and ranches in the area.*

■

As these brief but representative examples indicate, abandoned hardrock mines constitute a nationwide problem that merits a comprehensive, well-coordinated and sustained nationwide response. Today, however, no such program exists.

No federal agency has broad responsibility for overseeing restoration of abandoned mines on public and private lands. And no mechanism exists to coordinate — let alone overhaul — the piecemeal efforts of various federal, state, and regional agencies to prevent today's mining operations from becoming tomorrow's abandoned mines.

Calculating the Scope and Cost of a HAMR Program

Critical to the design of a new national Hardrock Abandoned Mines Reclamation ***(HAMR)*** program is the need to accurately estimate the size and cost of the problem and to develop a sound basis for determining program priorities and cleanup methods.

While ***HAMR*** sites will usually require several different kinds of cleanup, sites can be classified by the type of cleanup *predominantly* needed, making it easier to understand the scope of environmental degradation and calculate cleanup methods and costs.

Mineral Policy Center has estimated the scope and cost of the nation's abandoned mine lands problem based on six site classifications:

❶ Reclaimed and/or Benign
typically needs little if any further remediation

❷ Landscape Disturbance
needs landscaping/revegetation to prevent offsite impacts

❸ Safety Hazard
needs prompt but not necessarily extensive action

❹ Surface Water Contamination
may require extensive contamination-prevention work

❺ Groundwater Contamination
requires complex contamination-prevention work

❻ Superfund
severe public health threats.

CATEGORY	NUMBER OF SITES	AVERAGE COST PER SITE ($ thousands)	TOTAL COST ($ thousands)
❶	194,500	—	—
❷	231,900	$ 4.4	$1,000,000
❸	116,300	$19.5	$2,300,000
❹	14,400	$1,000 ↔ $3,000	$14,400,000 ↔ $43,200,000
❺	500	$5,000 ↔ $15,000	$2,500,000 ↔ $7,500,000
❻	50	$250,000 ↔ $350,000	$12,500,000 ↔ $17,500,000
TOTALS:	**557,650**	↔ = Range of estimate	**$32,700,000 ↔ $ 71,500,000**

Solving the Problem

The nationwide problem created by abandoned hardrock mines calls for a bold, two-fold national response:

- First, a Hardrock Abandoned Mines Reclamation program must be enacted — *and adequately funded* — to begin cleaning up the existing inventory of ***HAMR*** sites nationwide.

- Second, comprehensive national environmental regulatory standards for all current and future mining operations must be put in place to ensure that no more mines will be left unreclaimed.

As noted, there is no federal or state program currently in existence that comprehensively addresses the need to clean up old ***HAMR*** sites. Nor do any existing programs realistically have the potential to do so.

Only two federal laws — Superfund and the Surface Mining Act (which regulates coal mining) — even have provisions for addressing, albeit very narrowly, reclamation of abandoned hardrock mine sites. But neither law empowers any federal agency to comprehensively address ***HAMR*** sites nationwide, and it would be unrealistic to assume that either of these laws can or will be modified as extensively as would be necessary to create a regulatory framework capable of controlling the abuses of hardrock mining.

As for the need to adequately regulate *current* hardrock mining operations to guard against further abandonment, responsibility today lies chiefly with the states. While many states have mining laws on their books, most are woefully deficient regarding environmental protection, and as a matter of historical record most states have generally failed to halt environmental degradation by hardrock mines.

The necessary first step, then, is to enact and implement a comprehensive ***HAMR*** program with explicit authority to clean up abandoned mines on all lands: federal, state, tribal, and private. Reclaiming hundreds of thousands of abandoned hardrock mine sites nationwide will require a long-term commitment as well as close cooperation among many federal and state agencies. However, more than 15 years' relevant experience with the existing coal Abandoned Mine Lands program (administered under the Surface Mining Act) suggests that in most cases restoration of land to environmentally benign condition is technologically feasible at manageable cost and will yield important economic as well as environmental benefits.

HAMR in Action

The new *Hardrock Abandoned Mines Reclamation* program should be recognized as a dual opportunity — to restore long-neglected mining lands *and* to create useful, effective, *important* public service jobs in many mining-dependent communities which are suffering because of the mining industry's steadily shrinking employment base.

Planning and implementation of the ***HAMR*** program will provide an opportunity for federal, state, regional and local environmental, land-management, and employment agencies to collaborate on projects that will leave the nation immeasurably improved — in land restored and in jobs created.

Restoration of abandoned mine sites will require various kinds of reclamation, i.e., backfilling and grading of open-pit mines, sealing or filling of underground mine shafts, treatment and capping of toxic mine tailings, treatment of surface water and groundwater discharges from mined areas, diversion of surface drainage, restoration of stream channels, revegetation, reforestation, and restoration of wildlife habitat.

In most cases, abandoned mine sites can be restored to environmentally stable condition using readily available technology and locally available equipment and labor. ***HAMR*** projects will require advance planning followed by on-site reclamation work. Heavy equipment will be used to restore sites to approximate pre-mining contours or equivalent condition and to eliminate safety hazards, and workers will restore or redirect drainage, stabilize highwalls and slopes, and reseed vegetation. Engineers and scientists will work to eliminate or minimize contamination of water resources. Longer-term follow-up activities at sites will include fish and wildlife management and water-quality monitoring.

HAMR projects will have a positive — in some cases dramatic — impact on regional and local employment, both directly and indirectly. Projects will employ civil and mining engineers, geologists, hydrologists, surveyors, foresters, soil scientists, wildlife biologists, heavy equipment operators, truck drivers, and laborers, among other job categories. In addition, projects will require materials such as seed, mulch, fertilizer, pipe, filter fabric and stone, most of them locally supplied.

Based on Bureau of Labor Statistics data, Mineral Policy Center calculates that for every $1 million invested in reclamation of abandoned mines, 26 jobs will be created. ***When fully operational, a nationwide HAMR program will create at least 10,000 jobs,*** assuming an annual budget of at least $400 million. The HAMR program will be especially beneficial in many areas where declining employment in the mining industry has resulted in the creation of large reservoirs of

unemployed workers, many with skills that are directly transferable to mined lands restoration work.

Most ***HAMR*** projects will use heavy equipment extensively. Other projects, particularly in rough or mountainous terrain, could be modelled on the existing Crow Tribe Abandoned Mine Program, which is deliberately labor-intensive, offering many work opportunities for unskilled men and women. ***HAMR*** is thus a natural fit with President Clinton's national service initiative. The program will provide opportunities for first-time workers and veteran miners alike to contribute muscle and skill to projects of lasting benefit to the nation.

HAMR Funding

Mineral Policy Center projects that the total cost of cleaning up the estimated 557,650 hardrock abandoned mines will be in the range of $32 billion to $71 billion. Some sites need immediate action to protect public safety or halt severe environmental degradation. Other sites of less pressing priority can be addressed over an extended period of time.

It is possible to design a pay-as-you-go ***HAMR*** program financed by various combinations of fees on minerals removed from private land and royalties and fees on minerals extracted from public land, augmented by penalties for violations of federal law. Examining a subset of the overall funding mechanism, such as a minerals royalty on federal lands, illustrates the funding potential of a ***HAMR*** program. For example, a 12.5 percent royalty (the same rate charged to producers of oil and gas on public land) coupled with an annual $100 rental fee for mining claims on public land should yield about $400 million annually.

■

Conclusion: Action needed— now

The overall benefits of a *HAMR* program clearly outweigh the costs. Indeed, the costs of *not* initiating such a program are unacceptable — or would be if more people fully understood them.

When an aquifer becomes contaminated, for example, the health of everyone who may depend on that water is placed at risk. Conventional cost/benefit calculations, which fail to account for such health hazards, are clearly inadequate. Similarly, there is no conventional way to measure the cost of learning — perhaps decades from now — that toxic residues have penetrated human tissues in a community unlucky enough to be situated downstream from an abandoned hardrock mine.

We know what we need to do. We know how to do it. Now we must get on with the job.

A national ***Hardrock Abandoned Mines Reclamation*** program should be developed immediately — with three broad, clear objectives:

❶ ***Stop*** environmental and public health threats;
❷ ***Restore*** mined land to acceptable, benign condition;
❸ ***Prevent*** development of future hazards.

Some mining companies will acknowledge that the time is long past due to pay their fair share of the cost of a nationwide cleanup campaign. Others will oppose a ***HAMR*** program on various grounds, most of them bearing on imagined or overstated threats to the industry's profitability.

While the burden of paying ***HAMR*** fees could make some marginal mining operations unprofitable, and while the program must be carefully designed to minimize such adverse effects, the overriding and inarguable fact is that the hardrock mining industry as a whole can well afford to meet its obligations to the nation.

For more than a century, the industry has been paying next to nothing for the privilege of extracting the nation's minerals and then abandoning its worked-out mines. Now those mines are adding daily to the nation's environmental and financial burdens and threatening our future health and safety. These are powerful arguments for a program to begin repairing the damage — as part of a long-overdue campaign to bring long-obsolete 19th-century mining practices into line with the urgent environmental imperatives of the 21st. ■

Recommendations

Mineral Policy Center urges the President and Congress to act boldly to protect the nation's health — public and environmental — against the effects of irresponsible hardrock mining by taking the following steps:

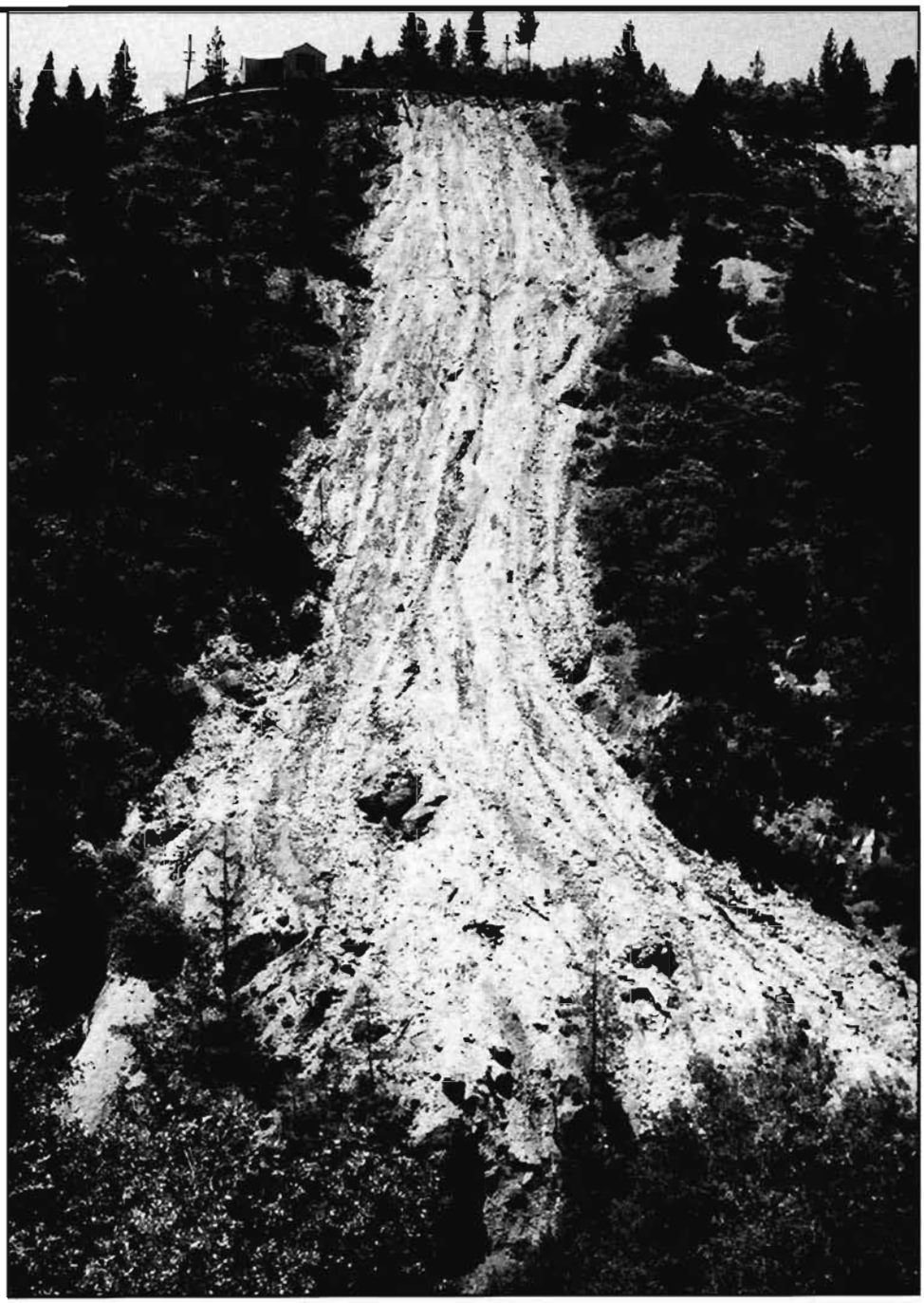
❶ ***Clean up abandoned mines,*** by creating a national Hardrock Abandoned Mines Reclamation ***(HAMR)*** program to:

- Conduct a nationwide inventory of ***HAMR*** sites on federal, state, tribal, and private lands, using uniform standards to record and evaluate site conditions;
- Establish national ***HAMR*** reclamation standards to ensure that land and water will be fully protected;
- Authorize states and tribes to perform the actual reclamation work within established federal standards;
- Provide adequate ***HAMR*** funding — at least $400 million a year initially — to prevent further threats to human health and safety and halt the spread of environmental damage.

❷ ***Protect future generations,*** ensuring that today's hardrock mining operations do not become tomorrow's abandoned lands, by creating a national regulatory program under the Resource Conservation and Recovery Act (RCRA) to ensure that *all* mine sites are properly restored after mining has been completed.

❸ ***Protect public lands*** from further mining damage by reforming the 1872 Mining Law to provide for land-use planning and discretionary land set-asides, post-mining cleanup, and a fair financial return to the citizens of the United States.

The combined impact of these actions will be to bring to an end the obsolete frontier-era mining practices that no longer have any place in a nation concerned about protecting public health and the environment for future generations. For too long, irresponsible neglect has been the order of the day. Mineral Policy Center calls for a new day — now. ■



Abandoned 30 years ago, the 4,400-acre Iron Mountain mine in northern California discharges vast quantities of iron and other heavy metals — principally zinc, copper, and cadmium — into rivers and reservoirs that supply Shasta County's drinking water. Fishkills in the Sacramento River have been recorded as far as 220 miles downstream from the mine. "It's as though a machine is operating deep within the bowels of the mountain," says one EPA official. "Iron Mountain produces as much heavy metal and acid contamination as all the other sources on the river combined."

1 Abandoned Mines: A Nationwide Problem

Why it's high time to confront an industry that has never wanted to clean up after itself.

Hardrock mining[1] is inherently destructive. Surface mining — the extraction technique of choice today — basically consists of digging up, hauling off, and dumping any trees, soil, and rock that happen to lie above a major mineral deposit. Forests, meadows, mountains, deserts, ranchlands — all have been laid waste.

Waste is, in fact, the main product of mining. For every ton of raw ore extracted, 100 tons of waste may be generated.[2] And the ratio of waste ore to processed commodity can be considerably higher: a ton of ore may yield less than an ounce of gold.[3]

The U.S. hardrock mining industry has historically kept its costs artificially low by leaving its mining and processing wastes wherever they might lie — on steep slopes, across watersheds, in toxic tailings ponds — with little concern about what might happen to them later. What happens to them later is what this report is all about.

