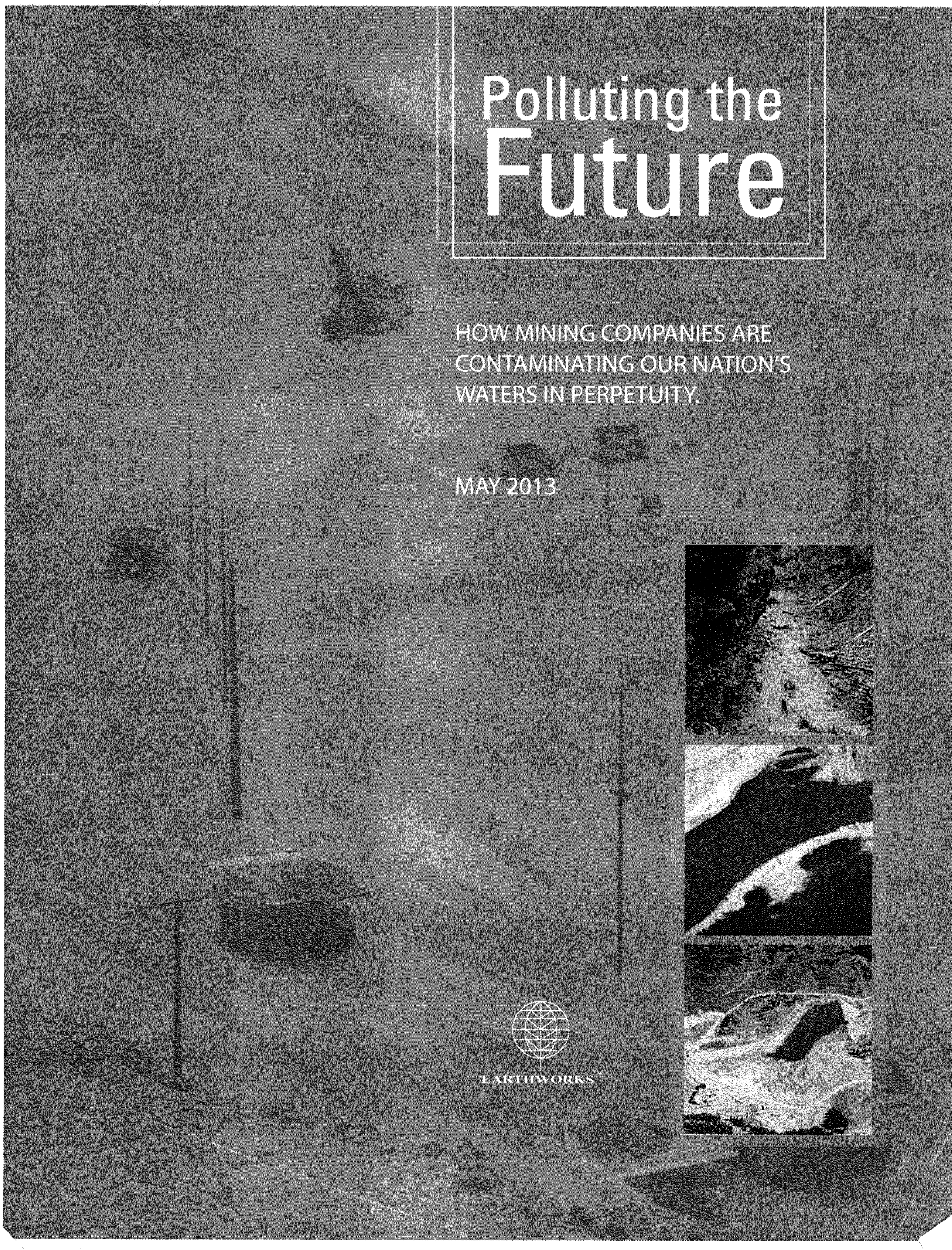
Polluting the Future

HOW MINING COMPANIES ARE CONTAMINATING OUR NATION'S WATERS IN PERPETUITY.

