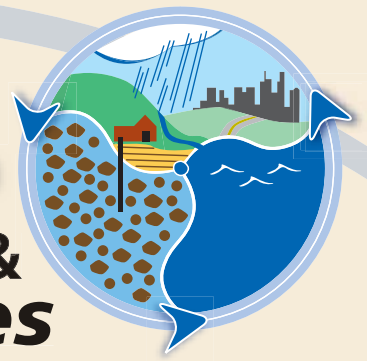


Ground Water & Abandoned Mines



Key Message

Current mining operations are generally permitted and managed according to stringent standards designed to prevent the creation of new AMD problems. Therefore, this report will focus on the most significant mining-related environmental issue—ground and surface water problems associated with abandoned mines. Issues associated with current mining operations may be addressed in future reports.

Abandoned mines with associated acid mine drainage (AMD) discharges are among the greatest threats to ground and surface water quality in many areas of the United States. While mining is extremely important to our standard of living, energy production, and national security, it can disturb the land and alter the hydrologic balance—affecting the quality and quantity of ground and surface waters in the vicinity of mining operations. Most modern mines are now reclaimed during and after completion of mining activities; but prior to the enactment of environmental laws in the 1970s, most abandoned mines were not reclaimed after it was no longer profitable to retrieve the mineral or coal resources.

Abandoned mine sites, along with associated acidic discharges, must be remediated. To optimize remedial work, state officials should use all available funding sources, develop new funding sources, build partnerships, and remove obstacles that prevent third parties from undertaking activities that address ground water contamination

problems. Future mining and reclamation activities must be planned with a critical eye to environmental and ecological circumstances, using information that incorporates adequate hydrological data, to prevent creation of new acidic discharges.

Such plans should evaluate the impacts or ramifications of mining before the fact and assist the industry in implementing mitigating measures. States should also adopt full-cost bonding requirements, or an equally effective alternative, to reduce the number of mine sites added to the abandoned mine lands inventory through bankruptcy.



Acid mine water discharge from historic underground workings (Fisher Creek, Montana).



The Spoils of Abandoned Mines

“While mine pollution problems also appear occasionally as a quick visible pulse that suddenly kills lots of fish or birds...more often they take the form of a chronic leak of toxic but invisible metals and acid that don’t degrade naturally, continue to leak for centuries, and leave slowly weakened people rather than a sudden pile of carcasses. Tailings dams and other engineered safeguards against mine spills continue to suffer from a high rate of failure”

Jared Diamond | *Collapse: How Societies Choose to Fail or Succeed*

why Abandoned Mines matter to ground water...

Many abandoned coal mines and hardrock mines emit acid mine drainage (AMD).

This takes place because the rocks associated with both types of mines often contain metal sulfides, such as pyrite. When the rock or coal deposits are excavated, the sulfides are exposed to water and oxygen and react to form sulfuric acid. Many abandoned surface and underground mines, and their associated spoil and refuse piles, provide an ongoing source of AMD and toxic heavy metals that can have long-term devastating impacts on ground water, community water supplies, rivers, and streams. AMD turns surface waters red and can coat creek beds with white aluminum and other metallic deposits, a deadly combination for aquatic life. (See Trout Unlimited’s *Restoring the Wealth of the Mountains*, 2005)

More than a million abandoned hardrock and coal mine sites are scattered throughout the United States. The Mineral Policy Center evaluated state and federal inventory data in 1995 and concluded that there were more than 557,000 abandoned hardrock mines nationwide, the majority in the western states. While most states have not completed detailed inventories or environmental impact assessments, the Western Governors



A mountaintop removal coal mine encroaches on a small southern West Virginia community.

Photo: Vivian Stockman / SouthWings / www.ohvec.org



Photo: savethewildup - http://www.flickr.com/photos_zoom.gne?d=46936825&size=o



Acid mine drainage (AMD) at a sulfide-rich nickel and copper ore deposit

Association estimates that up to 20 percent of these mines pose a threat to the environment.