An appalling legacy

Over the course of two and a half centuries, hardrock mining has left an appalling legacy: at least 557,650 abandoned mines in 32 states.[4] (We use the term "at least" advisedly, because many sites in remote areas have never been surveyed, and others may have entirely escaped official notice.) Some 50 billion tons of untreated, unreclaimed mine wastes cover public and private lands across the nation.[5]

Unfortunately, abandoned mines are not just a matter of historical curiosity. Irresponsible mining companies continue to walk away from problem sites (see *Welcome to Summitville*, page 22). So the industry's disturbing legacy is also a dynamic one: growing, changing, and threatening the well-being of more Americans every day.

Note: Source notes and photo credits appear at the end of this report.

Abandoned hardrock mines are silent killers. With every rain that falls, they release toxic chemicals downstream, sometimes into groundwater. With every wind that blows, they release pollutants into the air. Occasionally they claim their victims on-site — as, for example, when an unsuspecting hiker falls into an unmarked, unsealed mine shaft. More often, the damage they do is off-site, sometimes far downwind or even farther downstream — or, in the case of contaminated aquifers, deep underground. But whether the consequences are immediate and obvious or long-delayed and semi-invisible, abandoned hardrock mining lands constitute an environmental problem of the first magnitude.

What happens and why

In order to extract a mineral from the earth, soil and rock must be removed to reach the ore body. Historically, when this has been done by surface mining and/or open pit methods, earthmoving machines strip away ***overburden*** rock, depositing it downslope or wherever else is convenient. The overburden then becomes ***mine waste***. Placed on a slope, mine waste can wash down the hill as a landslide, pushing homes off foundations and blocking streams. More often it migrates less dramatically but just as dangerously.

Underground mining — now a less common but still significant practice and for many decades the principal extraction method — uses different means to arrive at the same end. Rock is displaced to sink ***shafts*** (vertical tunnels used for access and ventilation) and ***adits*** (horizontal tunnels used for access and drainage). Traditionally this displaced rock has been deposited immediately downslope or in the nearest natural depression in the surrounding terrain. And, until recently, when an underground mine ceased operation the operator simply packed up and walked away, leaving the ***workings*** — including adits, shafts and excavated areas — still in place, the mine openings unsealed, and the waste in huge piles, often astride drainage areas.

Ore removed from mines is treated by physical and chemical processes to extract marketable minerals. The ore may be crushed and ground; it may be treated with chemicals such as cyanide to leach minerals out of the ore. ***Tailings*** — the residues that remain after ore is treated — consist of processed rock and chemical reagents, often in a part-solid, part-liquid slurry that is left in heaps or dumped into washes or ponds. Sometimes chemical reagents are first extracted, in order to be recycled or disposed of separately; sometimes they are not.

In both waste piles and tailings ponds, rock containing ***heavy metals*** (e.g., cadmium, copper, iron, lead, manganese, mercury, silver, zinc)

has been removed from its natural subterranean surroundings; in its new location it is exposed to new environmental conditions. Heavy metals that would have remained stable indefinitely in a non-oxidizing environment are now exposed to the oxygen in air and water — and oxidation makes them hazardous to wildlife and human beings.

Tailings are particularly susceptible to the oxidation process: because they have been finely crushed, much of their surface area is directly exposed to air and moisture. Because tailings may also contain toxics associated with ore processing, they can be particularly hazardous. Air and water also reach the permeable rock that lines the walls of old underground adits, shafts, and workings.

Once liberated by exposure to moisture, heavy metals often migrate to the nearest body of water — usually a surface stream or underground aquifer that flows through or near the mine — and, from there, can travel long distances, depending on the volume and flow of the water.

Erosion, leaching, and acidification — all natural environmental occurrences — can trigger highly unnatural and undesirable phenomena when they interact with mine waste, tailings, and old workings.

Once liberated by moisture, heavy metals often migrate to the nearest body of water — usually a surface stream or underground aquifer that flows through or near the mine — and, from there, can travel long distances, depending on the volume and flow of the water.

- ***Erosion*** causes air and water pollution. Gravity, air, water, and ice act upon exposed rock, fracturing the crystalline structures that hold it together. Removal of vegetation, blasting of overburden rock, and use of heavy machinery create ideal conditions for erosion. Wind and water then pick up particles of rock, carrying them into streams, rivers, lakes, and reservoirs. The particles become suspended in the water, diminishing the amount of light that penetrates the water and altering the water temperature; these changes alone can threaten the survival of aquatic life. When the particles settle, they create sediment. Sedimentation affects fish spawning grounds, often decreasing species populations, and lowers streams' capacity to carry runoff, causing flooding. Heavily sedimented streams can also reduce the storage capacity of reservoirs and can incapacitate water treatment plants.

- ***Leaching*** — the process of rainwater percolating through piles of waste rock and tailings, dissolving the soluble components of rock — can be an extremely destructive process when it is not adequately contained. When rainwater passes through the waste, it liberates heavy metals in the exposed rock and transports them to surface streams and groundwater. The ability of the rainwater to liberate heavy metals is proportionate to the acidity of the water, as measured on the pH (potential of Hydrogen) scale, which expresses the acidity

of liquids in relationship to one another. Liquids with a pH of 7.0 are neutral. Liquids with a pH below 7.0 are acidic (the lower the number, the higher the acidity); liquids with a pH above 7.0 are alkaline. Because the scale is logarithmic, a decrease of 1.0 on the scale represents a ten-fold increase in acidity. As water's acidity increases, so does its ability to leach.

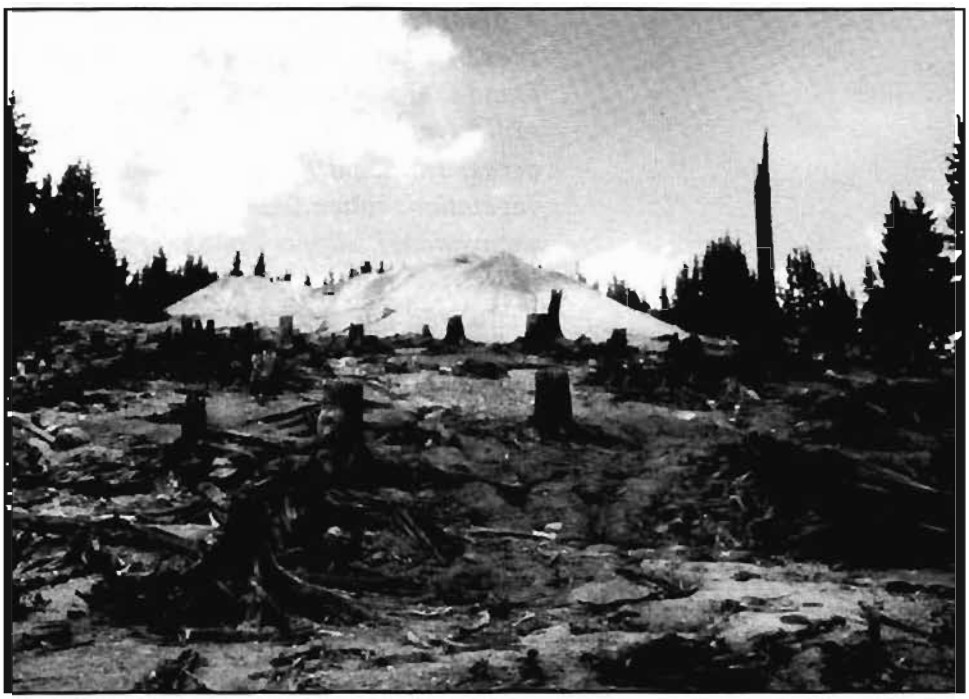
■ ***Acidification*** occurs when iron sulfides — pyrite and marcasite — are exposed to water and oxygen. These minerals slowly oxidize, forming dilute sulfuric acid and ferric hydroxide. The result is ***acid mine drainage.*** It can occur naturally, but the mining processes that bring sulfide-bearing rock to the earth's surface and fracture it expose much greater quantities of these susceptible minerals to weathering, with dire results. Acid mine drainage typically is 20 to 300 times more acidic than acid rain.[6]

If the pH of the acid solution falls below a critical value *and* naturally occurring acidophilic and iron-and-sulfur-oxidizing bacteria are present, the oxidation of pyrite and marcasite accelerates dramatically. Production of the acid at a rapid rate then becomes self-perpetuating and very difficult to stop. In addition, the acid solution coupled with the presence of an oxidant (ferric ion) can trigger further liberation of heavy metals from mine wastes, tailings, and old workings.

Nature is good at adjusting for small changes in acidity. Buffers in the soil neutralize runoff, keeping the pH of lakes and streams within the range needed to support life. But acid mine drainage overwhelms nature's defenses, carrying dissolved heavy metals into surface and ground waters and lowering the pH of the water.

Few fish can spawn — or survive — in water that is more acidic than pH 4.0. **Acid mine drainage often has a pH of 3.0, which will kill all aquatic life, and discharges from an abandoned gold-silver mine in California have been recorded at pH 0.6 — more acidic than battery acid, which has a pH of 1.0.**[7]

For an average of 10 miles downstream from its entry point, acid mine drainage affects the aquatic life of the receiving stream. As the acid drainage becomes diluted and neutralized, heavy metals that were dissolved in the acid drainage solidify and precipitate. The most visible manifestation of heavy metals precipitation is ***yellowboy*** — an orange-colored slime, composed primarily of iron hydroxides and sulfates, that is deposited along the banks of rivers and streams, sometimes for many miles. In the Arkansas River in Colorado, for instance, yellowboy has been found 150 miles downstream from California Gulch, the site of several abandoned mines.[8]



Nothing grows downslope from these old mine waste piles in Colorado. Trees that were cut when the mine was being worked would eventually have been replaced by new growth under ordinary circumstances, but heavy metals migrating through the soil have 'sterilized' it, making it too acidic to support vegetation.

Cause and effect

Except for a few highly publicized sites — mostly those that have been put on the Superfund National Priorities List by the Environmental Protection Agency — abandoned hardrock mines do not appear on any master map and are not part of any coordinated reclamation scheme.[9] **No government agency, federal or state, has a comprehensive plan to deal with abandoned hardrock mines.** Yet day in and day out, they pose an immediate threat to public safety and health — as well as a long-term threat to streams, lakes, rivers, and underground aquifers:

▸ ***Colorado:*** *A father and son were riding motorbikes cross-country when they suddenly plunged into an abandoned — and unmarked — mine; the son was killed. Just a few weeks later, in the same state, a two-year old boy fell 200 feet to his death in an unsealed mine shaft near his home in Central City.*[10] *Abandoned mines have been the cause of at least 22 fatalities in Colorado in recent years.*[11]

▸ ***Arizona:*** *A man walking at night alongside a highway near Tombstone fell into an unmarked mine shaft, plunging to his death. State mine inspectors believe there may be as many as 17,000 such unmarked sites in the state, but they say they usually learn of the locations only when someone gets hurt or killed in one — which happens, on average, half a dozen times a year.*[12]

▸ **Alaska:** *A preliminary field survey of abandoned underground mine sites in Chugach National Forest recreation areas popular with hikers found 200 sites where potentially lethal hazards include "abandoned explosives, rotten support timbers in adits, steep narrow and eroded access trails, partially caved and unstable adits, shafts concealed by vegetation, rotten ladders in stopes, winzes, and raises [types of excavations], slippery and/or rotten board crossings over a winze, heavy loose rock buildup on ceiling support timbers, poor mine ventilation, weathered and unstable equipment and structures . . ."* [13]

▸ **Arkansas:** *Long-abandoned bauxite mine pits have filled with acidic water. Because the acid has killed algae and all other aquatic life, the water is "a gorgeous sea-blue," according to a state ecologist, and the "blue holes" attract local kids who like to swim there. But because the walls are vertical and the bottom may be 200-300 feet down, the pits can be deadly: six people have drowned in them in recent years. The pits have also polluted at least 73 miles of streams.*[14]

▸ **National Parks:** *A preliminary inventory by the National Park Service has identified 1,936 abandoned mines in 120 parks, in every region of the country. Some 9,934 "associated hazards" have been catalogued, including unmarked mine openings, unidentified chemicals and other wastes, and contamination of streams and lakes used both by park visitors and by wildlife.*[15]

▸ **Arizona:** *A 45-unit mobile-home park near Globe, built on a backfilled site that contained untreated mine wastes, had to be evacuated — and was later condemned — after air samples were found to contain lethal levels of asbestos fibers.*[16]

▸ **Montana:** *Windblown particulates from old mine tailings piles in and around Butte deposited heavy metals on high-school baseball fields in such dangerous concentrations that the fields had to be excavated and the topsoil had to be replaced. The city's water treatment plant is built on old tailings deposits that contain dangerously high concentrations of copper, zinc, cadmium, arsenic, and lead. Sediments from mine tailings have contaminated more than 35 square miles of groundwater in the Butte area.*[17]

▸ **Idaho:** *Lead levels in Silver Valley soil downwind from the abandoned Bunker Hill silver mine — now a Superfund site — were found to be more than 30 times higher than maximum levels deemed "safe" by the Environmental Protection Agency. Virtually all of the 179 children living within a mile of the site were found to have potentially brain-impairing levels of lead in their blood.*[18]

▸ ***New Mexico:*** *After a molybdenum mine near Questa was inactivated when prices fell in the mid-1980s, tailings from the mine continued to contaminate the Red River (known locally as "Dead Red"), killing fish and destroying wildlife habitat, and also contaminated wells and* acequias *(water ditches) long relied upon by Taos County residents. Contaminated water also caused health problems among area high school students and affected agricultural production.*[19]

▸ ***Missouri:*** *A tailings pile abandoned by the St. Joe Minerals Corp. about 50 miles south of St. Louis became part of a state park after the company donated the land. The 130-foot-high pile functions as a dam, backing up 75 million tons of saturated mine waste. Worried about what might happen in an earthquake, the state hired an engineering firm to assess the dam's stability. The engineers found the dam structurally unstable; if it collapsed, mine wastes would flow "like fudge mix being poured into a pan" — through the park and toward the town of Flat River below. The state, legally liable if that were to happen, has embarked on a multi-million-dollar project to stabilize the dam.*[20]

Behind the town of Flat River, Missouri, stands a 130-foot-high hill that looks innocuous but isn't. The 'hill' is in fact a tailings pile, and behind it are 75 million tons of semi-liquid mine wastes that could engulf the town if the unstable pile collapses.

