



San Luis Mine (gold) in San Juan National Forest, Colorado

## Valuing Alteration

Alteration of the land for mineral resource extraction is often viewed negatively. However, many productive land-uses can be created from highly disturbed mining sites. The following pages introduce some of the conflicts and misperceptions surrounding mine reclamation. Each case study combines text and image to evaluate the post-mining landscape according to the following topics:

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Case Study: Post-Mine Land Use (pg. 20-23)

### Proximity to Value

Case Study: Summit County, CO (pg. 24-27)

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## Mined vs. Reclaimed



**MINED**

Summitville Mine, Colorado



**RECLAIMED**

Summitville Mine, Colorado

# Case Study: Summitville, CO

VALUE RATIO  
1.1:1

## What is the real cost of mining?

Reclamation costs often exceed the net profits from mineral extraction. Due to low bonding requirements, companies often declare bankruptcy rather than clean up their mining operations, leaving taxpayers to foot the bill for reclaiming the environment.



**MINED GOLD VALUE**  
**\$165,000,000**

### Before Reclamation, Summitville, CO

Summitville Mine acid mine drainage reservoir contains high levels of heavy metals. Cyanide, heavy metals, and acid leaked from the gold and silver extraction operations from 1985 to 1992 killing all aquatic life for 17 miles downstream.



**RECLAMATION COSTS\***  
**\$150,000,000+**

### After Reclamation

Reclamation costs can exceed the value of the resources extracted, rendering little to no net value gain. With mining profits already spent, large reclamation costs are economically unfeasible and often result in bankruptcy.

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Fields, Scott. "The earth's open wounds: abandoned and orphaned mines." *Environ Health Perspectives*. Volume 111 Number 3 (March 2003): A154-A161. <<http://www.ehponline.org/members/2003/111-3/focus.html>> (26 October 2008)

Consumer Price Index. <<http://www.bls.gov/CPI>>  
Silver Prices-Historical. <[http://www.goldmastersusa.com/silver\\_historical\\_prices.asp](http://www.goldmastersusa.com/silver_historical_prices.asp)>