MAY 2013



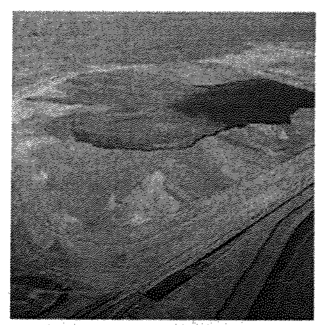
EARTHWORKS™

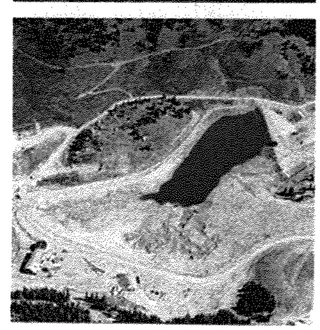
Polluting the Future:

How mining companies are contaminating our nation's waters in perpetuity.

EARTHWORKS, May 2013

By Lisa Sumi, environmental research and science consultant,
and Bonnie Gestring, Earthworks





PHOTOS AT RIGHT, TOP TO BOTTOM:

Zortman Landusky Mine, Montana. Photo by Andy Huff.
Bingham Canyon Copper Mine, Utah. Photo by Ecoflight.
Chino Mine, New Mexico.
Summitville Mine, Superfund Site, Colorado. Photo by the U.S. EPA.

COVER PHOTOS:

BACKGROUND: Bingham Canyon Copper Mine, Utah.
MIDDLE: Chino Mine, New Mexico. Photo by Gila Resources Information Project (GRIP).

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Executive Summary

Water is a scarce and precious asset, particularly in the western United States where the demand for freshwater is far out-pacing the supply. In order to access clean water, western states are proposing extraordinary investments, ranging from plans to spend $15 billion to transport water across the state of Nevada, to ideas for a pipeline from the Missouri River to Denver to offset the loss of water from the Colorado River, which in turn is struggling to provide water to seven states.[1]

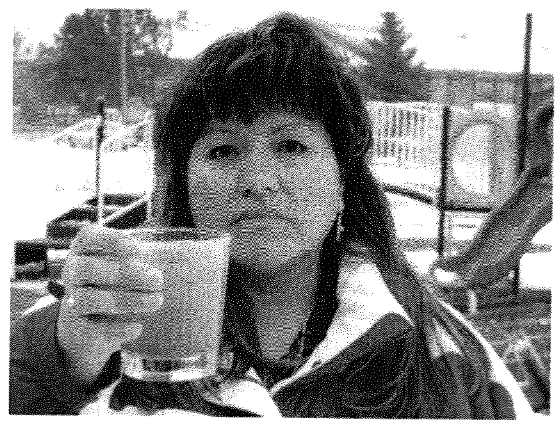
In the midst of declining fresh water supplies, an increasing number of hard rock mining companies are generating water pollution that will last for hundreds or thousands of years and new projects are on the horizon. Perpetual management of mines is a rapidly escalating national dilemma.

Our research shows, for the first time, the staggering amount of our nation's water supplies that are perpetually polluted by mining.

A lengthy review of government documents reveals that an estimated 17 to 27 billion gallons of polluted water will be generated by forty mines each year, every year, in perpetuity. This is equivalent to the amount of water in 2 trillion water bottles – enough to stretch from the earth to the moon and back 54 times.

Perpetual pollution from metal mines has contaminated drinking water aquifers, created long-standing public health risks, and destroyed fish and wildlife and their habitat.

The primary cause of this lasting pollution – acid mine drainage – is well understood. Yet, no hard rock open pit mines exist today that can demonstrate that acid mine drainage can be stopped once it occurs on a large scale.[2]



Acid mine drainage from Zortman Landusky mine, which operated from 1979-1997, yet water pollution will continue in perpetuity.

Acid mine drainage occurs when mineral deposits containing sulfides are excavated during open pit mining, and exposed to air and water. The sulfides in the exposed rock react with the oxygen and water to create sulfuric acid, which leaches other harmful metals from the surrounding rock, creating a toxic "soup" called acid mine drainage. Mines with acid drainage generally require on-site treatment in perpetuity.

The cost of water treatment is considerable, and is shouldered by the American taxpayer if the mining company is unable or unwilling to pay to clean up the toxic mess.[3] The long-term public liability is enormous: taxpayers are expected to pay for centuries of water treatment – long beyond the expected life of any mining corporation.

According to our research, water treatment costs at these mines are estimated to be a whopping $57-67 billion per year – a debt that our children and grandchildren are likely to shoulder to ensure clean water.