▸ ***Florida:*** *The aquifer that supplies drinking water to 90 percent of the state's population is being contaminated by heavy metals leaching from phosphate mine wastes. State officials have warned that groundwater may require decontamination treatment for 50 years.*[21]

▸ ***Wisconsin:*** *A 1980 survey of a nine-county area found 440 abandoned mines where uncontrolled erosion and sedimentation had*

affected water quality and plant growth. Elsewhere in the state, an abandoned lead-zinc mine has contaminated groundwater, forcing area residents to abandon wells or drill deeper for potable water.[22]

▸ ***Nevada:*** *Long-abandoned Comstock Lode gold and silver mines are still leaching heavy metals into the Carson River. Because the water now contains dangerously high levels of mercury, which can cause central nervous system disorders, area residents have been warned not to eat fish or waterfowl from the river.*[23]

▸ ***Vermont:*** *A mine that was closed in 1958 and left unreclaimed continues to leach contaminants into a tributary of the Ompompanoosuc River near Montpelier, acidifying the stream, degrading aquatic life and probably contributing to area groundwater contamination. After 35 years, vegetation has not yet taken hold at the orphaned mine site.*[24]

▸ ***Oklahoma:*** *Thousands of acres of land lie above an interconnected network of old mines that act as conduits, carrying surface water to groundwater. Passing through the mine workings, the surface water liberates heavy metals that contaminate the groundwater. Abandoned mines also "infringe upon wetlands areas and disturb their hydrologic balance," according to the Oklahoma Health Sciences Center.*[25]

▸ ***Oregon:*** *A long-abandoned uranium mine — which once supplied America's nuclear weapons industry — covers a 100-acre site in Fremont National Forest. On the site are piles of unprocessed, radioactive uranium ore and a 23-acre pond containing arsenic at levels 600 times those deemed "safe" by EPA. Contaminated water drains into a nearby creek and may be penetrating the aquifer that supplies drinking water to households in the area.*[26]

▸ ***California:*** *The Iron Mountain Mine, inactive since 1962, discharges 1,400 pounds of zinc, 400 pounds of copper, 4,800 pounds of iron and ten pounds of cadmium into Shasta County reservoirs every day.*[27] *(See photograph on page 12.)* *According to EPA, Iron Mountain discharges "one fourth of the entire national discharge of copper and zinc to surface waters from industrial and municipal sources."* [28] *The city of Redding had to temporarily discontinue using the Sacramento River for drinking water because of contamination levels.*[29]

▸ ***Tennessee:*** *The Copper Basin area in southeastern Tennessee may be the largest mining-and-milling-related disturbance in the United States. Since 1907, more than 50 square miles of land have been denuded of trees and vegetation. Today, nearly a century after the destruction began, much of the area is still devastated.*[30]

▸ ***North Carolina:*** *Erosion and sedimentation from abandoned mines has been cited by the Tennessee Valley Authority as a "critical" long-term threat to water quality in the western part of the state. Aquatic life has been destroyed along more than 100 miles of stream, TVA's Douglas Reservoir has been polluted, and TVA's Nolichucky Reservoir has been filled with silt, much of it from abandoned mines.*[31]

▸ ***Utah:*** *Sterile areas of barren rock cover countless hillsides where old underground mines once routinely dumped their waste downslope. Because the state has an arid climate and thin soils, damaged flora in these areas can take decades to recover. Some mine dumps are still barren a century after mining ceased, and old mines still release heavy metals into streams and groundwater. According to the Western Governors' Association, the Wasatch Front metropolitan area (Salt Lake City, Ogden, and Provo), which accounts for 70 percent of the state's population, is "directly exposed to one of the state's highest concentrations of abandoned mines."* [32] *This "exposure" primarily comes in the form of contaminated water sources and threats to the public's safety from open mine shafts and unstable waste piles.*

■

These grim stories — and there are *many* others — demonstrate that abandoned hardrock mines are creating major problems in all regions of the United States. Scope and severity vary considerably — clearly the major mining regions of the West have been most heavily impacted — but the threat is nationwide and requires a nationwide counterattack.

The tragic accidents caused by abandoned mines are bad enough, but they are eclipsed by the long-term environmental and public health problems that lie ahead — unless the problem is addressed now. What is needed is a sense of urgency. Groundwater contamination from mining is an especially complex and serious problem, for example, yet we still act as though groundwater is something we don't really need. But we do — and future generations will absolutely depend on it.

The U.S. cannot afford to deal with this problem haphazardly, delegating bits and pieces of responsibility for remediation and restoration to scores of federal, state, regional and local agencies. Yet that, paradoxically, is the only defense we have now. ■

Welcome to Summitville

If you are a United States taxpayer, you should be aware that on December 16, 1992, you acquired an interest in a defunct gold mine in the scenic San Juan Mountains of southwestern Colorado.

Here's how it happened:

In 1986 the Summitville Consolidated Mining Company began mining gold near the Continental Divide at the headwaters of the Alamosa River, which supplies water to farms and ranches on its way to the Rio Grande. Gold has been mined in the San Juan Mountains since 1750, according to local legend, but the Summitville mine created some new problems.

The company used cyanide heap leaching to recover gold from raw ore. The process usually involves building an impermeable lined pad on the ground, then dumping heaps of crushed ore on the pad and sprinkling them with a cyanide solution that leaches the gold from the ore. Although the heap leaching technique, which has been used for decades, can cause many problems, Colorado and other mining states still permit it.

In the case of the Summitville mine, the company claimed that it lacked sufficient level land for a pad; it sought and received permission to operate a valley-fill heap leach instead. That required damming a narrow valley to use as a containment vessel. As it happened, a creek ran through the valley. The company simply lined the heap with plastic and ran a drain under it. The company also built an unlined waste pile — without regulatory approval.

Major problems developed quickly:

• More water flowed into the leach heap than flowed out, creating the risk of overtopping the dam and producing a massive toxics spill.

• The unlined waste pile began generating acid runoff.

• Cyanide began leaking through the plastic liner into the creek, and from there into groundwater.

The company tried trapping the leakage and pumping it back into the 45-acre leach heap, but the water level rose and threatened to overtop the dam. The state considered closing the mine but feared getting stuck with an emergency cleanup, for which no state funds were available, so it opted to continue negotiating with the company instead. In return for posting a $7.2-million performance bond and building a water treatment plant, the company was allowed to keep operating.

Treating the water helped, but not enough. Acid-laced runoff eradicated aquatic life along 17 miles of the Alamosa. The state imposed wrist-slap fines totaling about $130,000 (the gold extracted from the mine since 1986 has been valued at more than $130 million), and the company promised to do better.

Last year the company and the state signed an agreement: the company agreed to begin reclaiming the site, and the state agreed to return some $2.5 million of the company's performance bond, to help finance the work. The state turned over the money — but the company just turned over: it filed for bankruptcy on December 3.

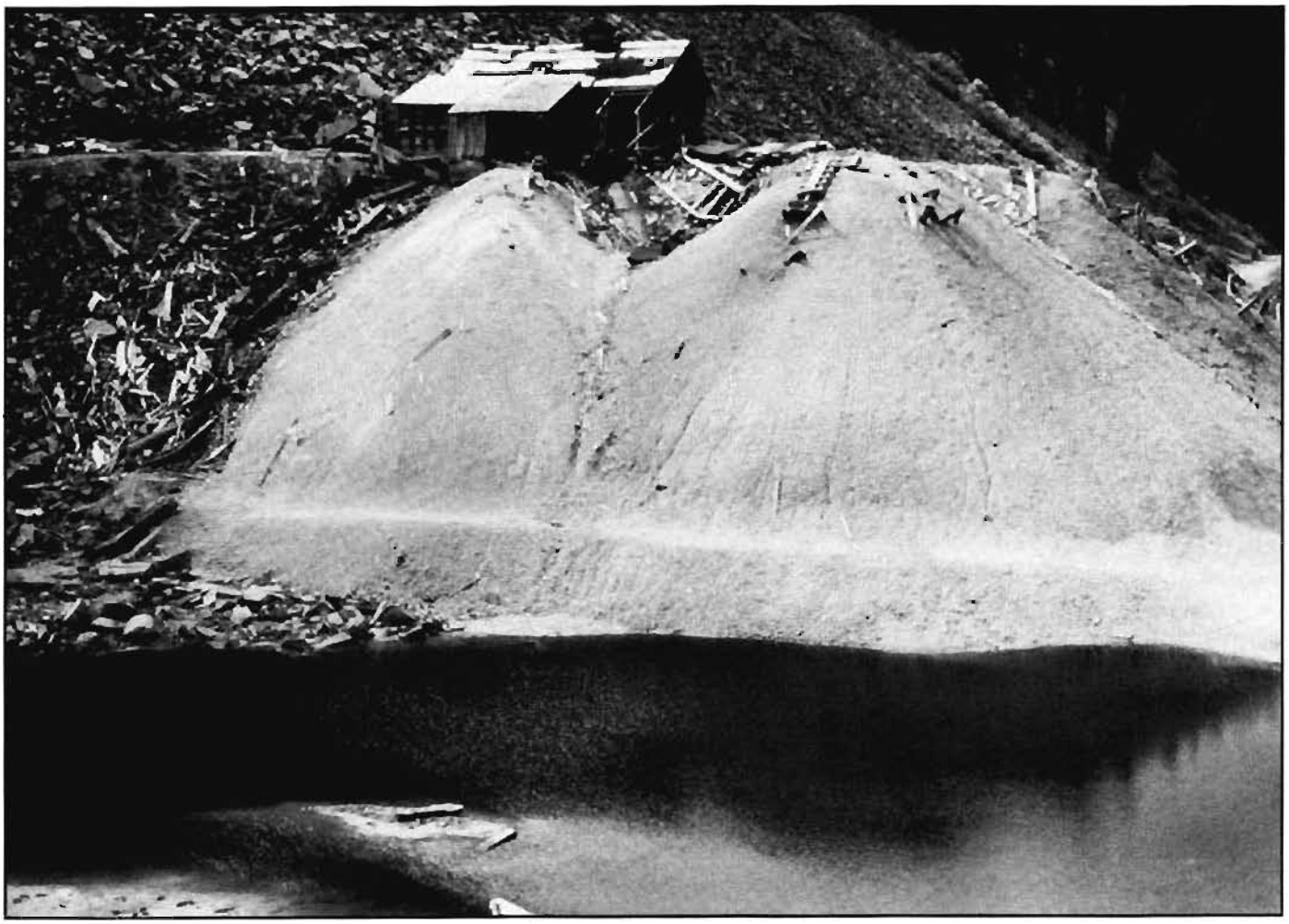
Summitville's parent company is Galactic Resources Ltd. of Canada. When the state asked Galactic to make good on Summitville's commitments, Galactic filed for bankruptcy too. That left Colorado holding the remaining $4.7 million of Summitville's performance bond — and facing a $60-million cleanup job.

Aerial view of a cancerous sore. High in the San Juan Mountains of Colorado, near the Continental Divide, the Summitville Mine sprawls across a valley, leaking contaminants into watersheds that feed the Alamosa River.

Overwhelmed, the state called in the Environmental Protection Agency. EPA took over the site on December 16. Since then, simply containing some 170 million gallons of cyanide soup has been costing about $38,000 a day — roughly $25 a minute.[33]

Welcome to Summitville, the mine that all of us as taxpayers now own.

The moral seems clear enough: U.S. environmental laws have not yet made it more costly for the mining industry to abandon mines than to reclaim them. Until mine owners are forced to internalize reclamation costs as part of their normal operating expenses, we'll continue to find ourselves involuntarily acquiring properties that somebody else exploited for their wealth and then left for us to clean up.■



Where mine wastes meet water, as at this site in Colorado, severe pollution is the result. Although scenes like this are commonplace in hardrock mining regions, abandoned mines have never been systematically surveyed nationwide.

2 Calculating the Scope and Cost of a Hardrock Abandoned Mines Reclamation Program

Despite abundant evidence that the problem is out of control, no agency has assessed the extent of damage.

The United States has no such thing as a uniform mining code. Instead the American mining industry runs along two tracks: one for coal mining, the other for hardrock mining.

The coal industry — after finally exhausting the public's willingness to accept mine disasters, black lung disease, and devastated terrain as a normal cost of doing business — operates today under relatively stringent laws and regulations, including a national program to clean up abandoned coal mines.[1] The hardrock mining industry, however, has been strikingly successful at escaping such regulation.

As a result, no federal mining or environmental law requires the industry to take responsibility for its abandoned mines. That means, paradoxically, that no one knows precisely how widespread the problem is or what it will cost to clean up — because no agency has conducted a comprehensive nationwide inventory of abandoned hardrock mines.

State surveys: scattered, incomplete

In rare cases, states have conducted exhaustive on-the-ground surveys of abandoned mine sites within their own borders. In 1989, for example, Montana completed a ten-year statewide study of abandoned mines on both public and private lands that identified more than 20,000 sites covering more than 150,000 acres. Surveyors found more than 1,300 miles of streams experiencing pollution from abandoned mines — noting that "no major river drainage in the state has escaped the impacts of hardrock mining" — and estimated that remediation measures would cost roughly $912 million, or an average of about $45,000 per site.[2]

Similarly, Wyoming's Department of Environmental Quality has completed a statewide inventory of hardrock mine sites and has

reclaimed 369 sites covering 15,000 acres at an estimated total cost of $82 million, for an average of about $222,000 per site.[3]

Most other mining states are at a much more preliminary stage of gathering and analyzing data on abandoned mining lands. California, for example, delegates responsibility for mine reclamation oversight to approximately 110 county and local governments under the state's Surface Mining and Reclamation Act and lacks a central coordinating mechanism.[4] The State Water Quality Control Board has estimated that there are at least 2,484 abandoned mine sites in the state that are polluting 578 miles of stream — but that estimate relies in part on a planning study that was done 21 years ago.[5]

California has no systematic program to remediate abandoned mine hazards, nor even to collect data on them. In 1988, when engineers from the University of California attempted to use available state government data to compile a master database of abandoned mine sites — at the request of the state legislature — they were unable to do so.[6] The engineers found that there were simply too many gaps and inconsistencies in the data.

In 1990 the Western Governors' Association ran into similar difficulty when it sought to undertake a nationwide "scoping study" of inactive and abandoned noncoal mines. Data from 32 states on the scope and cost of their abandoned mines were assembled and analyzed. A year later, however, WGA was able to report only that while the problem was "substantial" and the costs of remediation "significant," it could not attempt a comprehensive nationwide tally of sites or of the miles of streams affected, because of "wide variability among the states in the quality and quantity of information . . . ranging from states with on-the-ground inventories to states with little data beyond that found in national mining information databases." [7] (A follow-up report on the remaining 18 states noted the general inadequacy of available data and reported that in some states "there was reluctance on the part of state agency personnel to discuss inadequate reclamation laws or to define known [abandoned mine] problems.")[8]

When the Western Governors' Association tried to assess the extent of the abandoned mines problem nationwide, researchers found themselves struggling with 'wide variability' in the data — and some state officials didn't even want to talk about it.

Despite the absence of a consistent methodology, however, the WGA report does include state-by-state summaries (some of them fairly detailed), and, as such, it offers the most comprehensive overview of the problem currently available. Even allowing for wide variations in data collection procedures (i.e., some states count each abandoned mine opening as a separate site, while others aggregate many openings related to a single mine as a single site even though they are widely separated;

some states count disturbed acres rather than sites), the WGA survey makes the general scope of the problem abundantly clear.[9]

Federal studies: glimpses of the problem

At the federal level, there is no single study that can be used as a reliable guide to abandoned mine hazards nationwide. There are, of course, reports on the 52 hardrock mine sites that have been placed on the Superfund National Priorities List by the Environmental Protection Agency, but these studies provide limited insight regarding the scope of the problem as a whole, since most abandoned hardrock mine sites are not Superfund-scale — fortunately.

In 1988 the U.S. General Accounting Office (GAO) attempted to assess abandoned hardrock mine hazards, but only on federal lands, and GAO made no attempt to compile data on off-site damage (e.g., to streams not exclusively on federal land) or damage to public lands caused by mines on private land. Seeking to determine "the extent of unreclaimed federal land resulting from hardrock mining operations conducted under the Mining Law of 1872" and to estimate the cost of reclaiming such land, GAO concluded that 424,049 acres of federal lands have been abandoned and that reclamation would cost $284 million.[10]

GAO acknowledged that its efforts were inadequate, even allowing for the limitations of the study. "Our estimates may understate the full extent of unreclaimed federal land," the report noted, because "they did not include all states where hardrock mining occurs" and because "the only available database included only mining claims active since October 1976." [11] (Beginning in 1976, all mining claims on federal land were registered for the first time with the Bureau of Land Management.) Claims only active since 1976 would, of course, be hardly representative of the tens of thousands of mines developed and abandoned over the previous century-plus. By the same token, GAO's cleanup cost estimates focused on superficial landscape reclamation only and did not take into account the usually much greater costs of off-site cleanups such as stream restoration and groundwater decontamination. And GAO's totals did not factor in Superfund sites, each of which can cost hundreds of millions to clean up. In short, GAO's report gave Congress a very limited overview of the abandoned mines problem.