More than 200 years of coal mining (preregulation) in the Appalachian region have left a legacy of abandoned, unreclaimed mine lands. USEPA Region 3 regards AMD as the single greatest threat to surface water in the Appalachian environment, and identified more than 4,500 miles of streams that fail to meet aquatic use designation as a result of AMD in Pennsylvania, West Virginia, Maryland, and Virginia. (USEPA, 2007) There are 3,000 miles of streams degraded by AMD in Pennsylvania alone. (USGS, 2006) In neighboring Ohio, the Ohio EPA has inventoried over 1,300 miles of streams degraded by AMD. (Ohio Environmental Council, 2006)

In 1977, Congress enacted the Surface Mining Control and Reclamation Act (SMCRA) to address public health and safety and environmental problems associated with inadequate reclamation of coal mining sites. Information on the actual cost of cleaning up abandoned mines sites is not readily available to the public. However, according to the September 2004 *Reference Notebook* by the USEPA Abandoned Mine Land Team, as of April 2002, USEPA's estimated and

actual costs at 88 National Priorities List mining sites were more than \$2.8 billion. The document cites several studies that address possible costs associated with restoring abandoned mine sites. Costs run well into the billions. For example, in 1993, the Mineral Policy Center estimated that the worst 363,000 (out of the 557,000) abandoned mine sites would require between \$32 and \$72 billion for reclamation—and that was then.

In the absence of comprehensive federal or state inventories, the current total number of abandoned mines and the number that are degrading ground and surface water quality can only be estimated. There are

currently 25 abandoned mine sites on USEPA's Superfund list. The impacts of AMD from discontinued operations, and in some cases ongoing operations, are well documented,

ACID MINE DRAINAGE IN THE NATURAL ENVIRONMENT

AMD from abandoned underground mines or seeps from spoil or waste piles is caused by a variety of processes associated with unreclaimed abandoned mines, including:

- Underground and surface mines with workings below the water table must pump and discharge ground water from the active mining area throughout the operative life of the mine. Upon abandonment, pumping ceases, and ground water accumulates, interacts with the metal sulfides in the unmined ore or coal deposit, and eventually rises to the level where it discharges into local streams and rivers.
- Sinkholes that form as a result of mine roof collapse can capture water from streams, diverting

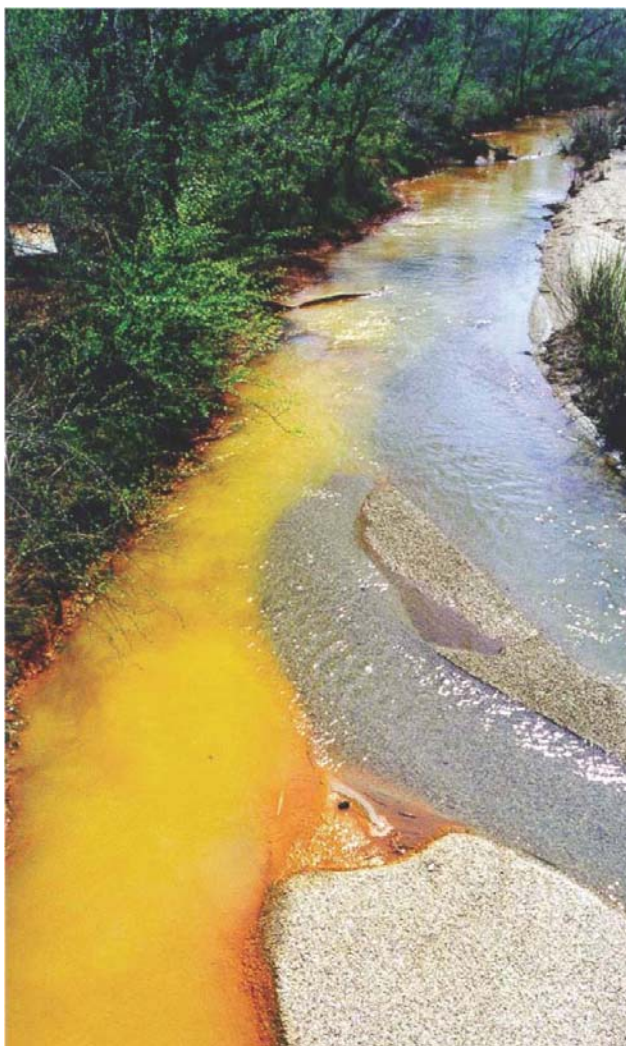


Photo: courtesy of the Oklahoma DEQ

Acid mine drainage has left a toxic legacy in this stream in the Tar Creek area of Oklahoma.

surface flow into abandoned underground mines. Diverted water reacts with metal sulfides in the underground mine environment and eventually resurfaces as an acidic ground water discharge.