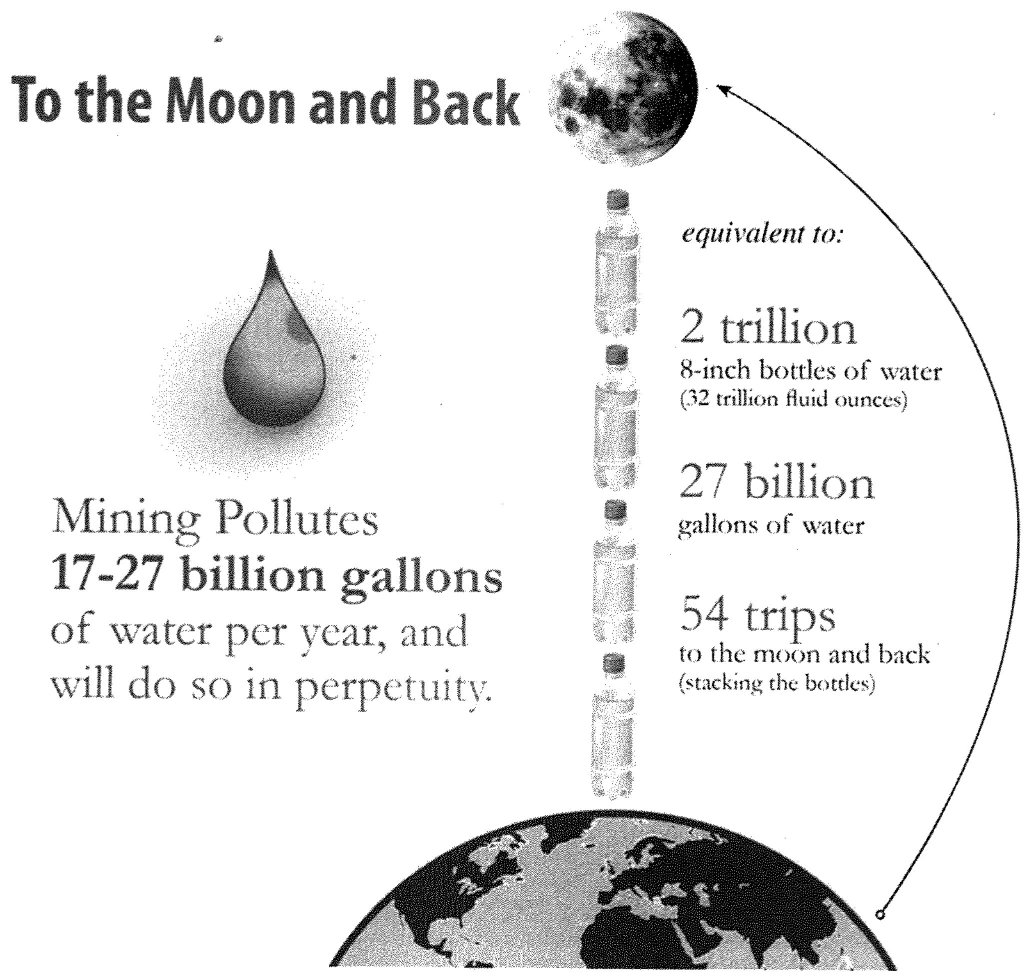
Metal prices are at record highs, driving proposals for new mines that could generate perpetual water pollution. Four new mines are currently proposed, which are predicted to generate perpetual pollution, or at high risk for perpetual pollution – an estimated 16.7-16.9 billion gallons a year. One of these high risk proposals is the Pebble Mine in Alaska, threatening the nation's largest wild salmon fishery. Yet, state and federal mining regulations are not equipped to address the lasting consequences to our nation's water resources.

Equally alarming is the growing number of mine pits, containing large volumes of water, which will persist forever. Although they are often referred to as pit "lakes," these mine pits generally contain polluted water that presents a permanent hazard to public health and wildlife.[4] The problem is at its worst in Nevada, where a University of Nevada scientist has determined that mine pits from gold mines will contain more water than all of the fresh water reservoirs in the state, excluding Lake Mead.[5]

"It is very troubling to me that we have foreign corporations come in, sometime with American subsidiaries that have no assets, then wind up going bankrupt, having left a mess behind that is almost irremediable [without a fix]."

— Senator Tim Johnson about acid mine drainage at the Brohm Mine, *Black Hills Pioneer*, May 22, 2000.