In March 1992 the Inspector General (IG) of the Department of the Interior issued an audit report on the Bureau of Land Management's oversight of abandoned hardrock mining sites on public lands. The highly critical report found that BLM had not "identified, prioritized, and scheduled needed reclamation of abandoned hardrock mining sites,"

and "had neither controlled access to hazardous sites nor taken precautionary steps to warn the general public of the dangers." [12]

In a September 1991 report, the IG estimated the cost of reclaiming the known universe of abandoned noncoal mines at $11 billion.[13] It is generally believed that the IG's figure seriously underestimates the total cost of reclamation nationwide. That conclusion is reinforced by the fact that for the March 1992 report the IG's auditors limited themselves to assessing readily apparent hazards (e.g., "drums with unidentified contents") and attempted no assessment of the generally much greater costs of remediating offsite effects such as groundwater contamination.

Mineral Policy Center's methodology

In the absence of a comprehensive nationwide site-by-site survey of abandoned mines, any effort to anticipate the probable scope and cost of a new national Hardrock Abandoned Mines Reclamation (HAMR) program must necessarily rely primarily on the reports summarized above, and must accordingly allow ample room for error. Mineral Policy Center's cost estimates, therefore, cover a low-to-high range, in an effort to offer as clear a picture as possible of the severity and cost of the HAMR problem nationwide.

The starting point for MPC's analysis was the 1991 Western Governors' Association scoping study, discussed above. MPC next turned to state agencies with jurisdiction over abandoned hardrock mines; they provided copies of published reports, memoranda, and correspondence, and these were augmented by lengthy phone interviews. MPC also conferred with numerous consultants and private contractors familiar with both coal and noncoal abandoned mine reclamation programs. The Environmental Protection Agency provided data on Superfund sites.

Critical to the design of a national HAMR program is the need to develop a basis for determining program priorities and cleanup methods. While HAMR sites will usually require several different kinds of cleanup, sites can be classified by the type of cleanup *predominantly* needed, making it easier to calculate cleanup methods and costs.

Mineral Policy Center has estimated the scope and cost of the nation's abandoned mine lands problem based on six site classifications: ❶ Benign; ❷ Landscape Disturbance; ❸ Safety Hazard; ❹ Surface Water Contamination; ❺ Groundwater Contamination; ❻ Superfund. To estimate the cost of reclaiming the nation's inventory of abandoned mines, MPC used average cost figures from those states which have ongoing mine reclamation programs.

❶ Benign:

Benign sites are those originally recorded as causing some form of landscape disturbance of a minor variety, and which are believed to pose no safety hazards or threats to water quality.

Scope: MPC estimates that there are approximately 194,500 benign sites. Most states exclude such sites from their databases, since reclaiming them is a low priority. However, Nevada and a number of non-Western states do include benign sites. For such states, half the total number of sites was assumed to be benign.

Cost: Assuming little if any near-term reclamation of benign sites, MPC assigned no cost to this category.

❷ Landscape disturbance:

These are sites which primarily cause mild environmental degradation or a significant aesthetic problem, or which may deteriorate and create safety hazards or threats to air and water quality. Landscape disturbances may include steep waste piles, poorly vegetated or severely eroded areas, or unreclaimed borrow piles.

Scope: MPC estimates that approximately 231,900 sites fall within this category. This estimate is derived from actual field inventories by each state or by the U.S. Soil Conservation Service, minus sites assigned to Categories 1, 3, 4, and 5.

Cost: MPC estimates an average reclamation cost of $4,400 per site. This estimate is derived from averaging actual cost figures reported by Arizona, Colorado, and Utah for sites of this type.

❸ Safety hazard:

These sites pose a potential threat to public safety, typically from falls or cave-ins. Shafts, adits, collapsed mine workings and sheer highwalls are common safety hazards.

Scope: MPC estimates that approximately 116,300 sites pose safety hazards. Eight states reported actual figures; MPC's estimate for the remainder is derived from averaging figures reported by Arizona, Idaho, Nevada, and New Mexico.

Cost: MPC estimates an average reclamation cost of $19,500 per site, based on averaging actual cost figures reported by Colorado and Utah.

❹ Surface Water Contamination:

These sites degrade surface water by discharging acids or heavy metals at levels that threaten aquatic life or drinking water quality.

Scope: MPC estimates that approximately 14,400 sites are currently contaminating surface waters nationwide. Six states reported actual figures; MPC's estimate for the remainder is derived from averaging figures reported by Arizona, Colorado, and New Mexico.

❹ Surface Water Contamination *continued*

Cost: Mineral Policy Center estimates that the cost to remediate sites causing surface water contamination will be in the range of $1 million to $3 million per site. Aggregate cost figures were unavailable in any state. This estimate was therefore derived by averaging actual or projected costs to reclaim seven representative sites in three states: California, Colorado, and Wyoming.

❺ Groundwater Contamination:

These sites contaminate groundwater directly, by leaching water that contains acids or heavy metals into aquifers and other groundwater sources, or indirectly, by discharging contaminated water into surface waters that feed groundwater.

Scope: Mineral Policy Center estimates that approximately 500 sites are currently causing some form of groundwater contamination. This estimate is based on MPC's studies of sites around the U.S. and our knowledge of specific sites. No state has fully surveyed the scope and characteristics of groundwater contamination problems caused by abandoned hardrock mines.

Cost: MPC estimates that the cost to remediate sites causing groundwater contamination will fall in the general range of $7.5 million to $12.5 million per site. This estimate is based on MPC's knowledge of specific sites and EPA's reports of costs associated with remediation and decontamination of groundwater at Superfund sites.

❻ Superfund:

Superfund sites are those abandoned hardrock mine sites that the Environmental Protection Agency has placed on the National Priorities List of the Superfund hazardous waste cleanup program as authorized by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and subsequent amendments.

Scope: EPA has 52 mine sites on the National Priorities List as of June 1993.

Cost: MPC estimates that the cost to reclaim sites on the NPL will fall in the general range of $250 million to $350 million per site. Based on an in-depth study of sites currently on the National Priorities List, EPA has concluded that reclamation will cost a minimum of $15 billion; MPC's estimated cost per site was derived by dividing the total cost by the reported number of sites.

Estimated Scope and Cost of a National Hardrock Abandoned Mines Reclamation (HAMR) Program

CATEGORY	NUMBER OF SITES	AVERAGE COST PER SITE ($ thousands)	TOTAL COST ($ thousands)
❶	194,500	—	—
❷	231,900	$ 4.4	$1,000,000
❸	116,300	$19.5	$2,300,000
❹	14,400	$1,000 ↔ $3,000	$14,400,000 ↔ $43,200,000
❺	500	$5,000 ↔ $15,000	$2,500,000 ↔ $7,500,000
❻	50	$250,000 ↔ $350,000	$12,500,000 ↔ $17,500,000
TOTALS:	557,650	↔ = Range of estimate	$32,700,000 ↔ $ 71,500,000

CATEGORY:

❶ Benign
typically needs little if any further remediation

❷ Landscape Disturbance
needs landscaping/revegetation to prevent offsite effects

❸ Safety Hazard
needs prompt but not necessarily extensive action

❹ Surface Water Contamination
may require extensive contamination-prevention work

❺ Groundwater Contamination
requires complex contamination-prevention work

❻ Superfund
severe public health threats, complex cleanup.

Note that of the estimated 557,650 HAMR sites, nearly 35 percent (Category 1 sites) represent little if any cost, and another 60 percent (Category 2 and 3 sites) can be reclaimed at reasonable per-site costs. However, because nearly 15,000 sites require extensive treatment, the total cost of a nationwide HAMR program could exceed $71 billion. ■

More Holes than Net: Federal and State Mining Laws

In discussing the scope and cost of a HAMR program it is important to recognize that the program will be effective *only* if accompanied by a set of national minimum environmental protection regulations, applicable to current and future hardrock mines, in order to prevent the creation of a new generation of HAMR sites. No such standards exist today. Unlike the coal industry, which is regulated by federal agencies with broad responsibility for health, safety, and environmental protection (and which pays into a national fund to clean up abandoned coal mines), the hardrock industry operates in a world where federal and state laws (1) provide little or no protection against continuing environmental damage, (2) require no national program to clean up the damage that has already been done, and (3) do not even require that the damage be inventoried.

"State environmental and reclamation regulations which can address [abandoned mine] problems are generally nonexistent," the Interstate Mining Compact Commission has found. "Most states . . . had no legal mechanism to reclaim abandoned noncoal mines and few had ever done so." [14]

In point of fact only a few laws (other than occupational safety and health laws) address hardrock mining in any capacity:

Surface Mining Act

The federal Surface Mining Control and Reclamation Act of 1977 (SMCRA) does not regulate hardrock mining; it does regulate coal mining, giving the Department of the Interior authority to require that coal mining practices be environmentally sound and that mined lands be reclaimed to full pre-mining productivity and surface contour. SMCRA also established (under Interior) an Abandoned Mine Lands (AML) program to clean up pre-enactment abandoned coal mines. The AML program is funded by a production fee on all coal mined on federal, state, tribal and private lands.

Under special, narrow circumstances, the AML fund may be used to reclaim noncoal sites, but only if a state has already completed all required coal reclamation projects (or if a state governor declares that a noncoal site poses a significant, immediate threat to public health and safety). Only Wyoming and Montana have qualified for AML funds by completing their coal reclamation work. Of the more than $3.2 billion collected under SMCRA for AML reclamation since 1970, only about $140 million has been spent on noncoal sites (of which more than $120 million was spent in Wyoming). Because the backlog of unreclaimed coal mines nationwide is still extensive, and because the coal AML program is severely underfunded, it cannot be expected to cover the costs of reclaiming more than a very small number of abandoned hardrock sites.

Superfund

The federal Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) created the Superfund program, which provides

for identification and cleanup of hazardous sites nationwide. Although active and abandoned mines have been ruled eligible for Superfund coverage, only 52 hazardous hardrock mining sites have been placed on the National Priorities List (NPL) by the Environmental Protection Agency. Superfund is vitally important as a way to address extremely severe problems at limited numbers of mining sites, but it cannot be expected to serve as a vehicle to address abandoned mines in general. For one thing, EPA normally places sites on the NPL only if they pose an imminent hazard to public health in heavily populated areas. While many mine sites might meet this test, most would not. For example, a mine leaching toxics into an aquifer that is not *currently* used as a source of drinking water would not qualify for the NPL, no matter how important the aquifer might someday be as a resource. This may seem inexplicable, but given the urgency of focusing on the most immediate threats posed by hazardous waste sites of many kinds, Superfund cannot also be expected to deal with the overall problem of abandoned mines. It should continue doing what it does best: (1) Provide a way for EPA to respond, on an emergency basis, to situations posing imminent threats to public health; (2) Deter — with the threat of long-term liability — companies from walking away from environmental disasters-in-the-making.

Other Federal Environmental Protection Laws

Several other major federal environmental laws — including the Resource Conservation and Recovery Act, Clean Water Act, Toxic Substances Control Act, and Federal Land Policy and Management Act — either narrowly touch on various problems caused by current mining or have the potential for doing so. However, none addresses the overriding need to reclaim and restore mine sites in order to eliminate the *source* of such problems.

1872 Mining Law

The 1872 Mining Law, which applies to hardrock mining on federal lands, is notable for what it does *not* contain: any environmental protection provisions, any authority for federal land managers to deny permits for poorly conceived mining plans, any cleanup program for abandoned mines. On the contrary, this 121-year-old law conveys "the exclusive right of possession and enjoyment" to anyone who finds minerals on public lands (which account for nearly a third of the nation's total land area). Far from providing a model of land stewardship and environment-consciousness, the 1872 Mining Law invites irresponsible exploitation.

State Laws and Regulations

Most mining states have laws that theoretically govern active hardrock mining. By and large, however, state environmental standards concerning the operation and reclamation of active operations are weak and inconsistent.[15] As a result, state regulators often fail to prevent today's mining operations from becoming tomorrow's abandoned mines. Moreover, the states lack adequately funded programs to reclaim existing hardrock abandoned mines. While some states have some capability to respond to public safety emergencies created by hardrock abandoned mines, this does not in any way substitute for statewide programs to eliminate all such hazards by cleaning up abandoned mines in general. ■

Closing a hole in the ground (as shown here at an abandoned mine on National Park Service-administered lands in New Mexico) can yield multiple benefits. Reclamation protects hikers against accidental injury or death and, by cutting off air and water from the old mine workings, halts the oxidation and migration of toxic heavy metals, protecting valuable groundwater resources against contamination.

3 *HAMR* in Action

Reclamation techniques will vary from site to site, but the basic goals should be the same everywhere.

An abandoned mine can be an intimidating sight. A gaping hole in the ground, a mammoth waste-rock pile, bright orange water pouring from a poisoned spring — all may seem daunting, even uncontrollable. Nevertheless the fact is that we have the know-how to reclaim these mines. For decades, mine reclamation specialists have been developing new approaches and innovative technologies to safeguard abandoned mine sites and reclaim existing mines. Successful reclamation projects have been undertaken in every part of the United States, from small placer mines in the Alaskan tundra to vast phosphate mines along the Florida coast; now we need many more of them.

Reclamation criteria

The HAMR sites highlighted in this report can all be reclaimed. But it is important to be clear about what constitutes 'reclamation.' Mineral Policy Center believes that reclamation projects at abandoned hardrock mines should, at the very least, accomplish four goals:

1. ***Remove the threat to public safety;***
2. ***Stabilize the site and halt environmental degradation, or avert potential degradation;***
3. ***Remove, treat or isolate migration of sources of toxic pollution to the land, air, surface and groundwater;***
4. ***Perform reclamation methods and activities that return the site to a land use as productive as before the commencement of mining.***

Many sites can be restored to approximate pre-mining condition at relatively little cost. At others, however, complete reclamation will be both difficult and expensive. This chapter describes both the methods and the overarching goals for reclaiming HAMR sites. The sites are divided into the six categories used throughout this report, ranked by

degree of concern: landscape disturbance, safety hazard, surface-water contamination, groundwater contamination, and Superfund.

❶ Benign

(Sites in this category are not discussed, since by definition they do not pose significant hazards to safety and health or to the environment.)

❷ Landscape Disturbance

Landscape disturbance sites are those which cause mild environmental degradation and/or a significant aesthetic problem or which may at some future point cause safety hazards or threats to water quality. The disturbance may include poorly vegetated or excessively eroded areas, steep waste piles, and abandoned mining equipment and buildings or other debris left on-site.

The reclamation goal for these sites should be to stabilize the site and re-establish the land's long-term productivity. The site should be regraded and revegetated to the extent possible, and safeguarded against erosion and other common problems. The site should be restored as much as possible to a contour that resembles surrounding terrain.

Many abandoned mine sites are noticeable by the various buildings and other debris left behind by the operator. Structures may include mills, machine shops, storage sheds, and water tanks, among others. The Bureau of Land Management notes that many structures may present "environmental liability or problems." These include: "fuel tanks, chemical drilling additive and explosive storage areas, shop and service areas, openings to underground workings, unused machinery, septic systems, cement pads and building foundations, and transformers which may contain PCBs." [1] To this extensive list can be added the asbestos-covered pipes and boilers often found in old buildings. To begin reclamation, contractors must dismantle these structures and transport them to safe disposal areas.