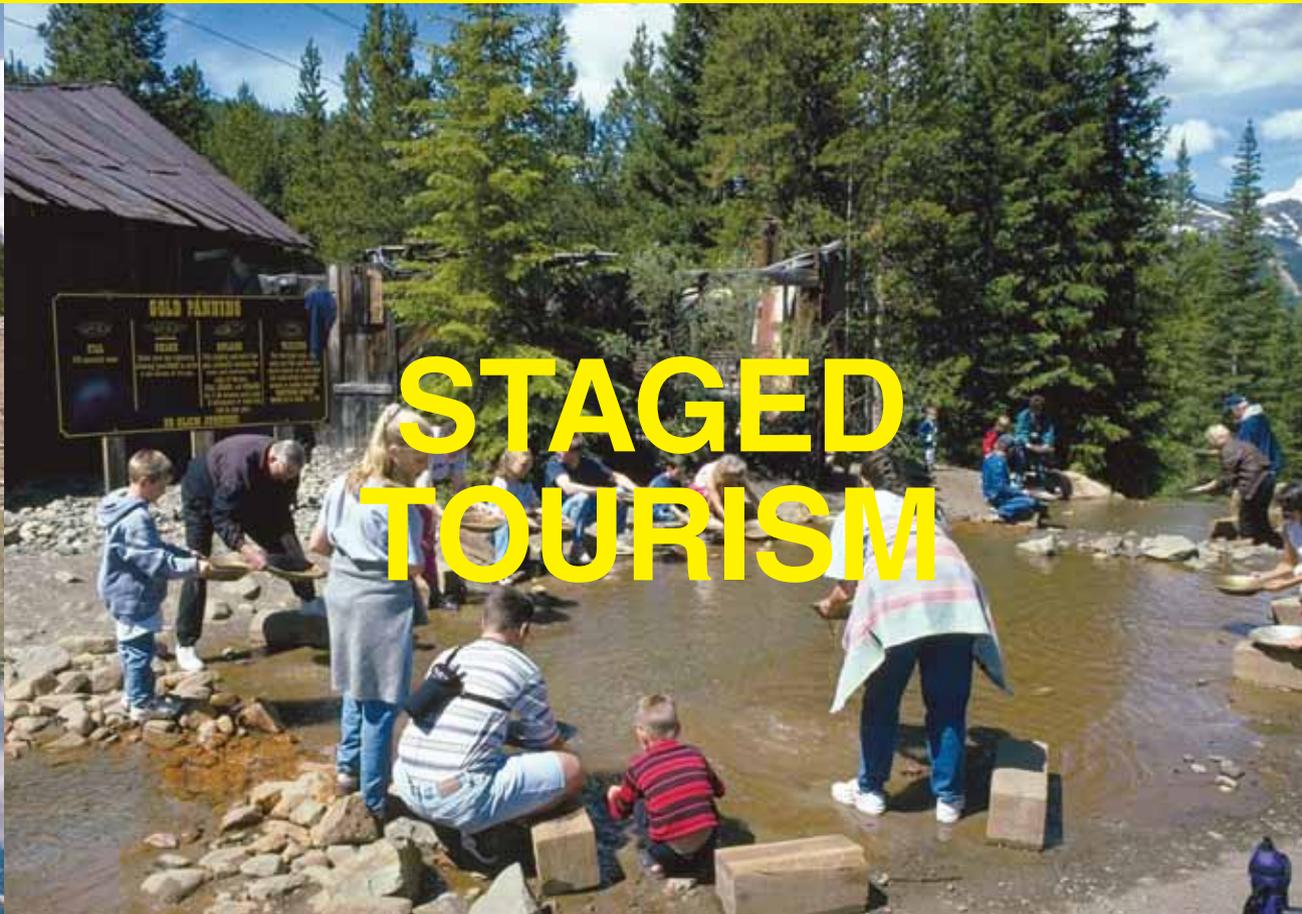
Gold Prices-Historical. <[http://www.goldmastersusa.com/gold\\_historical\\_prices.asp](http://www.goldmastersusa.com/gold_historical_prices.asp)> (26 October 2008)

\*(inflation adjusted value, 259,000 ounces extracted 1984-1992)

## Historical Authenticity vs. Staged Tourism



Mining Dredge Boat Relic, French Gulch,  
Breckenridge, Colorado



Country Boy Mine,  
French Gulch, Breckenridge, Colorado

# Case Study: Breckenridge, CO

## How are mined landscapes reclaimed for future generations to use and learn from them?

Mined landscapes are living ruins. They can simultaneously be dangerous and beautiful. Reclamation involves a conscious decision to erase the markings of the past or integrate them into the final design and land use. Post-mine land uses vary depending on local interests and needs.



### **HISTORICAL AUTHENTICITY**

**\$2,500,000 /YR**

(est. Open Space/Trails Budget from 0.5% sales tax)

#### **French Gulch Dredge Boat, Breckenridge, CO**

Dredge boat relics testify to the manner in which these sites are usually abandoned, as if the process of mining simply halted one day and all responsible parties flee the premise. If users could explore historical structures such as this one, without being exposed to health risks or hazards, the experience of mining history would be closer to authentic than an artificial re-creation or newly constructed artifact. Breckenridge's Open Space purchases and trails development are designed to safely access some of these heritage sites.



### **STAGED TOURISM**

**\$400,000 /YR**

(est. revenue/yr from tours at Country Boy Mine)

#### **Tourists pan for gold at Country Boy Mine, French Gulch, Breckenridge, CO**

Here tourists pay a fee to make-believe pan for gold in a safe pool of water. The tour mine operator 'seeds' the water with tiny bits of gold to create a touristic mining experience.

