The U.S. Interior Department's Abandoned Mine Lands Program: a 15 year Update

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Since a 5th ICARD presentation in 2000 covering the Bureau of Land Management's Abandoned Mine Land (AML) Program much progress has been made in identifying, prioritizing and remediating some of the many sites located on federally administered lands throughout the west. Many of these projects have involved coordination with other state and federal agencies. The projects have ranged from fairly straightforward closure of mine openings to extensive mine site remediation involving complex site geochemistry, several hundred acres of disturbance and several water treatment facilities. This presentation will briefly detail the process used to identify, characterize and prioritize AML sites. Several complex sites with a range of geochemical and reclamation issues, including long-term water treatment required to meet water quality standards, will be covered in greater detail. Impacts to all aspects of reclamation and water treatment facilities at some sites due to historically high spring floods in 2011 will be covered. These sites are primarily on lands administered by the Bureau of Land Management, but other sites on federally administered lands will be noted as well. While much has been done, much work remains to be done in addition to the ongoing operation and monitoring of existing remediated sites.

Key Words: Abandoned mine lands, acid drainage, reclamation, water treatment

Introduction

Agencies involved

The U.S. Department of the Interior (USDI) is one of 14 Cabinet level agencies in the Executive Branch of the United States Government. Together with the U.S. Department of Agriculture (USDA), another cabinet level agency, it is responsible for the wise stewardship of land and natural resources publicly owned and held in trust by the federal government. The USDI also has special responsibilities maintaining trust responsibilities to aboriginal peoples. The USDI includes agencies that manage lands, administer regulatory programs, operate and maintain water development projects and conduct basic research. Two agencies in the USDI, the BLM and the U.S. Geological Survey (USGS) have worked together with the U.S. Forest Service (USFS) an agency in the USDA,to restore lands damaged by past mining activity. The BLM and USFS administer more than 185 million hectares of public lands. These are lands mostly in the western U. S. maintained in federal ownership for the benefit of the U. S. population at large. The BLM and USFS administer these lands under the principle of multiple use management, which is defined as "management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people." The USGS is a scientific agency with responsibilities to provide scientific information to describe and understand the earth, minimize loss of life and property from natural disasters, assist agencies managing water, biological, energy and mineral resources and also to enhance and protect Americans' quality of life.

The impact of past mining on the nation's water supply is one of the areas the BLM, USFS and USGS and state governments have been coordinating their efforts to identify, characterize and reclaim inactive and abandoned mine sites, mostly in the western US (Church et. al. 1998). This critical element has generally resulted in the agencies developing a "watershed" approach on inventory and clean-up activities to deal with abandoned mine features in specific threatened watersheds to make the most efficient use of monies available.

Most state governments in the west do not have a specific source of funding for the cleanup of abandoned mine sites, even those posing risks to public health and safety as well as those causing environmental damage. States with coal resources have access to reclamation funds through the US Office of Surface Mining (OSM), another DOI agency; however these funds can only be used to clean up inactive and abandoned hard rock mines after a state has certified that it has cleaned up all abandoned coal mines. Since most western states have few coal mines, they have limited access to OSM reclamation funds. Montana, Colorado and Wyoming are exceptions to this generalization. Having cleaned up all of their abandoned coal mines,these States began an aggressive program of cleaning up abandoned hard rock mines in the 1990s. In Montana the initial action was to develop an extensive inventory of abandoned mine lands (AML) sites, prior to developing plans for prioritization and cleanup of AML sites. This inventory was completed in 1995 by the Montana Department of Environmental Quality, (DEQ). BLM identified the cleanup of AML sites as a priority budget item in 1996. Several BLM state programs have done AML work, but Montana and Colorado, because of the watershed approach noted above,have been the most aggressive in taking early action identifying and reclaiming AML sites. Completed AML inventories and work done by the state has also helped to focus the early remediation activities in Montana.