- Piles of mine waste, also called “gob” or “refuse,” are often found in unreclaimed piles near abandoned mines or in impoundments. When precipitation infiltrates the mine spoil, the underlying ground water becomes acidic and discharges at the base of these piles through seeps or springs.
- At some abandoned above-the-water-table surface mines, precipitation reacts with ore or coal-seam exposures created by mining. This can create acidic runoff or impoundments that discharge AMD.

SOLUTIONS—READY AND WAITING

Research is ongoing to develop both active and passive treatment technologies to reduce AMD and metal loadings in streams. Passive treatment involves the installation of limestone channels, wetlands, and successive alkalinity-producing systems (SAPS) at AMD discharge areas. The SAPS neutralize acid, while the wetlands provide the wherewithal to capture precipitated metals that would otherwise be discharged into local streams and rivers. Passive systems must be monitored, and accumulated metal precipitates must be removed periodically. Materials that generate alkaline conditions must also be replaced periodically.

Technologies have also been developed to increase the alkalinity of waters in recharge areas overlying acid-forming spoil or underground mine voids. Trenches filled with alkaline materials can neutralize acidic ground water before it discharges to surface water.

The most effective AMD solutions prevent the formation of acidic drainage through source control by reducing or eliminating air and water contact with



Photo: cobalt <http://www.flickr.com/photos/cobalt>

An abandoned mine in Chloride, Arizona.



A pipe driven into the hillside drains acidic water from a mine in Pennsylvania.

the underlying AMD-forming minerals. This can be accomplished by reducing recharge through these materials. Eliminating impoundments and diverting surface flow from recharge areas can reduce surface water infiltration through AMD-forming spoil. Capping recharge areas with impermeable materials also reduces recharge and hence the rate of AMD discharge. In addition, collapse features that capture surface water flow from streams can be filled and sealed, thereby reducing recharge of the underlying mine voids.



Photo: Kevin A. Geiselman

FUNDS AT WORK AND WORK NEEDING FUNDS

The SMCRA established the Abandoned Mine Land (AML) Program to reclaim previously mined areas that posed significant health, safety, and environmental problems to the public. Since SMCRA was enacted, the federal Office of Surface Mining has distributed approximately \$3.5 billion to states and tribes for AML project work.

Funded by a severance tax of \$0.35 per ton of surface coal and \$0.15 per ton of underground coal, the AML program has reclaimed more than 285,000 acres of abandoned coal-mine sites through the grants to states and tribes. According to the National Association of Abandoned Mine Land Programs (NAAML), hazards associated with more than 27,000 open mine portals and shafts, 2.9 million feet of dangerous highwalls, and 16,000 acres of dangerous piles and embankments have been eliminated and the land reclaimed. (NAAML, 2006).

Despite this record of accomplishment, NAAML reports that “over \$3 billion worth of listed health and safety coal problems remain, as well as another \$3.6 billion worth of identified high priority coal problems affecting the general welfare of individuals in the coalfields and numerous environmental coal-related problems.” Fee collections for the AML Program were due to expire on September 30, 2004.

After a series of short-term fee extensions, on December 9, 2006, the 109th Congress passed the Surface Mining Control and Reclamation Act Amendments as part of the Tax Relief and Health Care Act of 2006. The legislation reauthorizes the collection of the coal severance tax for 15 years and directs more money to states with the greatest number of AML problems. The legislation also allows states to set aside up to 30 percent of their grant money for abatement of acid mine drainage problems. The 109th



Photo: Copyright Stuart Jennings, Montana State

Waste rock revegetation at Zortman-Landusky Mine, circa July 1996. This gold and silver mine used cyanide to process the ore. A 50,000-gallon spill of cyanide solution contaminated a public water supply well. (<http://www.bettermines.org/zortman.cfm>)



Photo: Copyright Stuart Jennings, Montana State

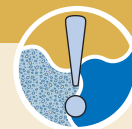


Slag placement as part of the Central Impoundment Area Repository cover system, Bunker Hill Superfund site near Kellogg, Idaho. The site is located in the silver, lead, and zinc mining district. (Image circa June 2000.)

Congress is to be commended for its decisive action in addressing this significant issue.

Western hardrock abandoned mines have received less attention, largely due to the lack of a dedicated federal funding source and varying levels of commitment at the state level. The Mineral Policy Center reports that “few projects are undertaken without some sort of partnership with, and funding from, federal land management agencies and the Environmental Protection Agency.”