New policies are needed to ensure the responsible development of our mineral resources, and to protect against decisions that result in permanent harm to our nation's waters. State and federal laws should be reformed to ensure that mining corporations demonstrate their ability, up front, to operate without creating perpetual water pollution. Regulations should be developed to restore protections against mine waste disposal in our nation's waterways, and to ensure that the financial responsibility for treatment is not shouldered by taxpayers; the bill for clean up should be placed squarely in the hands of the mining companies themselves.



Methods

For the purposes of this report, "in perpetuity" is defined as water pollution that will continue for hundreds or thousands of years, or for which government agencies can't predict a point at which water quality standards will be met without treatment.

The data in this report are based on information gathered from a lengthy review of state and federal government documents and correspondence with agency representatives. Company information and media reports were used as supporting documentation only when government data could not be located. Data sources for each mine site can be found at the end of the report.

The data are divided into three tables:

- Table 1. Existing mines known to generate perpetual water pollution
- Table 2. Existing mines likely to generate perpetual water pollution
- Table 3. Proposed mines predicted to generate perpetual pollution, or at high risk of perpetual pollution

Acid mine drainage is toxic to aquatic life.

The mines in Table 2 have many of the same characteristics as the mines in Table 1 (e.g., complex acid mine drainage (AMD), mine adits draining AMD that are unlikely to be plugged and cannot be remediated, sites that have undergone remediation but continue to leach acid and/or metal-laden water, heap leach pads that are likely to drain contaminated water at a steady-state volume for an indeterminate amount of time, etc.). These are definitely long-term pollution problems, but for these sites we were unable to find documentation that stated that water treatment would be required in perpetuity.

The volumes in Table 2 are significantly underestimated because we did not attempt to do a comprehensive review of "likely in perpetuity" sites. In many cases, volumes of contaminated water treated are reported in gallons per minute (gpm). Where treatment occurs on a continuous basis, we converted gpm to gallons of water treated per year using the following calculation:

Gallons per year = gpm x 60 minutes/hour x 24 hours/day x 365 days/year

It should be noted that there are mines in Arizona with acid mine drainage issues that may require long-term treatment, but public access to mining-related data from Arizona is limited. For the purposes of this report, it would have been too time consuming and potentially costly to obtain information through Public Records requests.

Site-specific water treatment costs are included, where available. As seen in the charts, cost data were not found for two existing "in perpetuity" sites, four sites that potentially require long-term or perpetual treatment, and two proposed mining projects that would require treatment in perpetuity.

Results

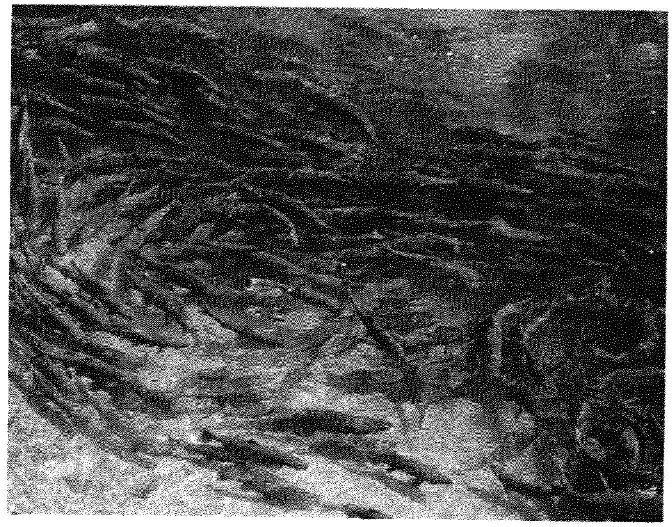
This report quantifies the impacts of perpetual pollution from hardrock mining to one of our nation's most valuable assets: **Water!** According to our research:

- An estimated **17 to 27 billion gallons of contaminated water** will be generated by forty hardrock mines, every year, in perpetuity (for hundreds or thousands of years).
- That's equivalent to the amount of water in **128 billion to 2 trillion water bottles – enough to reach to the moon and back 34 to 54 times.**[6]
- Water treatment costs for these mines is currently estimated at **$57-67 billion per year – a substantial long-term liability, given the uncertainties of financial assurance calculations, and the unlikelihood that the responsible party (i.e., mining corporations) will persist in perpetuity.**
- **62% of the mines** (25 out 40) are located, in part, on public lands.
- Another 13 mines are likely to generate water pollution in perpetuity, accounting for an additional **3.4 - 4 billion gallons of polluted water, per year.**
- Pollution from many of these mines has already contaminated drinking water aquifers, lakes and streams, agricultural lands, and prime fish and wildlife habitat.
- Four new mines are currently proposed, which are predicted to generate perpetual pollution, or at high risk for perpetual pollution – **an estimated 16.7-16.9 billion gallons a year.** One of these high risk proposals is the Pebble Mine in Alaska, threatening the nation's largest wild salmon fishery.