As noted in Part 1, mine operators must extract many tons of rock to obtain relatively small quantities of minerals, and historically they simply dumped the waste rock in large piles and left it there. As a result, old waste-rock piles are commonly found at HAMR sites. Fortunately, even waste rock has its uses in reclamation, such as backfilling large holes in the ground that may present safety hazards. Shafts, subsidence holes, pits and quarries can all be backfilled with waste rock and thereby safeguarded.

For most abandoned mine sites, the end goal is to stabilize the site and achieve sustainable revegetation, returning the site to a natural state.

This is a multi-step process. First, the contractor uses bulldozers or other earth-moving machinery to regrade steep slopes to a flatter angle that is resistant to erosion and capable of supporting vegetation. In addition, the slope should blend in with the surrounding terrain so as not to create an obvious eyesore.

Successful reclamation projects should be required to maintain control of storm-water runoff and ensure good water drainage on the site. Rainwater which fails to drain into the soil is likely to erode slopes, wash away vegetation, and even pick up toxic metals that may then contaminate surface streams. Regrading, resoiling and revegetating are probably the most important contributions to good water-drainage on the site. A contractor may also construct a "rock core drain" — a vertical column of rocks embedded in a slope to intercept water flow and direct it into the soil. If soil is already eroding from a slope, the contractor repairs the damage and constructs diversion ditches, sediment traps or settling ponds within the drainage area to capture sediment.

Regrading + resoiling + reseeding = recovery for many thousands of mine sites where landscape disturbance is the principal problem. Properly done, reclamation projects control water runoff, halt erosion, and re-blend sites with surrounding terrain.

Achieving sustainable vegetation is a challenge on abandoned mine sites. While today's mine operators are usually required to stockpile topsoil for eventual reclamation, no such practice was observed by the operators who abandoned their mines for others to reclaim. The contractor therefore must usually bring topsoil or some other alluvial fill material from elsewhere. The ground is sometimes then "ripped" — loosened — for about two to three feet below the surface. Ripping enhances water drainage into the slope and improves the chances of

revegetation. The ground may also be treated with chemical fertilizers or organic mulches to prepare for revegetation.

The contractor should next spread seeds on the site's regraded and resoiled areas so that vegetation will grow. Revegetation is utterly critical in most cases as a defense against soil erosion and weed invasion. It is important that close attention be paid to the mixture of plant species. The contractor should seed plants that are native to the area, or at least come from a similar climate and soil type. Cheap and low-maintenance species of grass are popular among contractors, but should not be the only vegetation used. To encourage biodiversity and enhance the site's post-mining value, the contractor should also plant tree and shrubbery species, preferably by hand.

Part of returning a site to productive use is encouraging wildlife to re-inhabit the area. Reclamation personnel grow vegetation similar to that in the surrounding terrain, and then design habitats suitable for wildlife specific to the area. Contractors have built nesting areas for birds, small rockpiles for rodent dens, and wetlands for a variety of species.

Cleaning up a site with landscape disturbance problems is generally a straightforward construction project. Clusters of sites can often be combined into a single project, facilitating cost-effective reclamation by a single contractor. Compared to sites with safety or water contamination hazards, landscape disturbance sites are relatively simple and inexpensive to handle, and complete reclamation should be possible.

❸ *Safety Hazard*

Many old mine sites pose a threat to public safety, and some have caused fatal injuries. Safety hazards most often take the form of openings in the ground, such as vertical shafts, horizontal adits, open pits or "glory holes." (The term, originally used to describe funnel-shaped mine excavations connected to underground haulage levels, is also used to describe the large depressions that open up at the surface when old underground mining areas collapse. These depressions may not be immediately dangerous, but property damage can occur and unsuspecting passersby may fall into the hole and sustain injuries.)

In addition, tailings dams and waste-heap slopes sometimes collapse, causing landslides that endanger lives and destroy property. Seismic shifts and heavy rains are the most frequent causes of landslides. A frightening example of this kind of threat can be found in Missouri's historic lead-mining belt. On the site of St. Joe State Park, named for the mining company that donated the land to the state, lie 75 million tons of processed lead tailings. In 1992 engineers found that the waste-

pile dam holding the tailings in place was structurally unsound.[2] The state park is only 80 miles away from a major earthquake fault, and seismologists have calculated that if the dam were to fail, the town of Flat River — about a mile below — could be buried under lead slurry.[3] *(See photograph, page 19.)* The Environmental Protection Agency has recently added the site to the Superfund National Priorities List.

Sites that pose a safety hazard must be reclaimed so as to remove any danger to the public. Less expensive stopgap solutions, such as fencing off a HAMR site, should be avoided, since they fail to provide long-term site management; in the absence of constant supervision, in fact, inadequate safeguards may lead to a recurrence of the original hazard.

Following is a brief description of various methods that are used to permanently resolve safety hazards. Most of these methods have been

Death trap: On a bright sunlit day this old mine opening on a Utah mountainside may appear highly visible, but pity the poor hiker who approaches at, say, sunset — semi-blinded by facing the setting sun and unaware that what's over the next rise isn't a long shadow but a deep hole. Sites such as this can be fenced off, but that's a temporary solution at best. Proper reclamation is required.

put into practice in Montana, Missouri, and Texas, among other states. Valuable lessons have also been learned from reclamation of coal mines in such states as Kentucky, Pennsylvania, and Wyoming.

Mine openings can be most cheaply safeguarded by backfilling with dirt and rocks or blasting them shut with explosives. Backfilling adits with hand-placed stones is labor-intensive but can actually prove more cost-effective than heavy machinery.[4] Some pits can be too large to be entirely backfilled; partial backfilling, followed by regrading to a gentle slope angle, may be an effective solution. Pits are sometimes backfilled with rock from an adjacent waste pile. Glory holes are also typically dealt with by backfilling, or at least by regrading and revegetating.

Highwalls, large open pits and waste piles have caused numerous falling accidents, many resulting in severe injury or death. Steep and unstable slopes should be regraded if possible to an angle that removes the danger to people who encounter them. The threat of landslides can be countered in this way, or by stabilizing the structure itself. Often, concrete retaining walls and other earth-stabilizing structures are constructed to abate the threat of continued landslides.

Contractors frequently safeguard mine openings with some variety of plug. Numerous designs and materials are currently used, sometimes within the same mine reclamation project. The contractor can fill the mine opening with concrete, spray a polyurethane foam over the opening, bolt a steel panel over the opening, or install a complex hollow core plug. Depending on the kind of plug, costs can run from less than $1,000 apiece to more than $8,000.

A wildlife survey should be carried out before backfilling or plugging mine openings. Often wildlife, particularly bats, nest in abandoned mine tunnels. Protection of wildlife habitat and public safety can be reconciled by installing grates with crossbars set wide enough to prevent human entry without impeding animal traffic *(photo, opposite page)*. Separate entrances and exits can also be constructed for wildlife use.

Abating safety hazards, while still within the realm of ordinary construction techniques, requires expertise to ensure that the site remains non-hazardous over time. Most such sites also suffer from landscape disturbance, and must therefore be regraded and revegetated. State agencies have learned much about controlling safety hazards from responding to emergency situations at various sites. The demand for these "emergency response" programs also serves to demonstrate the need to eliminate such emergencies by reclaiming abandoned mine sites.

This abandoned mine opening was a safety hazard to humans but made a fine home for bats. Solution? Instead of sealing the portal, the National Park Service installed a heavy-duty grate-and-gate combination that allows the bats free range while keeping people (except for wildlife scientists) at bay.

❹ Surface Water Contamination

Mine sites which discharge high concentrations of acids and/or heavy metals are a serious source of water contamination. Drainage of acid-laden water, commonly called "acid mine drainage" (see Part 1), occurs when sulfide rock is exposed to two substances: oxygen and water. Oxygen and water react with sulfur to create sulfuric acid, and the acidified water becomes a breeding ground for a naturally occurring bacterium, *thiobacillus ferrooxidans*, which dramatically speeds up the acid-forming reaction. Acid drainage often appears as myriad tiny and all-but-untraceable point sources.

Another mining-related water problem is the leaching of heavy metals into surface streams. This is perhaps the most deadly form of water contamination. Metals such as cadmium, copper, lead, zinc and mercury, liberated from their host rock by moisture — with the liberating reaction accelerating as acidity increases — can kill all the fish in a stream, poison community water supplies, and create severe health hazards that may not manifest themselves for years.

The goal of reclamation for sites suffering from acid or metal contamination is to eliminate the sources of contamination, or at least to prevent their spread. In approaching these problems, a contractor generally attempts to isolate the sulfide rock from oxygen or water, or both, so as to halt the acid mine drainage. At some sites, where water

contamination simply cannot be halted, the contractor must treat contaminated water as it is discharged from the site.

There are three common sources of water contamination: ***waste-rock piles,*** where the operator dumped rock which must be cleared away to reach the ore; ***tailings impoundments,*** where the ore that has been ground up and stripped of precious metals is deposited; and the underground tunnels — the ***workings*** — through which miners extracted and removed the ore.

When halting water contamination at surface structures such as waste-rock piles and tailings impoundments, a contractor usually attempts to divert streams away from the site, move the contaminated rock itself, or "cap" the structure to keep out water and air. Streams can be redirected away from the mine site by constructing diversion ditches, and dikes can be built around the perimeters of rock piles or tailings impoundments to prevent water intrusion.

The contractor may load contaminated rock or tailings into dump trucks, haul it away from the water source, cover it with topsoil and perhaps a layer of acid-destroying limestone, and revegetate. Hauling millions of cubic yards from one place to another is, of course, expensive. If the mine is of the open-pit variety, the contractor may be able to push the rock into the pit, cap it with soil and revegetate.

Surface water contamination can sometimes be halted by capping mine wastes — burying them under impermeable materials so that they are no longer exposed to the action of air and water.

One of the most successful reclamation techniques is ***capping*** — burying the source of contamination, such as old tailings or waste piles, under layers of various materials to keep out air and water. When contamination ceases, continual maintenance should not be necessary. Caps can be composed of rock, clay, soil, or synthetics, or various combinations of materials.

Capping a waste-rock or tailings pile can also abate another environmental and public safety problem created by abandoned mine sites: blowing dust. This is especially hazardous with piles composed of mill tailings and smelter slag byproducts, since such piles consist of very fine particles containing high concentrations of toxic heavy metals.

Surface structures such as waste-rock piles and tailings impoundments at least have the advantage of being out in the open. In most cases, capping and revegetating will halt much or all of the discharge by isolating the rock from water and oxygen. Underground mine workings, where there is nothing to cap and nothing to revegetate, require a different arsenal of reclamation techniques.

The most common technique for stopping acid mine drainage from underground workings is to install a ***waterproof seal*** at the opening. The seal has two functions: first, to prevent water acidified in the tunnels from leaking out of the opening and into a stream; second, to bottle up the tunnels until groundwater rises and floods the mine workings. It may seem paradoxical to combat acid mine drainage by adding large quantities of water. However, flooding can shut off the flow of oxygen; deprived of oxygen, the rock stops creating acid.

Seals can also be constructed with ***relief valves*** that allow excess water to be drained off during high-water seasons, thus avoiding some of the risks inherent in the sealing process. One of the engineering profession's oldest maxims is that "water will have its way." Water flowing through underground tunnels has to go somewhere; in the absence of relief valves or some similar mechanism, contaminated water may simply find another outlet, such as groundwater or a surface spring.[5] Water pressure might also cause seepage through fractures in the rock around the seal or even buckle the seal itself. Seals with relief valves are an innovative way to relieve water pressure, thereby avoiding seal failure and equalizing water flow.

If water contamination — from whatever source — cannot be halted, the water itself must be treated and detoxified. One fairly inexpensive form of treatment is to create an ***artificial wetland.*** The contractor constructs a marsh, where bacteria thrive and multiply. The acidified water is then run through the marsh, allowing heavy metals to bond with bacteria and certain vegetation (such as cattails) which absorb metals. The water emerges metal-free on the other side of the wetland.

If water contamination cannot be halted, the water itself must be treated and detoxified. One innovative and relatively inexpensive way to do that is to construct an artificial wetland.

The chief problem with artificial wetlands is climate. Originally devised for coal mines in areas with abundant rainfall, artificial wetlands in even moderately arid parts of the West have a tendency to dry up and fail.

When wetlands treatment is not effective, the only remaining solution is ***continuous treatment.*** The contractor pumps the contaminated water into a treatment plant, where it is neutralized with lime, limestone or some other alkaline substance. Further treatment to remove metals or other toxic substances may be necessary before releasing water back into the environment. Continuous treatment is obviously a last resort, since treatment plants are highly expensive to construct and operate and must usually be operated in perpetuity. However, such treatment may be essential at sites that are causing severe water degradation.

Experienced contractors and state regulators know that water contamination cleanup projects can be complex and may require a thorough understanding of hydrogeology and engineering practices. There have been several cases where poorly planned cleanup efforts have made pollution worse. "Do nothing at all until you know what you're doing," warns one leading expert.[6]

In many situations, however, straightforward low-tech cleanup measures will improve water quality dramatically. Such measures as stream diversion, soil capping and mine-portal sealing have been in use for many years, and could easily be of great benefit to the public if employed on a large scale.

❺ Groundwater Contamination

Remediation of acids and heavy metals that have reached groundwater adds an additional level of complexity and expense to that associated with surface-water remediation. Despite the reluctance of many state agencies to acknowledge the existence of groundwater contamination and to view it as a major mining-related problem, it is — and the consequences of looking the other way have already been tremendously destructive. After all, today's Superfund sites are the products of yesterday's indifference.

The goal of reclamation for sites causing groundwater contamination is the same as for sites poisoning surface streams. Reclamation should eliminate the sources of contamination or at least mitigate their environmental impacts. The most straightforward approach is to segregate the source of contamination from oxygen or water. When segregation is impossible, the water in the aquifer itself must be cleansed of contaminants.

The methods used to prevent groundwater contamination are in most cases similar to those used to prevent surface-water contamination. The contractor may cap waste rock and tailings with soil or a synthetic liner or haul them away. Surface streams can be rechanneled into diversion ditches that bypass the site, so as to isolate acid-forming rock from water. In underground workings, acid-forming rock can be isolated by opening a tunnel to drain water out, so that the water table sinks below the level of the mine. Alternatively, the openings may be sealed so that the mine floods and cuts off the flow of oxygen to the rock. If contaminated water is leaking to groundwater through fractures in the rock, the contractor can pump grout (a kind of mortar) into the fractures to seal and waterproof them. Cost and complexity generally will mirror equivalent projects for surface-water remediation.

Toxic substances that have already reached an aquifer generally spread outward to form a ***plume,*** or concentrated body of contaminated groundwater, which follows the aquifer down-gradient, in some cases toward a community water supply or a surface stream. The major method used to address this problem is a version of continuous water treatment called ***pump-and-treat.*** First, wells are sunk to the level of the plume. The wells then pump the contaminated groundwater to the surface, where it can be treated with lime or other substances and released. Other monitoring wells are sunk nearby to verify that no contaminants are escaping. Pump-and-treat systems must ordinarily be operated in perpetuity, unless the original source of contamination can be isolated and removed or treated.

California Gulch, CO: Aerial view of an underground contamination problem. The old tailings pond in the foreground is unlined and leaks heavy metals into groundwater as well as streams that feed the Arkansas River. The pond also poses an especially severe threat because of its close proximity to Leadville.