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Top figure calculated from the annual sales tax of 0.5% for Open Space and trails available at: <http://www.summitdaily.com/article/20090720/NEWS/907199995>  
<[www.townofbreckenridge.com](http://www.townofbreckenridge.com)>

Bottom figure calculated from the reported number of tours in 2008, found at:



**GEO TECHNICAL  
ENGINEERING**

Coeur Rochester Mine, Pershing County, Nevada



**INTEGRATIVE  
RECLAMATION**

Old Works Golf Course, Anaconda, Montana

# Case Study: Post-Mine Land Use

## Should post-mine land uses be designed and integrated earlier in the mining process?

We often remediate mining sites only to prevent more damage from being done to humans and the environment. Strictly engineered solutions often render sites useless for future programming, covering only the minimum in environmental legal limits. By creatively designing and integrating future land uses earlier in the mining process, economically viable outcomes can be reached. Recreational programming may yield a second life for the mining site.



### **GEOTECHNICAL ENGINEERING** **\$41,000,000**

(est. gross profit, Coeur Rochester Mine, 2007)

#### **Coeur Rochester Mine, Pershing County, NV**

Rising and falling mining commodity prices like gold can trigger the reopening or closure of mines such as this Nevada mine. Inexpensive hay bales are used for erosion control on recently mined land that has no integrated post-mine land use, serving as the cheapest form of geotechnical engineering. More extensive planning for post-mine land use might guide the engineering controls and design down a different path.



### **INTEGRATIVE RECLAMATION** **\$41,000,000**

(est. cost of building golf course on reclaimed land)

#### **Old Works Golf Course, Anaconda, MT**

Jack Nicklaus designed this golf course on mine waste. Black slag mine waste is reused as sand traps. The course remains open, popular, and thoroughly used with tee times available for \$33-44. Because the waste is entombed in the course, the management must keep track of any surface changes, replacing the soil in every tree hole and keeping drainage in check.

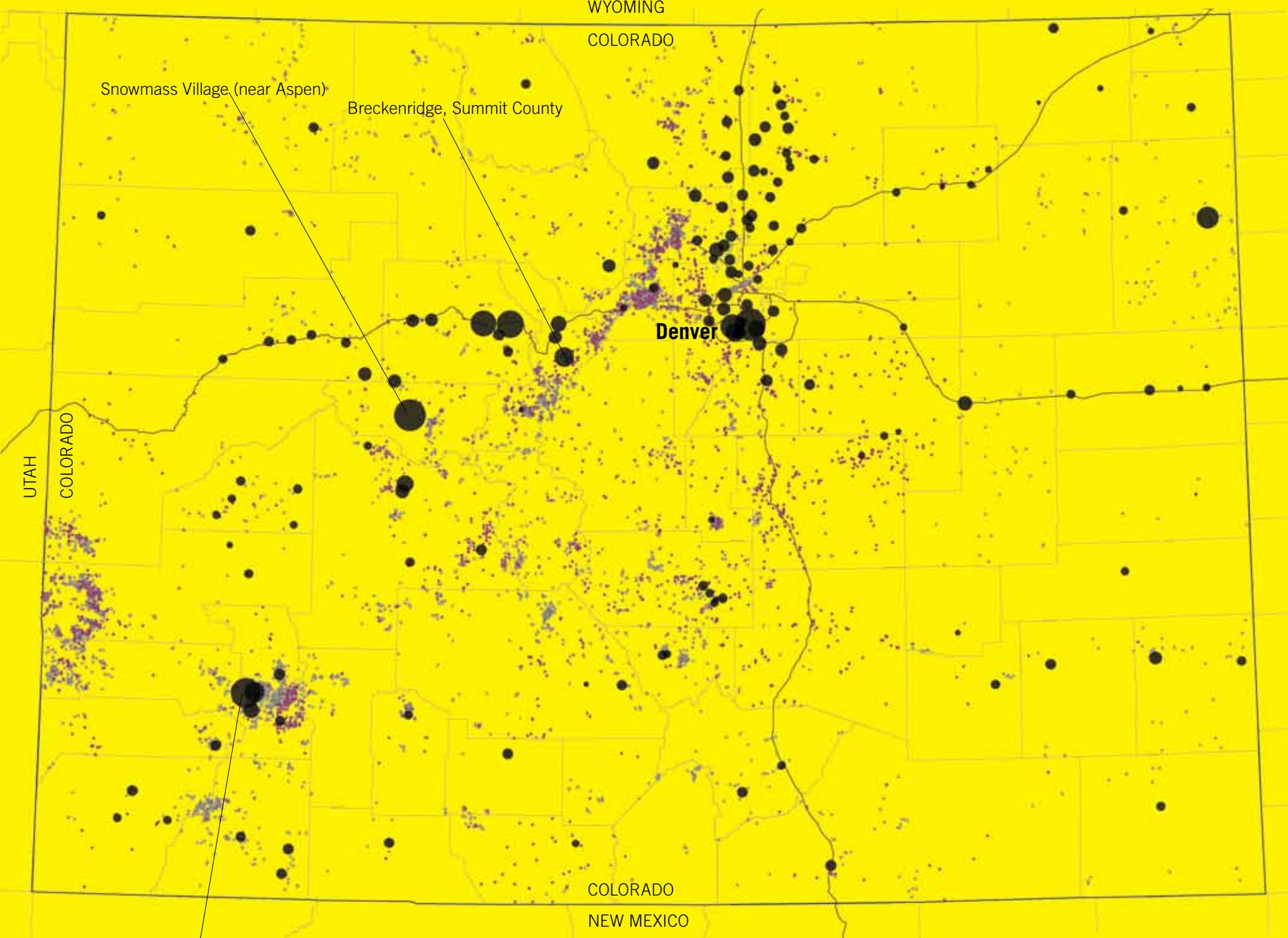
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Top figure from Coeur Rochester Financial Report, available at:  
<<http://www.coeur.com/operations-rochester-nevada.html>>