OHIO BUILDS AN AMD OFFENSIVE THROUGH COOPERATION



The AML Program has built an impressive coalition of partners dedicated to abandoned-mine reclamation and restoration. With the cooperation of private land owners, industry representatives, federal agencies, local officials, and watershed groups, thousands of acres of abandoned mined land have been transformed into productive land, and healthy fish and macroinvertebrate populations are returning to streams once considered dead and unrestorable.

For example, in 1998, Ohio created a section within its AML Program to focus on water quality issues caused by AMD. In cooperation with the Ohio Environmental Protection Agency and the Department of Natural Resources, Division of Soil and Water Conservation, state AML funds are used to support coordinators in mining-impacted watersheds. These coordinators, working with AML Program hydrogeologists, academics, and local citizens, monitor stream water quality, characterize AMD discharges, locate stream captures, and inventory toxic spoil piles and other sources of water quality impairment in order to develop acid mine drainage abatement and treatment (AMDAT) plans.

AMDATs are essentially mining Total Maximum Daily Loads (TMDLs) that establish watershed treat-

ment and remediation priorities within a watershed. They have enabled the AMD Section to leverage over \$1 million annually from federal agency partners, including the U.S. Forest Service, USEPA, U.S. Army Corps of Engineers, and the Office of Surface Mining, to design and construct AMD treatment systems.

The AMD Section has established an invaluable working relationship with a faculty group at Ohio University (OU) known as the Appalachian Watershed Research Group, which consists of researchers from a variety of academic disciplines, including faculty from the Departments of Geology, Geography, Biology, and Civil Engineering. Coordination for much of this work has occurred through a partnership with OU's Voinovich Center for Leadership and Public Affairs, which leverages the resources of the university to meet the research needs of state agencies.

The Appalachian Watershed Research Group is currently developing a long-term monitoring plan that will include a scorecard and annual report for watershed projects. OU is also establishing an Appalachian Region Water Resources Center to provide technical support and a graduate degree program in Mineral Resource Extraction and Restoration Practices.



SMCRA funds cannot be used for non-coal environmental restoration projects, except in states where all coal projects have been completed, such as Wyoming and Montana. These two states, with secure annual funding of \$28.8 million and \$3.7 million, respectively, are in the best position to undertake water quality remediation projects at abandoned hardrock mines.

Other states fund water quality projects by tapping into federal sources of funding, such as USEPA grants to states for nonpoint-source pollution control under Section 319 of the federal Clean Water Act. Funding is sometimes available through other federal land management agencies, Clean Water Act 104b3 Water Quality Cooperative Agreements, Brownfield Grants, and the Restoration of Abandoned Mine Sites (RAMS) Program within the federal Water Resources Development Act (WRDA).

Different states have developed unique strategies for securing funds to remediate abandoned mine sites. Indiana, through its Partners for Reclamation Program, receives significant private sector contribu-

tions. In 1999, Pennsylvania established its Growing Greener Program, which provides \$650 million in general funds over five years to remediate serious environmental problems, including AMD discharges from abandoned coal mines.

USEPA REMOVES DISINCENTIVES TO RE-MINING AND RECLAMATION

In 2002, USEPA amended its Effluent Limitations Guidelines and New Source performance standards to allow coal operators, under specific circumstances, to re-mine previously mined areas subject to modified effluent standards under a National Pollutant Discharge Elimination System (NPDES) permit. Under the changes, an operator gathers data on the quality and quantity of the preexisting pollution discharge to establish a baseline of the pollutants being discharged. In the mining permit application, the operator must demonstrate that re-mining and reclamation of the site is likely to improve or eliminate the preexisting discharge in order for the permit to be issued.



Photo: Copyright © Louis Maher

An old coal strip mine south of Victoria, Illinois.



PENNSYLVANIA: A NATIONAL MODEL FOR SUCCESSFUL RE-MINING

Pennsylvania serves as a national model for managing a successful re-mining program since enacting its re-mining laws in 1995. In a 2000/2001 study of 112 abandoned surface mines containing 233 preexisting discharges that were re-mined and reclaimed, 48 discharges were eliminated, 61 discharges were improved, 122 showed no significant improvement, and two were degraded. These environmental improvements occurred at no cost to the government or taxpayers because the operator's potential liability was limited and the operators were able to recover the coal that remained on the site.

At a site in Schuylkill County, the state and private sector are working together to implement an innovative re-mining solution that creates clean, zero-

sulfur diesel fuel while restoring the environment. Waste coal from spoil piles associated with abandoned mines will be the feedstock to create clean diesel fuel at the nation's first coal-gasification-liquefaction plant.