Many innovative techniques for groundwater treatment are being tried. In Montana, Atlantic Richfield (Arco) is preparing one such alternative to pump-and-treat systems. The Warm Springs Project, part of the remediation program at Clark Fork (see page 47), has received approval to construct an artificial wetland. Arco will dig an ***intercept trench*** to force contaminated groundwater to the surface, where it can be run through the wetland. Arco's engineer cautions, however, that the plan is feasible only because of an unusually shallow water table.[7]

Contractors have also been exploring the value of ***slurry walls.*** Deep trenches are dug on each side of the source of contamination, sometimes all the way down to bedrock. The trenches are then filled with a slurry

(generally some mixture of water and a bentonitic clay) which impedes the flow of groundwater. Some researchers have also been testing anti-bacterial agents which might drastically slow the generation of acid.

Groundwater remediation is a field still in its infancy. Engineers and scientists are working on various possible solutions, however, and some states with especially serious groundwater contamination problems are now beginning to act. While current reclamation methods can be very effective in dealing with groundwater contamination problems, there is a pressing need for more research and new experimental applications in this area. Meanwhile, as with surface-water contamination, some basic and inexpensive reclamation activities can often achieve dramatic effects in abating groundwater contamination at relatively moderate cost.

❻ Superfund

Sites which the Environmental Protection Agency considers sufficiently dangerous to public health to require priority cleanup attention are entered on EPA's National Priorities List and become Superfund sites. In a sense, there is nothing unique about Superfund sites: they have landscape disturbances, safety hazards, and contaminated water, just like other site categories. What distinguishes Superfund sites is the scope of environmental damage and the immediacy of the threat to public safety.

Reclamation of Superfund sites involves the same techniques as for other sites, but much more intensively applied. At the Bunker Hill site in Idaho, for example, the reclamation plan includes soil capping and revegetation of tailings impoundments to stop acid drainage, construction of a wetlands to treat contaminated water flowing from the tailings impoundments into the Coeur d'Alene River, demolition of a lead smelter complex, and removal of lead-contaminated soil from the yards of hundreds of homes close to the smelter.

One of the most complex and difficult cleanup tasks in the world is being carried out at California Gulch in Colorado. Located close to legendary Leadville *(see photo, page 45)*, California Gulch was until recently discharging water laden with cadmium, copper, lead and other toxic metals into the Arkansas River at the rate of 210 tons of toxics annually via the Yak Tunnel, a four-mile-long drainage tunnel.

EPA is midway through its California Gulch reclamation program.[8] The Superfund contractor has installed three seals at various points in the tunnel to prevent uncontrolled water discharges, grouted rock fractures and drill holes to reduce the inflow of clean water to the tunnel, and constructed a pond at the tunnel portal to capture the surges of contaminated water that are periodically emitted after floods,

Nightmare at Clark Fork

Hardrock mining has created one of the worst hazardous waste problems in America: the Superfund site at Clark Fork in Montana.

"Clark Fork" is actually shorthand for *four* contiguous Superfund sites stretching along a 125-mile stretch of the Clark Fork River Basin between Butte and Missoula. Within the four sites, which encompass a larger area than any other Superfund site, are 23 areas contaminated by various toxics migrating from millions upon millions of tons of mining and smelter wastes.

The Clark Fork Basin was the scene of some of the greatest silver and copper discoveries in U.S. history. A half-century ago, raw Butte copper ore was being delivered at the rate of 1,000 tons an hour to an Anaconda smelter 25 miles away where, as a contemporary guidebook noted, "3,500 men guide it on its progress through great ranks of machines and furnaces that extract the metals from the rock with scientific thoroughness and economy."[9]

Zinc, lead, iron, manganese, silver and other metals also went through Clark Fork's "scientifically thorough" smelters — which produced, among many other byproducts, immense quantities of arsenic and sulfuric acid, most of which was just dumped on the ground.[10]

In 1977, Anaconda was bought out by Atlantic Richfield (Arco); by 1980 Arco had closed the smelter and the giant mine that fed it. But the silent mine and its toxic wastes remained "a living wound on the Montana landscape."[11] Just before it closed, the mine had been "gobbling up parks and residential neighborhoods and edging closer to Butte's business district."[12] Some 125,000 people now live in uncomfortable proximity to Clark Fork's horrific wastes, and most of them rely on drinking water that is — to put it mildly — at risk.

EPA began investigating the area in 1982 and placed three sites on the National Priorities List the following year. In 1987, having found that the damage was far more widespread than first believed, EPA enlarged the perimeter of one of the original three sites and added a fourth.

The contaminants that EPA has found permeating Clark Fork are the stuff of nightmares: arsenic, beryllium, cadmium, copper, lead, mercury, and zinc, among others. Some are carcinogenic, others can cause neurological damage.[13] Cleanup efforts at the sites have been slow and laborious, partly because of protracted litigation and partly because of the sheer magnitude of the task. To date, only two of the 23 priority sites have been cleaned up.

The Clark Fork cleanup has been exceptionally complex, costly, and controversial. Since there are no other national programs to address Clark Fork's myriad problems, Superfund is the course of last resort. The program is often criticized, but the criticism misses the main point. The harsh lesson to be learned from Clark Fork is that uncontrolled hardrock mining can leave lasting problems of such overwhelming complexity that we simply have to make sure there are no more Clark Forks in our future. ■

spring snowmelts or other out-of-the-ordinary events. The contractor has also made plans for a permanent lime treatment plant, and for a surface- and groundwater monitoring network to detect any leakage of contaminated water.[14]

For sites of this kind, dealing with immediate environmental and public health hazards is the top priority. Less significant problems, such as reclamation of landscape disturbances, may be postponed. The best way to deal with a Superfund site, of course, is prevention. But the scope and destructiveness of such sites should not obscure the fact that reclamation is possible and is a wise investment in the long run. As the examples above show, techniques identical to those used at less complex sites can yield impressive results.

■

This chapter demonstrates that reclaiming abandoned hardrock mines is by no means an untested idea — on the contrary, such reclamation is already being successfully carried out. Many of the approaches outlined above have been used for years to deal with abandoned coal mines or are in use at active hardrock mining operations. Employing off-the-shelf methods will enable federal or state agencies to make fast, cost-effective use of HAMR funds — and the benefits of reclamation will be as self-evident as they are overdue. ■

No one would know that this was once a mine. That's the idea. This was, in fact, a waste pile from which acid water drained into a nearby stream. Today the stream runs clear.

Re-mining: Promising, but no Panacea

One cost-effective way to reclaim an abandoned mine is to re-mine it — re-open the mine or re-process old waste to recover any ore left behind when the mine was closed — and then complete the reclamation process.

The typical HAMR site was abandoned when the operator deemed the mine no longer profitable, often after encountering difficult geologic conditions or low-grade ore. But with today's mining technology, many previously mined areas can be re-opened and re-mined at a profit — and have been, particularly during the boom in the early 1980s.

Re-mining usually means re-opening or enlarging an old mine pit to recover the remaining ore. But it can also involve re-processing old tailings piles, or removing old mine waste piles that block access to ore.

Re-mining has appeal. It offers a way to reclaim land according to current environmental standards, with no need for outside funding. But there are at least three potential problem areas that must be considered.

First, some HAMR sites, particularly those with severe water quality problems, can be made much worse if an inept operator re-mines them and ends up simply exposing more old workings or waste to the elements. Second, mining companies will sometimes ignore certain previously mined areas to avoid potential legal liability for reclaiming them improperly. Finally, an operator may avoid re-mining a HAMR site — even though it is in close proximity to a new mining venture — because it is still not economical.

Mining companies routinely call for regulatory and financial "incentives" to make re-mining more abandoned sites attractive. But incentives can create more problems than they resolve.

Many HAMR sites simply do not require incentives to make them attractive to operators. The incentive is already there, in the ore. In other situations, the nature of the proposed incentives should be carefully scrutinized. It makes no sense to weaken environmental standards or limit liability for damage done by re-mining. On the other hand, offering financial incentives — such as a tax credit for reclaiming an off-site waste pile — can make eminent sense.

In no case, however, should operators be given HAMR funds to conduct re-mining activities. Mixing profit-making with a federal cleanup program invites misuse of incentives and political corruption. SMCRA's coal cleanup program wisely prohibits giving AML funds to coal operators to re-mine abandoned mines, and the HAMR program should operate the same way.

Mining companies should be encouraged to voluntarily re-mine and reclaim HAMR sites if they have the capability to abate the environmental or safety problems associated with the site. Re-mining offers the promise of assisting the HAMR program to meet its overall goal. The promise is limited, however, and is sometimes oversold. Whatever its merits, re-mining should not be viewed as a panacea nor as a substitute for a national HAMR program. ■

Molybdenum mining in a national forest once meant jobs for the people of Questa, a traditional Hispanic village in the upper Rio Grande valley of New Mexico. Now the mine is silent, but its legacy lingers: Millions of tons of waste rock, dumped down mountainous slopes above the Red River, have contaminated watersheds, killed fish, destroyed wildlife habitat, polluted wells and irrigation ditches, affected agricultural production, and caused health problems among area residents. Unless reclaimed, the open pit mine will remain an open wound.

4 Making *HAMR* Work

Picture the United States as a bed covered by a quilt. Someone has been using a powerful chemical to extract bits of fabric . . . and has left traces of the chemical scattered throughout the quilt. Question: How well would you sleep under that quilt tonight?

This analogy may seem far-fetched. It isn't. Day in and day out, hundreds of thousands of abandoned mines are leaking contaminants into the nation's watersheds and underground water supplies, creating toxic chemical reactions that threaten aquatic life and human health. We can hardly expect to sleep soundly until we have a systematic program to deal with this threat to our quilt of air, soil, and water.

Fortunately we have the means at hand. A coordinated nationwide Hardrock Abandoned Mines Reclamation program can save the nation's irreplaceable land and water resources at manageable cost — and can create new jobs in many communities that have been adversely affected by the mining industry's shrinking employment base.

Establishing a HAMR Program: first steps

A nationwide HAMR program will require a clear picture of the scope and severity of the problem; a master blueprint and cleanup timetable; a dedicated financing mechanism; and an effective federal-state administrative structure.

Superfund clearly cannot serve as the administrative vehicle for a HAMR program. Superfund focuses, as it should, on addressing the nation's most severe and most immediately threatening hazardous waste problems, regardless of the kind of hazardous waste involved. As part of its programmatic design, Superfund also seeks to establish liability and to recover cleanup costs from those responsible.

A HAMR program, on the other hand, will need to be designed to cope with one particular set of problems — those caused specifically by hardrock mining and ore processing — and with the peculiarities of the mining industry. Establishing liability for mines abandoned decades ago will rarely be feasible or cost-effective, and even in cases of more

recent abandonment the offending company will typically either have gone bankrupt or will have been taken over by a corporate entity that had nothing to do with the original crime. Both situations argue for designing a HAMR program that is broadly funded and unencumbered by liability issues.

SMCRA meets these criteria vis-a-vis coal reclamation, and a thorough examination of its history and implementation should be part of developing a national HAMR program. SMCRA's Abandoned Mine Lands (AML) reclamation program, jointly administered by the Interior Department's Office of Surface Mining (OSM) and the states, is funded by a tonnage-based reclamation fee assessed against current coal producers. Over a 15-year period through fiscal year 1992, the program had collected $3.2 billion and had spent $2.6 billion to reclaim approximately 104,000 acres of abandoned mine sites.[1]

When SMCRA was enacted, OSM was faced with data deficiencies similar to those involving abandoned hardrock mines. After several false starts, OSM developed a uniform data collection methodology used by trained survey crews who conducted a state-by-state inventory of abandoned coal mining sites. Twenty-three states and three Native American tribes subsequently established OSM-approved coal AML reclamation programs. OSM and the states and tribes now have nearly 15 years of experience at reclaiming abandoned coal lands under widely varying conditions in Appalachia, the Midwest, and the West.

In planning a HAMR program, much can be learned from 15 years of experience with the Office of Surface Mining's abandoned coal lands reclamation program.

At best, OSM has had uneven leadership over the years, and the AML program has yet to fulfill its potential. OSM has acknowledged that only about 10 percent of the nation's pre-1977 abandoned coal lands problems have been addressed.[2] But problems of political will should not be confused with design flaws. The basic structure of the coal AML program and its funding mechanism both appear to be sound. And the coal industry, which predicted terrible economic consequences from having to pay a reclamation fee, has in fact suffered no apparent harm; U.S. coal output is 40 percent higher now than in 1977.[3]

The logical next step, then, is to enact a national Hardrock Abandoned Mines Reclamation program jointly administered by the federal government, the states, and the tribes and funded by fees on all current hardrock production on public, private, and tribal lands.

The HAMR program must be financed by a national funding mechanism that spreads the financial burden for cleaning up the nation's HAMR sites fairly across the industry that produced them. Mineral Policy Center recommends that a national fee based on a percentage of gross

mineral production be instituted for all current and future hardrock mines on federal, state, tribal, and private lands. The revenues should be deposited in an interest-bearing fund under the jurisdiction of the Department of the Interior. In addition, the HAMR fund should also include revenue generated by the collection of royalties, rental fees, and penalties for hardrock mining activities on public lands. MPC recommends that the national HAMR funding mechanism be set at levels capable of generating initially at least $400 million per year.[4]

MPC recommends that a national fee based on a percentage of gross mineral production be instituted for all current and future hardrock mines on federal, state, tribal, and private lands.

Examining a subset of the overall funding mechanism, such as a minerals royalty and rental fees for mining claims on federal lands, illustrates the funding potential of a HAMR program. A royalty rate of 12.5 percent is currently charged to producers of energy minerals — coal, oil, and gas — extracted from public lands; this is also the rate frequently charged to mineral producers by private landowners.[5] If a 12.5 percent rate were charged to producers of hardrock minerals on public lands, the projected annual revenue from royalties alone would be approximately $400 million.[6]

Whatever the fee schedule, revenue projections should be adjusted to reflect anticipated losses of production, if any, that might be precipitated by imposing additional costs on the industry. Even a minimal reclamation fee might have the effect of making some marginal mining operations unprofitable. Obviously every effort should be made to take such considerations into account. However, given other variables that can have proportionately greater effect on profitability — recessions and recoveries, which drive consumer demand; trade agreements and dollar valuations, which affect minerals imports and exports; and multilateral bank lending policies, which affect Third World minerals producers' competitiveness — it is doubtful that a reclamation fee *by itself* would actually have much effect on most U.S. minerals producers.

Getting the HAMR program up and running

The Hardrock Abandoned Mines Reclamation program should be developed around three broad priorities, applicable to abandoned mine sites whether on public or private lands:

❶ *Halt* existing environmental and public health threats;
❷ *Restore* land and water to acceptable condition;
❸ *Prevent* future problems.

In designing such a program, planners can profit from lessons learned in developing the coal AML program. Particularly important is the need to undertake, as a first step, a coordinated, comprehensive state-by-state

survey of abandoned hardrock mine sites in order to compile a reliable data base to facilitate identifying problem sites and prioritizing cleanups.

While the nationwide survey is being designed and carried out, the designated federal coordinating agency can work with other key federal agencies (e.g., the Environmental Protection Agency, the Bureau of Land Management, the National Park Service, the Forest Service, the Fish and Wildlife Service, and the Soil Conservation Service) and with the states and tribes to develop (1) a preliminary priority cleanup list and timetable and (2) a formula to distribute reclamation funds.

Since total funds available from a national reclamation fee will inevitably be limited, states can help to accelerate the HAMR process by earmarking additional funds. States that are able to make such a commitment will be able to leverage program funds and move more rapidly toward the goal of eliminating all abandoned mine hazards.