Mines generating perpetual pollution	Annual Volume of Water Pollution (billion gallons)	Annual Treatment Cost ($ billion)
Existing mines known to generate perpetual water pollution (Table 1)	17 to 27	57 to 67
Existing mines likely to generate perpetual water pollution (Table 2)	3.4 to 4	1.4 to 2.9
Proposed mines predicted to generate perpetual pollution, or at high risk of perpetual pollution (Table 3)	16.7 to 16.9	3.1
Total	37.1 to 47.9 billion gallons of water	62 to 73 billion $

Policy Recommendations

PROTECT VITAL PUBLIC RESOURCES: The EPA should use Section 404c of the Clean Water Act to protect Alaska's Bristol Bay – the nation's most productive and valuable wild salmon fishery.

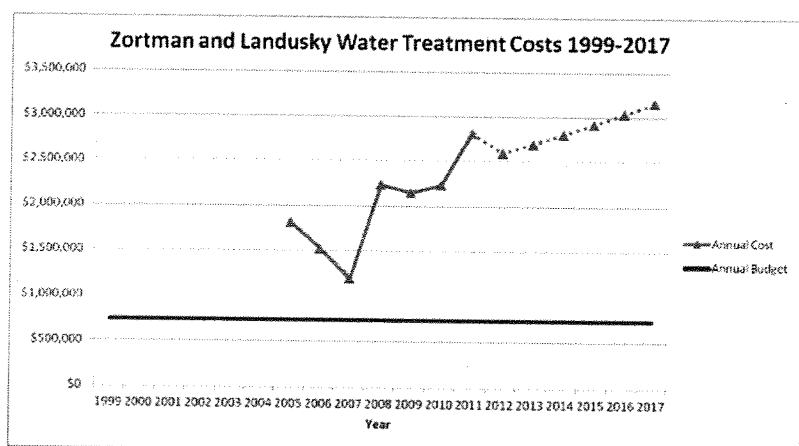


Bristol Bay, Alaska supports the world's largest wild salmon fishery.

The U.S. Environmental Protection Agency (EPA) has authority under Section 404c of the Clean Water Act to restrict the disposal of mine waste into rivers, streams, lakes or wetlands if the science shows that it will have an unacceptable adverse effect on fisheries.[7]

In 2010, Alaska's commercial fishermen and Alaska Native Tribes petitioned the EPA to use its 404c authority to restrict mine waste disposal from the proposed Pebble Mine into the waters of Bristol Bay, Alaska – which supports the most productive and valuable wild sockeye salmon fishery in the world.[8] The fishery is valued at approximately $480 million annually, supplies 14,000 jobs, and sustains the Alaska Native communities in Bristol Bay, who rely on the fishery as their primary source of food.[9]

In April 2012, the EPA completed and released a scientific study of the potential impacts to the Bristol Bay wild salmon fishery of developing the Pebble deposit.[10] The study outlined severe and lasting impacts to Bristol Bay salmon from the mine footprint alone, including the likely direct loss of 55-87 miles of streams used for spawning and rearing habitat for salmon and 2,500-4,000 acres of wetlands which provide additional salmon habit. The presence of sulfide in the Pebble deposit and its proximity to water, put it at high risk for acid mine drainage. The draft assessment and peer reviewed report identify the potential for water treatment in perpetuity.[11]



Annual water treatment costs at the Zortman Landusky mine have far exceeded the bond amount. Graph obtained from Montana Department of Environmental Quality.

The EPA should initiate Section 404c of the Clean Water Act to restrict mine waste disposal in Bristol Bay's waters to protect our nation's most important wild salmon fishery, and the businesses and Alaska Native communities that depend on it.

REFORM FEDERAL LAW:
Require hard rock mines to demonstrate, up front, that the mine can meet water quality standards without perpetual treatment.