Bottom figure combines the cost of the golf course itself, at \$11 million, as well as the \$30 million clean up.

Total removal of contaminated material would have cost an estimated \$65 million. Additional information can be found here:  
<[http://grounds-mag.com/golf\\_courses/grounds\\_maintenance\\_golf\\_course\\_reclaim/](http://grounds-mag.com/golf_courses/grounds_maintenance_golf_course_reclaim/)>

# Proximity to Value, Colorado



**LEGEND**

Average land values adjacent to mine activity

- Active Mine
- Inactive Mine
- \$ 1,000,000+
- \$ 250,000 - 999,999
- \$ 100,000 - 249,999

# Case Study: Summit County, Colorado

## How close is your home to an abandoned mine?

With populations moving further out of central cities, more people than ever live in close proximity to active and abandoned mine sites. In Colorado, general proximity to a mine is not a determinant of less land value. In fact, many recreational hotspots and resort towns overlap with relic mining districts. Multimillion dollar homes often sit near towns that were built solely on the economic activities of mining, many of which resulted in multimillion-dollar reclamations. Colorado serves as an example of how numerous the active and inactive mining sites are and how close they often sit to high-value real estate.



**\$ 330,700** Median price of new home in Western Region, 2007

**\$ 615,384** Construction costs per residential building permit, Summit County Unincorporated Area, 2006-2007

**\$ 709,713** Construction costs per residential building permit, Breckenridge, Summit County, 2006-2007

**271** Number of inactive and active mines in Summit County

United States. Department of Housing and Urban Development. Office of Policy Development and Research. *U.S. Housing Market Conditions: 4th Quarter 2007*. February 2008. <[http://www.huduser.org/periodicals/ushmc/winter07\\_1/USHMC\\_Q407.pdf](http://www.huduser.org/periodicals/ushmc/winter07_1/USHMC_Q407.pdf)> (2 December 2008)

United States. Geological Survey. Mineral Resources Data System. [Reston, Virginia:] U.S. Geological Survey, 2005. <<http://tin.er.usgs.gov/mrds>> (2 December 2008)

United States. Census Bureau. Annual new privately-owned residential building permits single family for places in Colorado. <<http://censtats.census.gov/cgi-bin/bldg-prmt/bldgsel.pl>> (2 December 2008)