It will also be important to establish a special HAMR emergency response component to the overall HAMR program, based on the AML emergency response program under SMCRA. A HAMR response team must be able to respond quickly — without administrative confusion or inter-agency red tape — to emergency situations (such as landslides and cave-ins) where human life is imminently endangered.

Although the nationwide inventorying and cleanup planning process will inevitably be time-consuming, it is important to understand that the HAMR program can get under way without undue delay.

Step ❶ — Halt existing environmental and public health threats

Although a comprehensive nationwide inventorying and cleanup planning process will necessarily be time-consuming, it is important to note that the HAMR program can get under way without undue delay.

Within a few months after enactment of HAMR legislation, federal and state agencies should be able to compile an interim inventory of high-priority sites based largely on existing assessments and surveys. Then the coordinating agency should designate one or more high-priority sites in each of the states that have been particularly impacted by the effects of hardrock mining.

These sites can serve as pilot projects designed to demonstrate rapid, cost-effective restoration strategies using the best available technologies. The first of these high-profile HAMR projects can be under way within nine months after enactment. Later, when the nationwide inventory has been completed, federal and state agencies can reassess priority cleanup selections and revise timetables and funding allocations accordingly.[7]

Step ❷ — Restore land and water to acceptable condition

To end degradation of the nation's vital water resources, the HAMR program will reclaim land and water, using a variety of techniques to control erosion, leaching, and acidification, as described in Part 3.

The program will reclaim people, too. Implementation of the program will provide an opportunity for federal, state, and local environmental, land management, and employment agencies to collaborate on a project as important in its own way as the work of the Civilian Conservation Corps during the 1930s — public service conservation work that met a need and left the nation richer in resources restored and jobs created.

CCC enrollees learned basic work skills that served them well for the rest of their lives — while battling erosions and dust storms, reseeding forests, clearing streams and restoring wildlife habitat. HAMR will operate on a much smaller scale but in much the same way. The program will employ workers who will be able to take pride in streams running clear, trees and grasses growing on what had been barren land, wildlife returning to native habitat, and the knowledge that future generations will be safe from the hazards of abandoned mines.

The HAMR program will reclaim people, too — providing opportunities for government agencies and communities to collaborate on conservation projects as important in their own way as those of the Civilian Conservation Corps in the '30s.

The employment benefits of abandoned mine restoration work are visible right now in Montana. The Clark Fork Superfund project *(see page 47)* has, ironically, created a booming reclamation industry in Butte. As the authors of a recent article in *Smithsonian* magazine noted: "Earthmoving is under way at a number of sites, and that has meant more than a year of union wages for some 200 people. The cleanup could continue for a decade or two — about the life span of a pretty good copper mine." [8]

At the Crow Reservation in southern Montana, an abandoned mine cleanup program supported by SMCRA-AML funds has been deliberately designed to be labor- rather than machinery-intensive. Accordingly, the Crow are doing as much of the cleanup work as possible by hand: hand-placing rocks to close mine openings, hand-planting seedlings, hand-building diverse wildlife habitats, and hand-tending revegetation.

It works. "Doing a site by hand, we're able to work around whatever existing vegetation is there. With heavy equipment, you would have to destroy the existing vegetation. Actually we're pretty competitive with heavy equipment. Our costs are low, and the results are just as good as those of any of our contractors," says John Small of the Crow Tribe.[9]

The cost-effectiveness of designing certain reclamation tasks to be labor-intensive as opposed to equipment-intensive is emphasized by other professionals in the reclamation industry as well.

"Hand-placing rock in abandoned mine adit entries may be the most cost-effective technique for adit closure," notes Richard Juntunen of Resource Management Associates in Clancy, Montana, "but it is seldom specified [in cleanup plans] because it does involve mostly hand labor. Hand-planting of trees and seedlings is the best way to provide natural diversity in reclamation." [10]

As noted in Part 3, reclamation and restoration of abandoned mine sites will typically require backfilling and grading of open-pit mines, sealing or filling of underground mine shafts and adits, treatment and segregation of toxic mine tailings, treatment and control of surface and groundwater discharges from mined areas, diversion of surface drainage, restoration of stream channels, revegetation and reforestation, and, where appropriate, restocking of fish and restoration of wildlife habitat.

Most HAMR projects will be able to use readily available technology — and locally available equipment and labor.

In most cases, abandoned mine sites can be restored to environmentally stable condition using readily available technology and locally available equipment and labor. HAMR projects will typically require a period of advance planning followed by on-site reclamation work lasting weeks or months — longer in cases of severe water contamination. Heavy equipment will be used to restore sites to approximate pre-mining contours or equivalent condition and workers will restore and/or redirect drainage, stabilize slopes, irrigate soil and reseed vegetation. Engineers and scientists will work to eliminate or minimize post-cleanup contamination of water resources. Longer-term follow-up activities will include fish and wildlife management and water-quality monitoring.

Much of this work can be designed to be relatively labor-intensive. Mined-land restoration projects can thus have a positive — in some cases dramatic — impact on regional and local employment, both directly and indirectly. The HAMR program will create useful work for civil and mining engineers, geologists, hydrologists, surveyors, foresters, soil scientists, wildlife biologists, heavy equipment operators, drill operators, truck drivers, and landscaping laborers, among others. In addition, projects will require materials such as seed, fertilizer, pipe, filter fabric and crushed stone, most of which will be locally supplied.

Federal Bureau of Labor Statistics data suggest that for every $1 million invested in reclamation of abandoned mines, 26 jobs will be created.[11] A fully operational nationwide HAMR program can be conservatively expected to create employment opportunities at any given time for at

least 10,000 men and women, assuming a $400 million annual budget. Given that the entire hardrock mining industry currently employs only about 50,000 people (more than 40 percent fewer than in 1982),[12] HAMR projects will represent a considerable boost to employment — particularly in areas where declining employment in mining and mining services has created large pools of experienced unemployed workers with skills that are directly transferable to mined land restoration.

In many instances — notably in rough or mountainous terrain — reclamation projects either must be or can be designed to be labor-intensive, providing work opportunities for men and women without special skills. The HAMR program thus lends itself to a national service program of the kind envisioned by President Clinton.

Mined land restoration projects can, in fact, become an important component of a multi-faceted national environment-restoration initiative. First-time workers and veteran miners alike will have new opportunities to contribute muscle and skill to projects of lasting value.

Step ❸ — Prevent future problems

The HAMR program, when fully operational, can play a major role in halting and reversing mine-based degradation of our environment. To be fully effective, however, HAMR must be accompanied by significant improvements in regulatory oversight of active hardrock mines, now and in the future. Otherwise the HAMR program, no matter how successful, will only be overtaken by a new generation of abandoned mines and their attendant hazards.

In particular, there is an urgent need to:

■ Create a national regulatory program under the federal Resource Conservation and Recovery Act (RCRA), giving the Environmental Protection Agency explicit authority to regulate all mining and mining-related wastes as hazardous and providing appropriate federal and state agencies with adequate enforcement power and bonding authority to prevent mine operators from abandoning unreclaimed operations.

■ Reform the 1872 Mining Law governing mining on federal lands, particularly by requiring comprehensive land-use planning, giving land management agencies broad discretion to deny mining permits, requiring post-mining cleanup, and providing for a fair financial return to the public for access to minerals owned by the public.

The benefits are clear. A tailings pile that no longer sends toxics downstream benefits the entire food chain, including all the human beings at the end of it.

The environmental and health benefits of a HAMR program, both immediate and long-term, ought to be obvious. A sealed mine shaft reduces the risk of a tragic hiking accident; a mine tailings pile that no longer sends toxics downstream benefits the entire food chain, including all the human beings at the end of it.

Mine wastes that no longer contaminate groundwater resources represent a direct benefit to every nearby homeowner who draws water from a well and an indirect benefit to the 40 percent of U.S. households that rely on groundwater resources for their drinking water (a percentage that is increasing all the time).[13]

Reclamation yields environmental benefits that are analogous to the practice of preventive care in medicine. It is simply much easier to prevent contamination of groundwater than to clean it up later. In short, almost *any* cleanup strategy that stops pollution at or near the source will prove superior to later remediation.

Industry warnings: familiar arguments

Nevertheless the mining industry — or at least some elements of it — will vigorously oppose any fee-based HAMR program. Opponents will argue that there are really not all *that* many abandoned mine sites . . . and most of them are *far* from the nearest community . . . and mining companies no longer operate irresponsibly anyway.

When these arguments have been disproven, HAMR opponents will counter that any additional operating costs will drive many companies out of business, resulting in the loss of thousands of jobs in mining and thousands more in mining services. They will warn that in order to survive, mining companies will have to scale back their operations or move to more hospitable countries, thus offsetting any projected revenues from reclamation fees. Hoping to drive new wedges between workers and environmentalists, the industry will argue that only environmental zealots would want to impose new burdens on employers while much of the U.S. economy remains in recession.

These are familiar arguments. Many corporations play variations on the same themes whenever they find themselves facing unwelcome taxes or regulations. In most cases, of course, they eventually manage to pass such costs on to consumers. The coal industry, which attempted to block enactment of SMCRA by predicting a calamity if Congress enacted it, promptly adapted to the new law — and today is so profitable that the few remaining independent coal companies are targets for acquisition by both U.S. and international energy conglomerates.

Coal mining employment, meanwhile, has continued to decline. That trend, however, is attributable not to the costs of new laws and regulations but to dramatic productivity gains brought about by changes in production technologies over the course of several decades.[14] Reclamation fees have had no discernible impact on this underlying, historically long-term trend.

The hardrock mining industry, which has experienced a similar pattern of technological evolution, should certainly be able to withstand the impact of being charged modest fees to extract minerals — particularly from lands owned by the public. The United States is, after all, the only industrialized nation that still virtually gives away minerals which rightfully belong to the nation as a whole.[15]

In the *absence* of reclamation fees, in fact, damage to the environment becomes "a cost that the typical profit-maximizing mineral producer does not usually account for in the normal business decision-making process," as the Congressional Research Service has noted.[16] Thus reclamation fees simply have the effect of compelling industry to acknowledge a cost that up until now has been passed on to society.

Reclamation fees simply force the mining industry to acknowledge a cost that up until now has been passed on to society to pay.

■

From Maine to Alaska, from Florida to California, our nation is plagued by problems generated by more than 500,000 abandoned hardrock mining sites. Each year, scores of people die or suffer injury at these sites. Each year, scores of communities are endangered by the lethal pollutants that these sites release into the world. We can no longer afford to act as though these silent killers are invisible as well.

The costs of *not* initiating a HAMR program have become intolerable. For more than a century the mining industry has been getting virtually a free ride at public expense. The result is a pattern of environmental devastation which, unless addressed now, can only get worse.

There can be no more powerful argument for launching a nationwide cleanup program without further delay. Finally, at the very end of the 20th century, we can bring the outmoded mining practices of the 19th into line with the environmental imperatives of the 21st. ■

A river runs through it,
and the river is poisoned.
When water runs through mine wastes,
as here at Iron Mountain in California,
it picks up contaminants that find their way
to streams, rivers, lakes, reservoirs and groundwater.
Despite efforts to divert Iron Mountain's runoff,
toxics continue to pollute the Sacramento River —
once the best salmon and rainbow trout habitat in the state.

5 Recommendations for Action

Mineral Policy Center urges the President and Congress to act boldly to protect the nation's health — public and environmental — against the effects of irresponsible hardrock mining by taking the following steps:

❶ ***Clean up abandoned mines,*** by creating a national Hardrock Abandoned Mines Reclamation (HAMR) program to:

- Conduct a nationwide inventory of HAMR sites on federal, state, tribal, and private lands, using uniform standards to record and evaluate site conditions;
- Establish national standards to ensure that land and water will be fully protected;
- Authorize states and tribes to carry out the actual reclamation work within established federal standards;
- Provide adequate HAMR funding — at least $400 million a year initially — to prevent further threats to human health and safety and halt the spread of environmental damage.

❷ ***Protect future generations,*** ensuring that today's hardrock mining operations do not become tomorrow's abandoned lands, by creating a national regulatory program under the Resource Conservation and Recovery Act (RCRA) to ensure that *all* mine sites are properly restored after closure.

❸ ***Protect public lands*** from further mining damage by reforming the 1872 Mining Law to provide for land-use planning and discretion, post-mining cleanup, and fair financial return.

The combined impact of these actions will be to bring to an end, at long last, the obsolete frontier-era mining practices that have no place in a nation concerned about protecting public health and the environment for present and future generations. For too long, neglect has been the order of the day. Mineral Policy Center calls for a new day — now. ■

Notes

Part 1:

1. "Hardrock mining" is generally defined as the extraction of metals (e.g., copper, gold, iron, lead, magnesium, silver, uranium, zinc) and nonfuel minerals (e.g., asbestos, gypsum, phosphate rock, sulfur) by surface or underground mining method. The principal hardrock mining states (i.e., those where total material handled exceeds 1 million tons per year) are *Alaska, Arizona, California, Colorado, Florida*, Georgia, *Idaho*, Indiana, Iowa, Kansas, Kentucky, *Michigan, Minnesota, Missouri*, Mississippi, *Montana, Nevada, New Mexico*, New York, *North Carolina*, Ohio, Oklahoma, Pennsylvania, South Carolina, *South Dakota, Tennessee*, Texas, *Utah*, Vermont, Virginia, Washington, *Wyoming*. States shown in *italics* produce more than 10 million tons of mining waste per year. (*Source*: U.S. Bureau of Mines.)

The scope of this study excludes the examination of non-hardrock mineral abandoned mine sites such as sand, gravel, and limestone, which together with hardrock abandoned mines exist in all 50 states.

2. Donald Rogich, "Trends in Materials Use: Implications for Sustainable Development," U.S. Bureau of Mines, Division of Mineral Commodities, April 1992.

3. Ibid.

4. Mineral Policy Center, May 1993 estimate. For a discussion of MPC's methodology, see Part 2 of this report.

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

6. Southern Illinois University at Carbondale, First Midwestern Region Reclamation Conference, *Proceedings*, June 1990, p. 1-1.

7. Ibid.

8. Ibid.

9. In connection with their responsibilities under CERCLA, Federal land managers at the Bureau of Land Management and the Forest Service have recently begun inventorying abandoned mines on federal land under their jurisdiction. According to officials involved in the project, however, its scope and methodology are unclear and not necessarily comprehensive, and it is estimated that this project will take many years to complete due to present budget limitations and low agency priority.

10. Western Governors' Association (hereinafter cited as 'WGA'), *Inactive and Abandoned Noncoal Mines: A Scoping Study*, August 1991: Volume II, Colorado, p. 6.

11. Ibid, p. 7.

12. Ray Archer, "17,000 Death Traps Await Unwary Victims," Phoenix *Arizona Republic*, April 9, 1992.

13. WGA, op. cit., Volume II, Alaska, p. 3.

14. WGA, op. cit., Volume II, Arkansas, p. 3; Michael Thompson, Arkansas Department of Pollution Control and Ecology, phone communication, May 7, 1993.

Notes to Part 1 (continued):

15. U.S. Department of the Interior, National Park Service, *Abandoned Mineral Lands in the National Park System: A Pictorial Summary*, March 1990.

16. EPA, *Wastes*, op. cit., p. 4-66.

17. Montana Department of Health and Environmental Sciences, *Summary and Overview: Groundwater Injury Assessment Reports, Clark Fork River Basin*, May 3, 1993.

18. *Mine Regulation Reporter*, December 21, 1990, p. 579.