Hard rock mining is no longer the "pick and shovel" enterprise of a century ago. Modern mines operate on a massive scale, and release more toxics to the environment than any other industry -- 1.9 billion pounds of toxic chemicals in 2011, the most recent data available.[12] Yet, mines on America's federal public lands are still governed by the 1872 Mining Law, which was enacted over 140 years ago to settle the west. The 1872 mining law contains no provisions to address long-term water pollution. Furthermore, most state laws are also inadequate to protect the public against perpetual pollution, with the noted exception of three states. New Mexico and Michigan effectively prohibit mines that will require perpetual management, and Wisconsin prohibits mining sulfide rock until a U.S. or Canadian mine in acid-generating rock has been operated and closed for 10 years without causing "pollution of groundwater or surface water from acid . . . or the release of heavy metals."[13]

It is possible to design many mines to preclude conditions that will require long-term water treatment.[14] Yet, there are some mines, particularly sulfide deposits, where perpetual pollution may be unavoidable. Research shows that mines with high acid generating potential and close proximity to water are at highest risk for water pollution.[15] If it is not possible to design preventative measures into the mine to ensure that, with a reasonable degree of certainty, it will not pollute in perpetuity, then the mine should not be permitted.

It is fundamentally bad public policy to permit mines that will require water treatment forever. Some argue that funds can be put into a long-term trust to generate sufficient interest to cover water treatment costs into the future. However, there is no way to ensure that financial assurance will cover the cost of water treatment in perpetuity. No one can predict what water treatment costs will be 50-100 years in the future, or if economic conditions will generate a return on investment, or even if the institution that holds the bond will be in existence.

"At Zortman and Landusky (mine), through this month, I have personally signed invoices totaling $56 million dollars, and there's no end in sight."

—Warren McCullough, head of Montana's mine permitting program, testifying at Montana Senate Natural Resources Committee hearing about the cost of water treatment in perpetuity. February 18, 2011

Citizens who live downstream from a mine site should not have to live with the threat of upstream water pollution in perpetuity, nor should future generations. The long-term financial risk to the public, and the lasting consequence for our nation's water resources are too great. New regulations are needed in federal and many state laws that make it clear that the risks of such long-term water treatment are an unacceptable risk.

REDUCE THE RISK:
Restore regulations to prohibit mine waste disposal in waters of the U.S.

Congress enacted the Clean Water Act in 1972 to protect our rivers, streams, wetlands and lakes from being used as waste disposal sites. However, there are two loopholes in the regulations, approved in 2002, which allow the industry to dispose of mine waste directly in our nation's waters.

Under the first loophole, regulations that define "waters" allow mine developers to designate natural lakes, rivers, streams, and wetlands as "waste treatment systems," exempt from the Clean Water Act. For example, mine developers may dam a stream and dump their untreated wastes above the dam, rendering miles of the stream toxic and lifeless, based on the legal fiction that the water is no longer water, but a "waste treatment system." This exemption defeats the very purpose and spirit of the Clean Water Act.

In the second loophole, a 2002 revision of regulations redefined the term "fill material" under Section 404 of the Clean Water Act. Section 404, was intended to regulate the placement of rock, soil, clay, sand, and other normally inert materials in water for construction-related activities (under a permit issued by the Army Corps of Engineers, "the Corps"). For 25 years, the Corps prohibited using fill material permits to dispose of mine waste. In 2002, however, EPA and the Corps expanded the definition of "fill material" to include tailings from hard-rock mines.

The Brohm Mine (Gilt Edge), which operated from 1988-1996, will require water pollution in perpetuity due to severe acid mine drainage.

The effect of this change is that hazardous contaminants from mine waste are now exempt from EPA pollution rules and permitted—with no pollution control treatment at all—under a Corps regulatory scheme intended for relatively innocuous construction fill materials. Congress intended the fill rule to be used in water bodies for certain constructive purposes, such as building bridges or roads that have unavoidable impacts on waterways. This rule change reverses thirty years of mining policy, to once again allow mine waste to be deposited directly into America's streams and lakes. While discharging wastes directly into wetlands, streams, and lakes may be cheaper for mining companies, it is not the only way of doing business. Mines can treat their waste, dispose of it responsibly, and still operate profitably.

The good news is that EPA and the Corps can close the loopholes with a couple simple rule changes. First, the agencies should explicitly limit the waste treatment system exclusion to only manmade waters. This was, in fact, how EPA originally interpreted the regulation back in 1980. And second, EPA and the Corps can revise the 2002 definition of "fill" to once again exclude waste disposal.