History

Mineral development in the western United States began in earnest after the gold rush started in California in 1849. Development activities preceded the legal framework that was to come with the General Mining Law of 1872, which is essentially a mineral development and land disposal law. It did not include even the most rudimentary level of environmental protection. At the time the law was written, there was no recognition of the environmental consequences of direct discharge of mine and mill wastes into the nation's rivers and streams or the impact of this activity on the availability of drinking water supplies, and riparian and aquatic habitats. Miners operating on federal lands had little requirement for environmental protection until the 1960s and 70s, although the dumping of mine wastes and mill tailings directly into the nation's rivers was halted by an Executive Order in 1935. It is important to recognize that these early miners were not breaking any laws, because there were no laws to break. They simply disposed of mine waste in whatever was the most expedientmanner, often with significant long-term adverse environmental impacts. Many of these mines discontinued activities as the ore ran out or metal prices changed leaving a variety of physical safety hazards including open shafts and adits, highwalls, and various other physical hazards in addition to the environmental impacts. Some were abandoned; others simply changed ownership as operations ceased. Environmental problems range from extensive areas of unreclaimed waste piles with acid drainage discharging into streams to dispersed mill tailings that have impacted streams along much of their length. These impacts are the legacy of historical mining that we are attempting to remediate throughout the west today.

USGS ACTIVITIES

The USGS has been active in identifying, characterizing and monitoring environmental conditions at AML sites since the 1980s. Much of the work has been focused on a science based watershed approach to characterize AML sites and support effective remediation of inactive and abandoned mine lands. The components of the watershed approach include statewide prioritization, watershed and site characterization and monitoring (USGS 1999a). Using the watershed approach, the USGS efforts have focused on the Animas River in Colorado and the Boulder River in Montana. These two drainages have somewhat similar mining histories, but significant differences in the mineral deposit types and geology. The Animas drainage is characterized by high potential for environmental problems based on the mineral deposit types and number of mines. The Boulder watershed has lower risk based on mineral deposit types and number of mines and was included as a different geologic and geographic setting. These watershed investigations enabled the USGS to estimate pre-mining conditions, define current conditions, identify and characterize sites, sources and ecosystem health, and develop cleanup goals and a monitoring network for land managementagencies. The USGS has also focused on the use of tracers for monitoring impacts

because of the complexities measuring streamflow in mountain streams (USGS, 1999b). The USGS has also identified and studied pertinent processes taking place at inactive mine sites.

AML Progress

Montana

In Montana the BLM has coordinated AML remediation work with the State of Montana, DEQ, the USGS, USFS and private landowners. In 1997 BLM, in cooperation with the Montana Bureau of Mines and Geology (MBMG) and the USFS, completed an inventory of all AML sites on public lands. Following completion of this inventory work, BLM began to develop priority projects in conjunction with work done by the USGS, USFS and DEQ. The various agencies recognized that because many of these sites often involved a complex mix of private and public (BLM and USFS) administered lands the most logical process would often involve a coordinated approach so as to maximize both the reclamation/remediation and the value of the projects.Typically the agency with the majority of land involved becomes the lead agency. If the majority of land is private the DEQ is the lead. The lead agency contracts the design and reclamation work; the other agencies pay for the portion of work on the land they manage through interagency agreements or grants. Hiring one contractor improves the efficiency and results in significant cost savings. In many cases, a joint repository is sited in the most environmentally favorable location and often on federal land.Two of the earliest projects completed included the Park/Marietta Mine-North Fork of Indian Creek project and the Comet Mine/High Ore project. Total costs (BLM, USFS and DEQ) for the Park/Marietta-North Fork Indian Creek project was approximately US$1.6 million. Total cost for the Comet Mine/High Ore project (BLM and DEQ) was approximately US$ 3 million. The Indian Creek watershed was heavily impacted by hard rock mining in the upper reaches of the drainage, and by extensive placer mining in the lower reaches of the drainage. The project reclaimed the abandoned Park Mine site (Figures 1 and 2) and provided a repository on private lands for streamside tailings, which had been deposited throughout the North Fork drainage on USFS, BLM and private landsas flood events breached tailings impoundments below the Park mine.