19. Concerned Citizens of Questa, NM, Testimony to the House Interior Subcommittee on Mining and Natural Resources, April 18, 1989.

20. R. C. Adams, "Flowing Failure," *Missouri Resource Review*, Summer 1992, pp. 8-13.

21. Florida Department of Environmental Regulation, *Gypsum Stack Status*, November 1988, p. 2.

22. WGA, op. cit., Volume IV, Wisconsin, p. 5.

23. *Mine Regulation Reporter*, March 2, 1990, p. 67.

24. WGA, op. cit., Volume IV, Vermont, p. 5.

25. WGA, op. cit., Volume III, Oklahoma, p. 4.

26. EPA, *Wastes*, op. cit.

27. University of California at Berkeley, *Mining Waste Study: Final Report*, July 1988, p. xxiii.

28. U.S. Environmental Protection Agency, *Iron Mountain Mine Superfund Site: Proposed Plan for Cleanup of Boulder Creek Contaminant Sources*, May 1992.

29. Ibid., p. 195. Note: The quotation used in the photo caption on page 12 is from Glen Martin, "Abandoned Mines Pollute the River," *San Francisco Chronicle*, June 17, 1992.

30. WGA, op. cit., Volume IV, Tennessee, p. 3.

31. WGA, op. cit., Volume III, North Carolina, p. 3.

32. WGA, op. cit., Volume II, Utah, p. 2.

33. Mineral Policy Center, "The Summitville Mining Disaster: A Poisoned River Runs Through It," Background Fact Sheet and Press Clips, February 4, 1993.

Notes to Part 2:

1. The principal Federal laws governing coal mining are the Mine Safety and Health Act of 1977 (P.L. 91-173) and the Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87), which includes an Abandoned Mine Lands (AML) program to reclaim coal mine lands abandoned prior to the Act's enactment. By characterizing the AML program as "relatively stringent," Mineral Policy Center does not mean to imply that the program has been adequately funded, administered, or enforced. A detailed assessment of the objectives, accomplishments, and shortcomings of the coal AML program is beyond the scope of this report; for a useful overview of SMCRA, including the AML program, see *Environmental Regulation of Coal Mining: SMCRA's Second Decade* by James M. McElfish, Jr., and Ann E. Beier, Environmental Law Institute, Washington, D.C., April 1990.

2. WGA, op. cit., Volume I, p. vii.

3. According to the Wyoming Department of Environmental Quality (memorandum to Mineral Policy Center, January 22, 1993), only $2.6 million worth of hardrock reclamation (about 3 percent of the total) remains to be done, with one noteworthy exception: The Farris Haggarty Mine, a defunct copper mine on patented land, has been emitting copper-rich water at a rate of 100 gallons per minute for several years and, according to state regulators, has sterilized several miles of the Haggarty River. Reclamation is expected to be very expensive; a study is under way, but reclamation cost estimates were not yet available when this report went to press.

4. WGA, op. cit., Volume I, p. 25.

5. Richard Humphreys, California Water Quality Control Board, telephone communication, April 5, 1993.

6. University of California at Berkeley, *Mining Waste Study: Final Report*, July 1988 (op. cit.), p. xxxii.

7. WGA, op. cit., Volume I, p. 2.

8. WGA, op. cit. In July 1992, under funding from the Interstate from the Interstate Mining Compact Commission, Volume IV of the WGA report, addressing the 17 remaining states, was completed.

9. Ibid.

10. U.S. General Accounting Office, *Federal Land Management: An Assessment of Hardrock Mining Damage*, April 1988.

11. Ibid.

12. U.S. Department of the Interior, Office of Inspector General, *Audit Report: Hardrock Mining Site Reclamation, Bureau of Land Management*, March 1992.

13. U.S. Department of the Interior, Office of Inspector General, *Audit Report: Noncoal Reclamation, Abandoned Mine Land Reclamation Program, Office of Surface Mining Reclamation and Enforcement*, September 1991, p. 4.

14. WGA, op. cit., Volume IV, Introduction, p. 2.

15. Western Governors' Association, Mine Waste Task Force, *State Noncoal Mine Waste Regulatory Programs: Tabulated Survey Results*, August 1990.

Notes to Part 3:

1. U.S. Bureau of Land Management, Nevada State Office, *Surface Management of Mining Operations*, September 1989.

2. Tom Uhlenbrock, "Dam That May Fail, Bury Flat River, Mo., To Be Fixed," *St. Louis Post-Dispatch*, May 20, 1992.

3. R. C. Adams, "Flowing Failure," *Missouri Resource Review*, op. cit.

4. Richard Juntunen, President, Resource Management Associates, letter to MPC, May 7, 1993.

5. John Sonderegger, Professor of Hydrogeology, Montana College of Mineral Science and Technology, telephone communication, April 16, 1993.

6. Ibid.

7. Sandra Stash, Montana Superfund Manager, Atlantic Richfield Corp., telephone communication, April 19, 1993.

8. *Mine Regulation Reporter*, May 8, 1992, p. 54.

9. *Montana: A State Guide Book*, Work Projects Administration, Federal Writers' Project, American Guide Series (1939), p. 81.

10. Ibid.

11. Neal Peirce and Jerry Hagstrom, *The Book of America: Inside 50 States Today* (Norton, 1983), p. 681.

12. Ibid.

13. U.S. General Accounting Office, *Superfund: EPA Could Do More to Minimize Cleanup Delays at the Clark Fork Sites*, November 1991.

14. U.S. Environmental Protection Agency, "Yak Tunnel Cleanup: Explanation of Significant Differences" (Fact Sheet), April 1989.

Notes to Part 4:

1. U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement, *Surface Coal Mining Reclamation: 15 Years of Progress 1977-1992.*

2. Environmental Law Institute, *Environmental Regulation of Coal Mining: SMCRA's Second Decade*, April 1990, p. 253.

3. U.S. Department of Commerce, *1993 U.S. Industrial Outlook*, January 1993.

4. This target represents a balanced approach between the critical need to generate adequate resources capable of financing the cleanup of a very large inventory of HAMR sites in a timely fashion and the need to set a funding

Notes to Part 4 (continued):

level that will not significantly impact the mining industry in general. In setting this target, MPC examined, among other things, SMCRA's AML program, which annually generates over $225 million; a 1993 study by the Congressional Budget Office regarding public land mineral royalties and job impacts; and the FY 1993 Congressional Appropriations bill and report for the Interior Department, which estimated the annual revenue generated from rental fees from mining claims.

5. Congressional Research Service, *The Federal Royalty and Tax Treatment of the Hard Rock Minerals Industry: An Economic Analysis*, October 1990.

6. Congress is currently considering putting in place a minerals royalty for Federal lands. In 1992, Congress instituted a $100 annual rental fee for all mining claims held on Federal lands. According to President Clinton's 1993 Budget Report to Congress, a royalty and rental fee will generate substantial revenue. The Administration projects that a 12.5% gross production royalty, phased in over time, will generate at least $277 million per year by 1997. Additionally, annual revenue from the $100-per-year rental fee for mining claims is estimated to generate over $80 million per year, net of administrative costs ["A Vision of Change for America," Office of the President, February 17, 1993, p. 78]. Coupling part or all of these revenues with those to be created by instituting MPC's recommendation of a national fee for hardrock mining production (for all operations on Federal, state, tribal, and private lands) would clearly provide sufficient revenues to fund the HAMR program initially at a minimum of $400 million annually.

7. Under SMCRA's AML program, typical timeframes for projects involve three to six months for design, three to six months for grant applications, two to four months for procurement, and two to six months for construction. (Source: Richard Juntunen, President, Resource Management Associates, Clancy, MT)

8. Dan Baum and Margaret Knox, "We Want People Who Have a Problem with Mine Wastes to Think of Butte," *Smithsonian*, Sept.-Oct. 1992.

9. John Small, AML Director, Crow Tribe, telephone communication, May 13, 1993.

10. Richard Juntunen, President, Resource Management Associates, letter to MPC, May 7, 1993.

11. U.S. Department of Labor, Bureau of Labor Statistics, *1988 Employment Requirements Table*, May 1991. Note that there is no category for mine reclamation *per se*. MPC has used the "Construction, New Nonbuilding Facilities" category, as recommended by BLS manpower analysts.

12. U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, February 1992. As of December 1991, the metal mining industry employed 57,900 workers. Although the metal mining industry has historically been thought of as a major employer, it no longer is; it currently employs fewer people than, for example, kitchen-cabinet manufacturing (70,500) or funeral homes (84,900).

13. Council on Environmental Quality, *Environmental Trends*, 1989.

14. U.S. Energy Information Administration, *Annual Outlook for U.S. Coal 1991*.

15. John E. Young, *Mining the Earth*, Worldwatch Paper 109, Worldwatch Institute, July 1992.

16. Congressional Research Service, op. cit.

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• and, finally, the countless individuals, families, and community organizations who are living with the daily hazards of abandoned mine sites and whose stubborn refusal to accept the status quo inspired this report. Some provided information, others provided inspiration. We thank you all — and hope our work will be useful to you.

Photo Credits

Colorado Department of Natural Resources, 17, 24; Environmental Protection Agency, 12, 60; David T. Hanson, 45; Philip M. Hocker, Mineral Policy Center, 23, 50; Thomas Kruzen, 19; National Park Service, 34, 37, 41, 48; Bryan Peterson, cover; Utah Division of Oil, Gas and Mining, 39.

Mineral Policy Center

Hardrock mining and oil and gas exploration and extraction are major sources of environmental damage to the United States — sources which are not adequately controlled by existing law or regulation. Nonfuel mining generates twice as much solid waste each year as all other U.S. industries and cities combined — and much of this waste is hazardous. The outdated laws and policies governing these resources conflict with the public's right to environmental protection and fair value for its resources, with the government's need for efficient regulation, and with the mineral industry's need for stability and security of its exploration investments.

To respond to this problem, Mineral Policy Center was established in 1988 in Washington, D.C., to:

- Educate and assist citizens' groups and agency personnel working with conservation problems related to legislation such as the 1872 Mining Law, the Mineral Leasing Act, and the Resource Conservation and Recovery Act;
- Serve as a Washington source for information on the environmental problems with those laws, and the problems the laws cause the mineral industry;
- Lobby for reform amendments to the laws and the corresponding federal regulations;
- Encourage improved state action to reduce mineral development impacts on state and federal domains.

As an expert "service bureau" for local groups, the Center provides technical, legal, and political strategy assistance to deal with mineral threats to sensitive areas. It draws on examples of successful strategies used in the past, and trains activists and regulators to deal successfully with the technical nature of mining's impacts and regulations.

Tax-deductible contributions help support this important service. Contributors of $25 or more per year receive periodic issue updates and *Clementine*, the Center's Journal of Responsible Mineral Development, which reports on major minerals issues nationwide.

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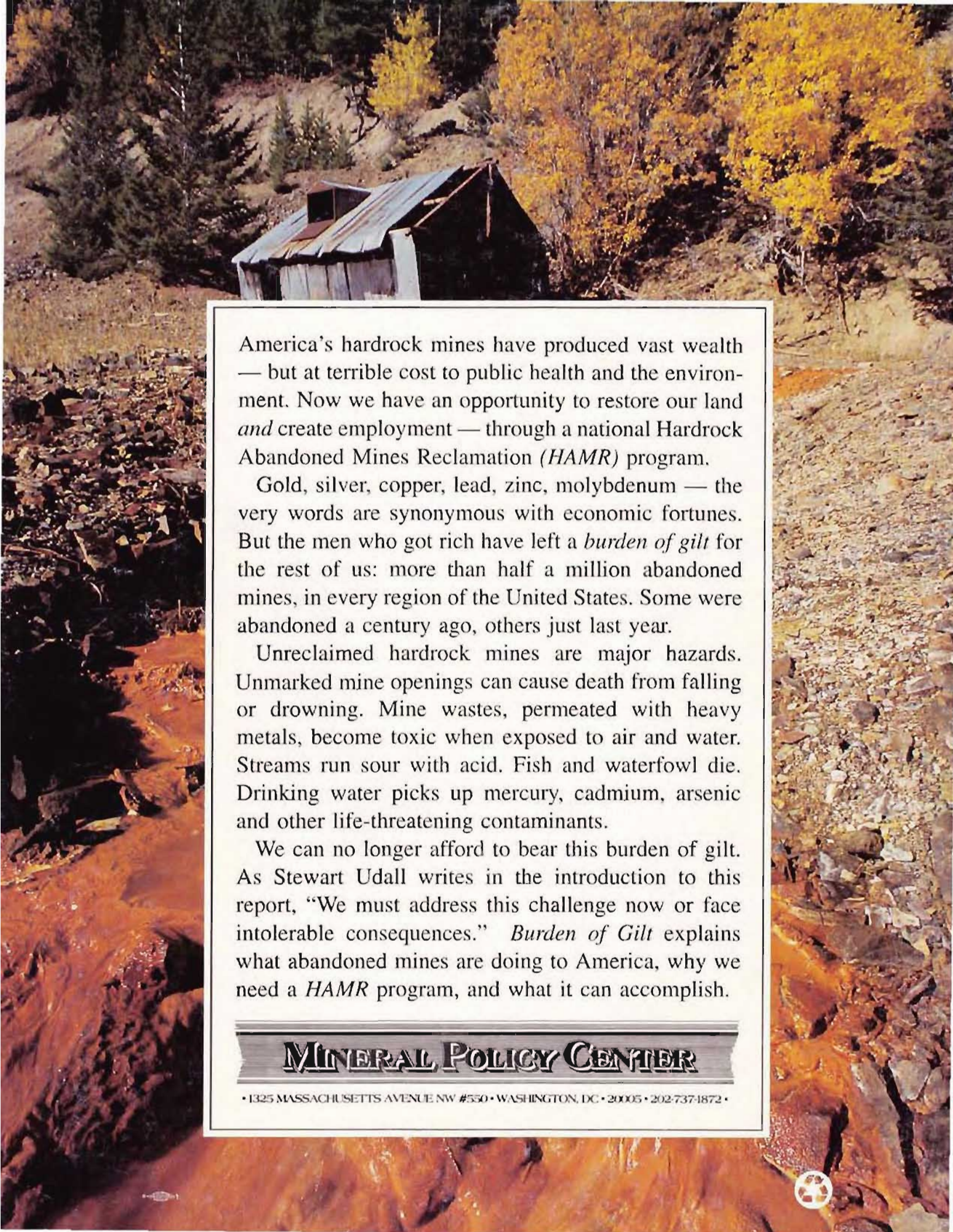

America's hardrock mines have produced vast wealth — but at terrible cost to public health and the environment. Now we have an opportunity to restore our land *and* create employment — through a national Hardrock Abandoned Mines Reclamation *(HAMR)* program.

Gold, silver, copper, lead, zinc, molybdenum — the very words are synonymous with economic fortunes. But the men who got rich have left a *burden of gilt* for the rest of us: more than half a million abandoned mines, in every region of the United States. Some were abandoned a century ago, others just last year.

Unreclaimed hardrock mines are major hazards. Unmarked mine openings can cause death from falling or drowning. Mine wastes, permeated with heavy metals, become toxic when exposed to air and water. Streams run sour with acid. Fish and waterfowl die. Drinking water picks up mercury, cadmium, arsenic and other life-threatening contaminants.

We can no longer afford to bear this burden of gilt. As Stewart Udall writes in the introduction to this report, "We must address this challenge now or face intolerable consequences." *Burden of Gilt* explains what abandoned mines are doing to America, why we need a *HAMR* program, and what it can accomplish.

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