Pennsylvania has over 8,500 acres of unreclaimed refuse piles containing an estimated 2.1 billion tons of waste coal that currently release AMD into local streams, rivers, and ground water. By 2009, a state-of-the-art power plant will be generating 40 million gallons of clean diesel fuel and generating enough electricity to power 40,000 homes, while eliminating an ongoing threat to the environment and a hazard to public health. (See April 2006; *Governing*; www.governing.com/articles/4coal.htm)



(Left) Over 40 acres of abandoned minelands were restored on formerly productive farmland in North Liberty, Pennsylvania. (Right) Volunteers planted 3,000 wetland plants in just a few hours as the final step in a mining reclamation process. The site was mined extensively in the 1940s. It was originally reclaimed in 2001 through a public-private partnership effort. Two ponds were built as part of the erosion and sedimentation control plan, a portion of the ponds was converted into wetlands. It was completed on October 18, 2003.

This revision is designed to encourage operators to re-mine previously mined lands to remove remaining reserves and waste coal from abandoned lands, thereby eliminating sources of AMD without spending tax dollars. Absent the modified limitations, operators are reluctant to mine areas with AMD discharges because they would be unable to meet NPDES standards while conducting mining operations.

LEGISLATIVE INITIATIVES

Good Samaritans

There are many volunteers ("Good Samaritans") who are interested in helping restore watersheds impaired

by abandoned mines. However, the threat of liability pursuant to the Clean Water Act (CWA) and/or the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) discourages such third-party cleanups. A volunteer conducting a partial cleanup could become liable for the entire cleanup or could be obligated to obtain a discharge permit that requires compliance with strict water quality standards in streams that are already in violation of these standards. Liability may be assigned even though the volunteer did not cause the pollution.

If this threat of liability were removed, volunteers would have an incentive to restore watersheds impacted by AMD. "Good Samaritan" legislation has been introduced aimed at removing barriers to



Photo: Copyright Stuart Jennings, Montana State

At the Yankee Doodle tailings pond in Montana, a mix of clean influent water from upgradient (left) with mine tailings (right) can be seen.

voluntary cleanup of abandoned mine sites. Good Samaritans include federal, state, or local government agencies, citizen groups, and mining companies. The legislative concept has broad support from organizations, including the National Mining Association, Western Governors Association, Western States Water Council, Interstate Mining Compact Commission, Trout Unlimited, National Environmental Trust, and many others. (Refer to EPA website <http://www.epa.gov/water/goodsamaritan/>)



Photo: Copyright Stuart Jennings, Montana State

Iron precipitation in a wetland at the toe of the Opportunity Tailings Pond, Anaconda, Montana.



Recommended Actions



To Congress:

- ▶ Enact Good Samaritan legislation to encourage third-party efforts to remediate AMD problems without the risk of penalties and liability.
- ▶ Work with interested parties to enact an Abandoned Hardrock Mines Reclamation Act that would attempt to address problems caused by abandoned hardrock mines. This would essentially be the hardrock equivalent of the Surface Mining Control and Reclamation Act (SMCRA).
- ▶ Continue to appropriate funds for remediation of contaminated abandoned-mine sites that pose an immediate threat to human health under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

To Governors and State Legislatures:

- ▶ Increase the level of state commitment to address and resolve the problem of abandoned mines and AMD; recognize AMD and environmental issues as a use of funds under the Abandoned Mine Land Program; and establish funds dedicated for cleanup of abandoned mine sites that are not covered under SMCRA or CERCLA.

To State Agencies:

- ▶ Establish comprehensive inventories of abandoned mines and AMD-degraded aquifers, underground mine pools, and streams, and develop a strategy to address identified abandoned mines and AMD discharges on a priority basis.



If not adequately reclaimed, abandoned surface and underground mines, and their associated spoil and refuse piles, provide an ongoing source of acid mine drainage and toxic heavy metals that can have long-term devastating impacts on ground water, community water supplies, rivers, and streams.

An open-pit copper mine in Morenci, Arizona. This mining complex is over nine miles long and includes an open-pit mine, tailings impoundment, and waste piles.

Photo: Copyright © Michael Collier



Section 10 References: Ground Water and Abandoned Mines

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Photo: savehewildup - http://www.flickr.com/photos_gne?id=469368925&size=o

Acid mine drainage is a byproduct of mining ore, which contains sulfides (e.g., pyrite) and has been deemed one of the most serious threats to water quality by USEPA.
(http://www.epa.gov/region3/acidification/what_is_amd.htm)