Figure 1. Park-Marietta mine in 1996 prior to reclamation.

Figure 2. August 2011, photo taken from approximately the same point after reclamation of the Park-Marietta Mine.

High Ore Creek was similar to Indian Creek with the Comet mine, an inactive hard rock site, at the upper end of the drainage. Extensive streamside tailings deposits are located below the Comet mine on both BLM and private lands, extending down High Ore Creek to the Boulder River (Figure 3). Both the USGS and the MBMG had completed extensive characterization work in the drainage to help support remediation efforts (Fey and Church 1998). The DEQ had completed initial reclamation work at the Comet Mine in 1990 and 1997 in coordination with BLM, which provided a repository site. BLM with the support of USACE and DEQ and several private landowners have coordinated to complete restoration

along High Ore Creek (Pioneer Technical Services 1997, 1999, 2000). Figure 4 below shows the streamside vegetation 12years after the reclamation was completed. Total BLM expenditures for the High Ore Creek project totaled slightly less than US$2,000,000. DEQ expended approximately US$1,200,000 on their initial work at the Comet Mine. We expect to continue monitoring the reclamation worksat both Indian Creek and High Ore Creek with assistance from other government agenciesand local universities (Nimmick 2007)**.**

Figure 3.Upper High Ore Creek prior to reclamation.Figure 4. The same stream reach 10 years after reclamation.

The BLM has completed eleven other projects in western Montana involving collaborationwith DEQ with BLM's share of the projects totaling approximately US$5,000,000. Costs are generally shared on a pro-rata basis. Interagency coordination is developed through annual coordination meetings and routine staff contacts. One of the most recent projects included coordination with the Great Divide Ski area north of Helena, where hillside tailings impacted one of the ski runs. BLM, DEQ and the ski area coordinated to have the tailings removed and hauled to a repository located on BLM administered lands. This repository also served as a destination for waste from an adjacent DEQ project. Additionally, the BLM has unilaterally completed six AML reclamation projects in western and eastern Montana and South Dakota totaling over US$5,000,000 and cooperated with EPA on another two projects.The BLM has also completed over 400 projects to make hazardous mine openings (HMOs) safe, either through physically closing, gating or fencing hazardous sites.

Colorado

In Colorado early work by both the USGS and BLM were concentrated in the Animas River Watershed. Inventory work completed in the Animas drainage indicates that a total of 60 mines will require cleanup work. As in Montana, the primary effect of the historic mining in the drainage is degraded water quality and riparian and aquatic habitat. Mining activities have severely impacted habitat for fish and wildlife.
BLM in Colorado has spent over US$1,500,000 primarily on cleanup of the upper Animas and Arkansas River watersheds and spends approximately US$100,000/yr on monitoring and maintenance efforts. This work began in 1994 with an inventory of abandoned mines on public lands and has continued with remediation efforts in partnership with other state, federal and corporate partners. To date over 100 minesites impacting water quality have been remediated and over 1500 hazardous mine openings have been closed or otherwise made safe.

All the remaining inactive mines on federal lands in Colorado have been inventoried and have been identified as future projects for cleanup except those with land status issues.

Other StatesNevada has been working on the inventory and characterization of AML sites since 1994 and has identified over 100,000abandoned hardrock mines on public lands in Nevada, including 13 mines that

may impact water quality in several priority watersheds. Nevada BLM has completed 5 water quality AML projects and over 200 physical safety sites have been remediated.