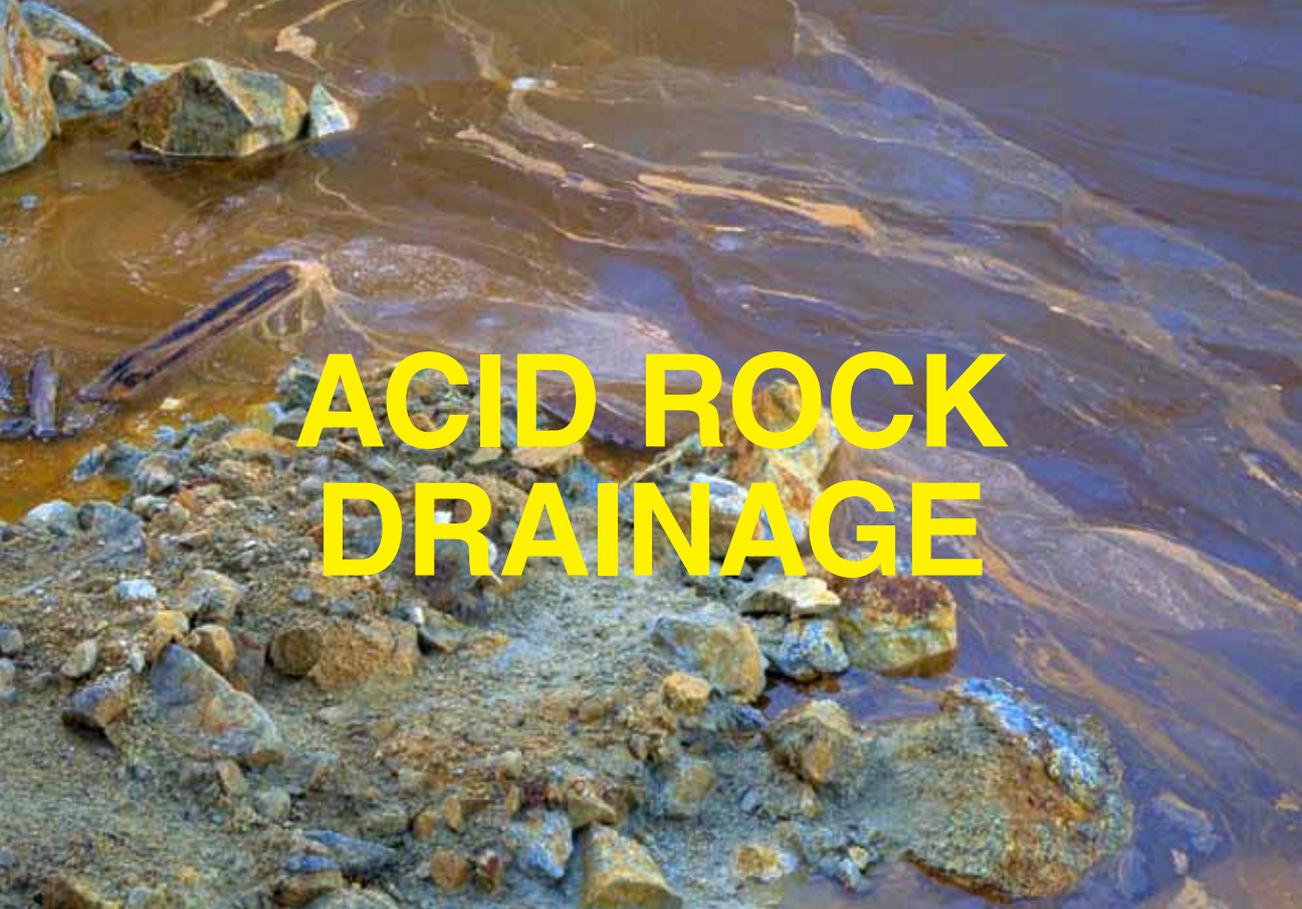
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## Water Quality vs. Acid Rock Drainage



**WATER QUALITY**

Surface water pooling, Arizona mine



**ACID ROCK DRAINAGE**

Acid rock drainage at Berkely Pit Mine, Butte, Montana

# Case Study: Water Quality & pH

## Is pH a measure of reclamation success?

The quality of natural water sources varies depending on location, context and geology. While most humans, fish and animals need water around pH6.5 to live, some organisms (mostly microbotic) flourish in highly acidic, lower pH conditions found on mining sites. These conditions, though rare, are also found in the natural world, where rock fissures come into contact with surface waters. The end use, preceding site conditions, and ecological potential should help guide the desired pH level for reclamation.