HOLD CORPORATIONS ACCOUNTABLE:
Put the cost of clean up on the industry, not on the taxpayer.

The EPA has identified 156 hardrock mining sites nationwide that have the potential to cost between $7 billion and $24 billion total to clean up (at a maximum total cost to EPA of approximately $15 billion).[16] These costs are over 19 times EPA's total annual Superfund budget of about $775 million for 2013.[17] According to the EPA Inspector General, the majority (59 percent) of all the projected mines sites in the Comprehensive Environmental Response, Compensation and Liability (commonly known as CERCLA or Superfund) program will need 40 years to "in perpetuity" for cleanup. Furthermore, the agency questions the ability of businesses to sustain efforts for such lengths of time.[18]

"... our data also show that the majority (59 percent) of all the projected sites will need 40 years to "in perpetuity" for cleanup, and we question the ability of businesses to sustain efforts for such lengths of time."

— EPA Office of Inspector General report referring to metal mine clean-up liability in the Superfund program.

Most corporations have existed for far fewer than 100 years, and few modern governments have operated for more than 200 years. Mining corporations simply won't be around to manage water treatment that will continue for thousands of years.

Water pollution in perpetuity has real consequences for our economy and the surrounding communities.

"Contaminated water impacts the health of living resources and also agriculture, municipal and industrial water supplies, and commercial recreation. The socioeconomic effects of contaminated water include the increased costs of water treatment where practicable, the costs of developing additional sources of water where contaminated water cannot be rendered useful through treatment, and ancillary effects such as the inability of urban and rural subsistence fishermen to obtain a safe protein component for their diet."[19]

University of Nevada scientist has determined that mine pits in Nevada will contain more water than all of the fresh water reservoirs in Nevada, excluding Lake Mead.

For the existing mines that are polluting, or will likely, generate pollution in perpetuity, there is no way to put the genie back in the bottle. Yet, important regulatory changes can be made to reduce the liability to the public, and hold mining corporations more accountable for their pollution.

New regulations should be initiated to give the EPA authority to require financial assurance to better ensure that funds are in place for long-term water treatment. Applying CERCLA at high risk active mines instead of waiting for closure has the advantages that an operating facility generally has a positive cash flow and can obtain financial assurance required under a CERCLA order.

Based in part on concern over estimated total cleanup liability at US hardrock mines, the US EPA began the process in 2009 to establish federal financial assurance requirements for hardrock mining. This important rule-making needs to be completed, so taxpayers will be better protected, corporations held more accountable.

Table 1. Existing mines known to generate perpetual water pollution

Site name (Owner, if any)	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Red Dog[20] **(Teck Resources & NANA Corp.)**	AK	Predicted: 1.53 billion gallons until 2026; 1.35 billion gallons thereafter.	Predicted post-closure water treatment costs: $10,540,000	Active	Private	**Resources at Risk:** Untreated discharge would exceed water quality standards for ammonia, cadmium, cyanide, lead, nickel, selenium, zinc and total dissolved solids. Potentially affected resources aquatic organisms in the Middle Fork of Red Dog Creek, Ikalukrok Creek (spawning grounds for Arctic grayling and Dolly Varden char), and Wulik River, as well as the Kivalina water supply.
Iron Mountain Mine[21]	CA	Actual (2003 – 2007): annual treatment plant inflow ranged from 150 - 590 million gallons.	Operating costs (2007): $1.25 million.	Abandoned Superfund	Private	**Impacted Resources:** Contaminated water from the mine is metal-laden and more than 6,300 times more acidic than battery acid, which has caused the virtual elimination of aquatic life in sections of Slickrock, Boulder and Spring Creeks. Impacted organisms include Chinook salmon, steelhead and other resident trout species, hundreds of species of aquatic insects, clams, mussels and plants in the Sacramento River. Between 1981 and 1996 approximately 20 million fall-run Chinook salmon were killed in the river. Spring Creek downstream of the Stowell Mine and Iron Mountain Mine will never be clean enough to support a fishery. **Resources at Risk:** Sacramento River within 3 miles of the site is the source of drinking water for approximately 70,000 people. The river is a commercial salmon fishery and spawning ground for winter- and spring-run Chinook salmon, which is an endangered species.
Keystone, Rising Star and Bully Hills Mines[22]	CA	Estimated: 2.6 to 5.3 million gallons.	Approx. $20,000 per year.	Inactive	Private	**Impacted Resources:** Keystone mine discharges copper, cadmium, and zinc two miles upstream of the confluence with Lake Shasta. Copper in the discharge contributed to fish kills in South Fork Squaw Creek and the lake. Bully and Rising Star mines drain into Town Creek and an unnamed tributary to Horse Creek, which drains to Shasta Lake. Discharge from abandoned workings and waste rock dumps continues to degrade water quality and habitat conditions in the affected area of West Squaw Creek. **Resources at Risk:** The constructed wetlands treatment system at Keystone cannot consistently meet numeric effluent limits designed to protect all beneficial uses, including protection of aquatic life and sensitive fish species.
Lava Cap[23]	CA	Not yet treating. Estimated requirement: 46 to 69 million gallons.	Water treatment is required, but no treatment selected yet, so. Therefore no cost estimate.	Closed (1943). Superfund Site.	Private	**Impacted Resources:** Drinking water wells near the mine site have been contaminated with arsenic, in concentrations varying from two to ninety times the drinking water standard of 10 parts per billion (ppb). Fish in Lost Lake have been found to contain arsenic at low levels and consumption of these fish ordinarily would not be considered to present a high risk to people; however, EPA recommends limiting fishing recreation to catch-and-release at this time. **Resources at Risk:** Arsenic found in Little Clipper Creek and Lost Lake and in shallow groundwater below the tailings. The immediate watershed basin contains two California Species-of-Special-Interest (foothill yellow-legged frog and western pond turtle), and reptiles, amphibians, fish, birds, and mammals.