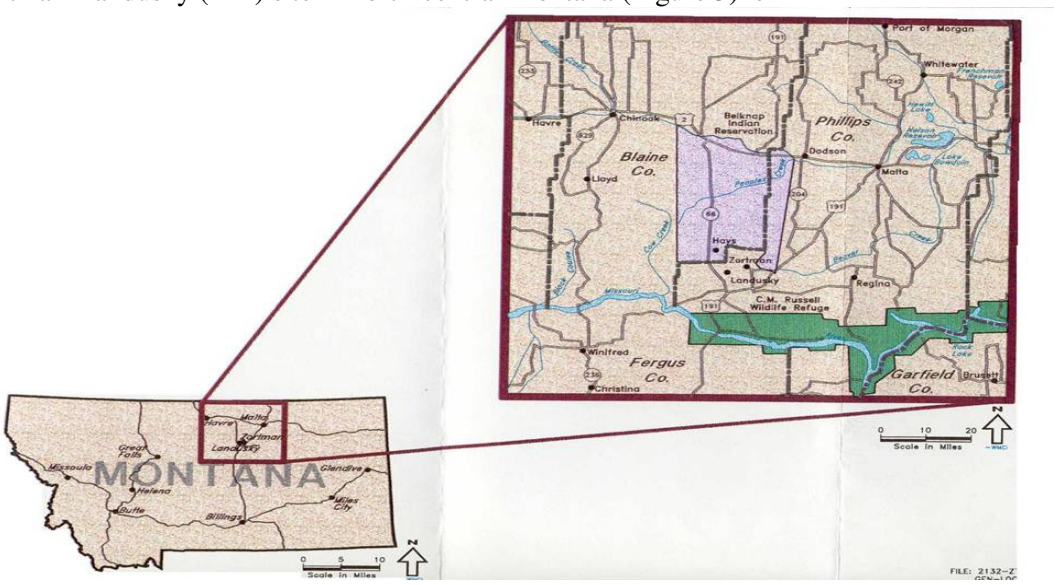
Utah has identified over 10,000 AML sites on public land and has completed a major watershed remediation project in the Cottonwood Wash watershed in partnership with other State and Federal agencies.

The BLM in Arizona, California andNew Mexico has been primarily involved in inventory and characterization work. Idaho BLM has been involved in the Bunker Hill and Kellogg area Superfund cleanup. Washington BLM has been actively involved in the Midnight uranium mine cleanup, coordinating with EPA and other agencies.Wyoming, because of the availability of OSM funds, has long had an active AML program.

Newer AML Challenges

As complicated as some of the older AML sites are, they are generally smaller sites, limited in areal extent. Examples of newer, larger and more complexsitesare the Beal Mountain and Zortman-Landusky mines in Montana,the resultofthe Pegasus Gold Corporationbankruptcy. The Beal Mountain site west of Butte is managed by the USFS and has cost over US$17 million in federal and state funds in the 13 years since the 1998 bankruptcy.

The Zortman-Landusky (Z-L) site in north-central Montana (Figure 5) is



located

Figure 5.General location of Zortman-Landusky site.

in the Little Rocky Mountains, one of Montana's "island mountain ranges" east of the main Rocky Mountains.

Following the 1998 bankruptcy, reclamation at the site was completed in 2005 by the BLM and DEQ using a combination of financial assurance and public monies (Williams et. al., 2009). Operating and maintenance costs for the existing water treatment plants and the site have been paid with mostly public monies, though a trust established through the bankruptcy will provide approximately US$700,000 annually until2017, when additional state and federal monies will be used. This is approximately ½ of the annual operating expenses (DEQ,2011).

In late May of 2011 the Z-L site received over 30 cm of rain in approximately 30 hours. The National Weather Service, Great Falls, Montana estimated the total May precipitation events in north central Montana to represent a 270 year recurrence interval event. The specific recurrence interval for the Z–L event was not calculated, but may well have been an even larger storm.

The storm severely impacted a wide variety of reclamation and water treatment infrastructure, including the Swift Gulch water treatment plant (Figures 6 and 7 below), roads and waste and water collection and storage facilities throughout the site.

Figure 6. During the storm water flowed through the building housing the treatment plant, to the right (Figure 7), an elevation difference of approximately 3.5 meters from theflow pictured above.

Figure 7.Swift gulch ARD treatment building, showing evidence of flow through the building.

The resulting downcutting, disruption and destruction of the installed collection infrastructure resulted in a repair cost of approximately US$252,500 at the Swift Gulch treatment plant.