## ACID ROCK DRAINAGE

During reclamation, pH can be mechanically adjusted to liberate metals in water sources, resulting in better water quality.

**pH 2.5**

### **Mining Pit Lake**

Berkeley Mine, Butte, MT

**pH 3.5**

### **Natural Acid Drainage**

Upper Alamosa River Watershed, CO

**pH 5.0**

### **Lowest pH fish eggs will hatch**

Generic threshold

**pH 6.5**

### **French Gulch**

Breckenridge, CO

**pH 6.5 - 7.5**

### **Drinking Water Standard**

EPA

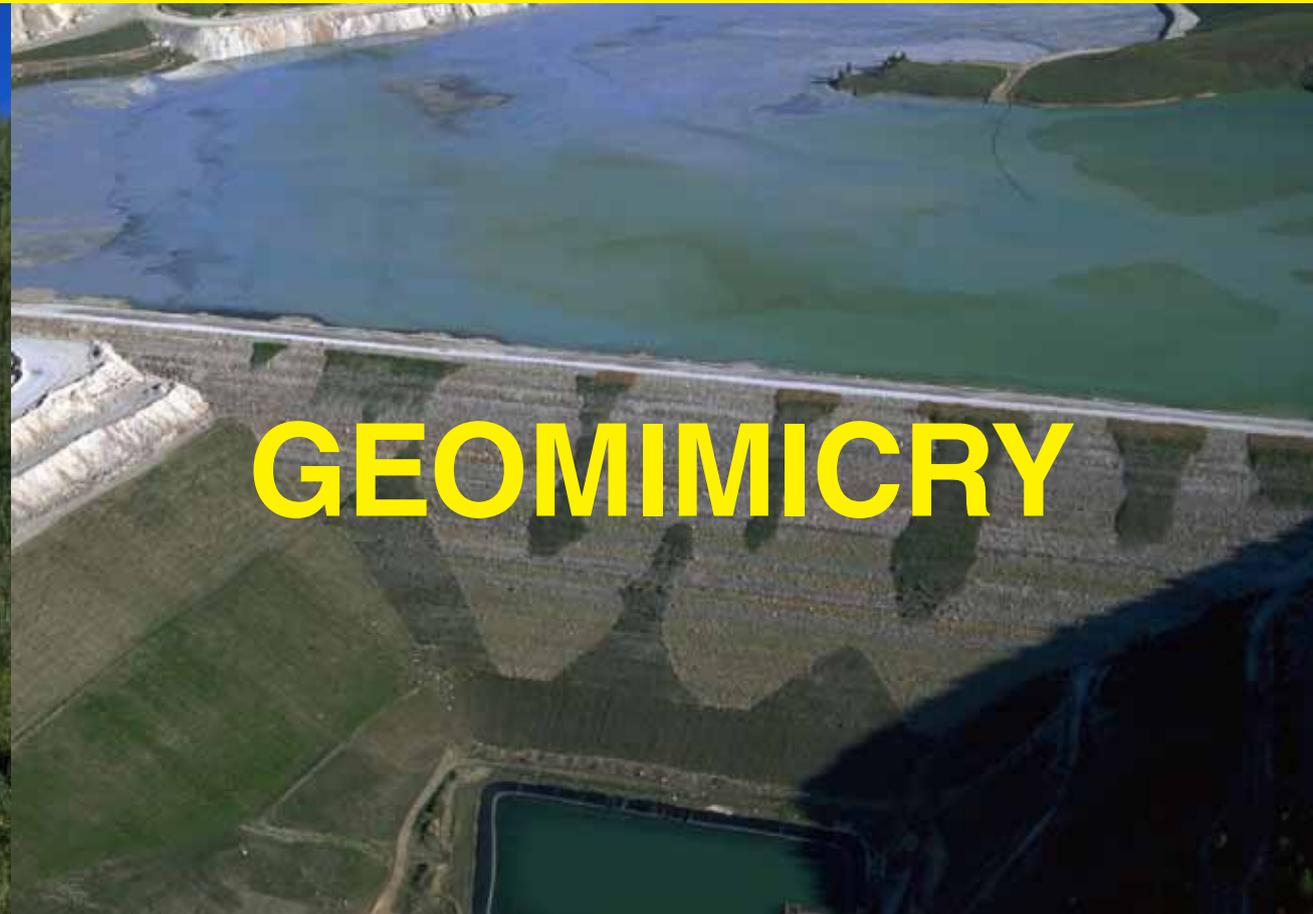
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< <http://pubs.usgs.gov/wri/wri014027/>>  
Newbrough, P. and C.H. Gammons. "An experimental study of water-rock interaction and acid rock drainage in the Butte mining district, Montana." Environmental Geology 41 (2002):705-719. <[http://www.mtech.edu/mines/geological\\_eng/PDF/NewbroughGammonsEnvGeol02.pdf](http://www.mtech.edu/mines/geological_eng/PDF/NewbroughGammonsEnvGeol02.pdf)> (2 December 2008)



# REBUILDING HABITAT

Bat habitat in mine shaft entry,  
Idaho potash mine



# GEOMIMICRY

Montana Tunnels Zinc Mine, Montana

# Case Study: Post-Mine Habitats

## Can mining sites serve as significant habitat areas for endangered or other species?

If endangered species are found on a site, several regulations may apply to how the site can be altered. A series of actions by the U.S. Fish and Wildlife Service may be taken to designate critical habitat and protect the water, land, and air associated with that species. This designation may significantly alter the reclamation plans of a mining site, transforming what was considered dysfunctional waste into potentially viable habitat. Providing new habitat for any ecologically valuable species may help garner financial, public and private support for reclamation design.



### REBUILDING HABITAT

#### Potash Mine Bat Gate, ID

Bat gates or cupolas ensure the protection of bat roosts, which often develop in abandoned mines. Many mining adits and openings are little different than natural caves, helping build new habitat for bat populations to roost and expand.



### GEOMIMICRY

#### Montana Tunnels Mine, MT

One reclamation strategy involves mimicking the patterns of vegetation found in various geomorphological environments. In this case, the technicians attempted to approximate the pockets of soil and accumulation of vegetation on natural talus and scree slopes at a steepness of 1:75:1. The rationale is that plants might better survive in a reclamation scenario if their structure and environment mimicked the closest natural equivalent.

**Water Reservoir vs. Wetland**



Climax Molybdenum Mine, Colorado



Miami Mine and smelter, Claypool, Arizona

# Case Study: Post-Mine Water Use

## How can inactive mining sites potentially address the widespread water limitations in the West?

Water, as a scarce resource, could present an opportunity for certain types of relic mining sites. If metal pollution or acid mine drainage are not present, topographical and hydrological engineering can provide water storage and valuable aquatic habitat in the arid Western region. If cleansing and polishing of water drainage is needed, wetlands might be a low cost design alternative. Both options have tourism potential for the resort towns that are often in close proximity to mining sites.



### **WATER RESERVOIR** **4,600**

(acres owned by parent company, 2009)

#### **Climax Molybdenum Mine, CO**

Climax Mine and other mines that sit at high altitudes in the upper reaches of watersheds possess great potential as water storage sites. Simple site manipulation can yield a range of reservoir sizes and types. Climax was the world's largest Molybdenum mine and sits high above the town of Breckenridge at Fremont Pass. Freeport-McMoran Copper & Gold, Inc., the current owner, is currently spending hundreds of millions to update the mine and restart operations.



### **WETLAND** **9,060**

(acres of Miami Mine operations, 2006)

#### **Miami Mine, Claypool, AZ**

The complex assemblage of mine tailings, pits and processing facilities at the Miami Mine has waxed and waned with the commodity price of copper. The water that falls onto the site and courses beneath it contains high levels of metals and acidity due to interaction with the exposed rock. Regardless, these shallow wetlands attract waterfowl and aquatic vegetation.

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"Dig It: Climax mine plans still on hold,"  
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summitdaily.com/article/20090730/  
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