The Carter Gulch waste dump (Figures8 and 10below) was originally reclaimed in 1998.The rock in the toe of the dump had been altered by weathering and oxidation and was subsequently saturated. The failure of the midslope diversion channel during the storm event triggered the dump failure, resulting in an oversteepened and unstable dump face. Repair of this slope is estimated to range from US$300,000 for short term stabilization to approximately US$14.5 million for dump relocation. Figure 10 shows in detail the various water collection features washed out as the dump failed. Roads and erosion control infrastructure throughout the site were heavily impacted, as shown in Figure 9below. Costs for repairs to the road infrastructure are in the orderof US$100,000. The total cost for repairs range from US$3 million to US$14.5 million, depending on how the Carter Gulch dump is handled.Repairs to the Z-L site will have to be funded by the state of Montana and/or bythe Federal government because the site went through a bankruptcy. Given the current austerity climate with public finances, the costestimate is an extremely sensitive issue.

Figure 8. Carter Gulch waste dump washout. Approximately 43,000 m^3 were washed down Carter Gulch, see figure 10 below.

Figure 9. Numerous roads and erosion control infrastructure features at the mine site were heavily damaged.

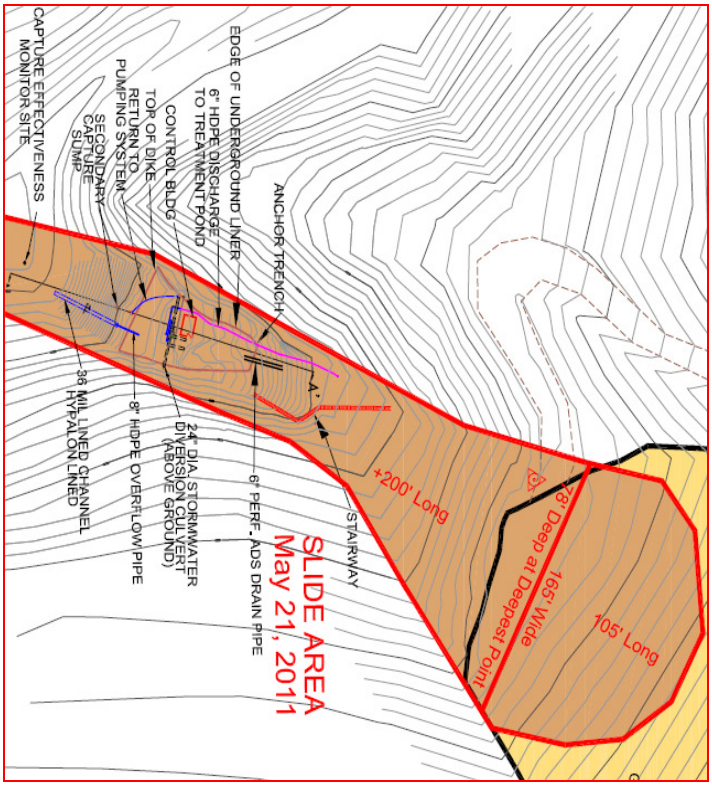


Figure 10. Detail of the various water control and collection features destroyed when the Carter Gulch dump failed.

SUMMARY OF REMEDIATION ACCOMPLISHMENTS

Following the BLM's success in the Boulder River and Animas River watersheds and in other areas, the US Congress has consistently appropriated monies to the BLM for its AML program., This funding has enabled the BLM to continue to inventory sites, remediate hazardous mine features and improve water quality at sites where mine wastes were impacting environmental quality. The BLM and other Federal and State agencies continue to make progress in remediating AML sitesthat represent both safety and environmental hazards.When BLM can partner with federal, state and private parties, funding and

reclamation opportunities are dramatically improved. The newer, larger sites, as represented by Zortman-Landusky and Beal Mountain, will continue to be challenges as the agencies try to remediate additional sites and maintain existing remediated sites. In a time of budgetary austerity and a changing climate, only by state and federal agencies working together will continued progress be possible in dealing with our legacy sites.

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