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	**State**	**Annual Volume of Water Pollution**	**Annual Treatment Costs (Operating and Maintenance)**	**Status**	**Land Ownership**	**Impacted Resources / Resources at Risk**
Leviathan[24]	CA	Actual (2011): 32 million gallons treated.	Operating costs (2011): $3.264 million.	Abandoned. Superfund.	Private, state and U.S. Forest Service land.	**Impacted Resources:** The mine, 24 miles southeast of Lake Tahoe, has contaminated a nine-mile stretch of mountain creeks. **Resources at Risk:** Leviathan Creek, E. Fork Bryant Creek, E. Fork of Carson River, which serves as major drinking water supply. Contaminated sediment and soil along the stream system may pose an increased risk to plants and animals, and humans who might use these resources.
Argo Tunnel[25] **Central City/Clear Creek**	CO	Argo Tunnel treatment plant actual (2011): 118 million gallons. A second treatment plant, in the design phase, is projected to treat 105 million gallons/yr.	Operating and maintenance costs (2010): $900,000. North Fork Treatment Plant (under design) O&M: estimated at $1,000,000	Closed and active. Superfund.	Private	**Impacted Resources:** Clear Creek, especially North Fork of the creek. Zinc, copper, cadmium and manganese are found in surface water and affect trout, aquatic insects and other aquatic organisms. **Resources at Risk:** Same as impacted.
Captain Jack[26]	CO	Estimated (2008): 26.3 million gallons.	Estimated O&M (2008): $28,500. May increase to $148,000 if Phase II is implemented	Abandoned. Superfund.	U.S. Forest Service, state and private.	**Impacted Resources:** Elevated levels of metals such as lead, arsenic and thallium are present in ground and surface water and sediment samples from Left Hand Creek, as well as its tributaries and wetlands along the creek. These contaminants pose a risk to the local environmental and aquatic life. **Resources at Risk:** Left Hand Creek is a source of drinking water for the Left Hand Water District (approx. 15,000 users). Quality of water at the drinking water intake has not yet been impacted by the contamination.
Climax Mine[27] **(Climax Molybdenum)**	CO	Existing (2004): more than 3.25 billion gallons. New plant being constructed. Estimated average: 2.9 billion gallons.	Existing (2004): Estimated operating costs as high as $4 million.	Active (re-opened Aug. 2012).	Patented mining claims and other fee land.	**Impacted Resources:** In the past, Climax mine discharges of zinc, copper, cadmium and lead into Tenmile creek exceeded basic standards for aquatic life, and cadmium, lead and manganese were above water supply standards. The mine, when operating, has also been a significant uncontrolled source of phosphorus to Dillon Reservoir. Nutrient enrichment from phosphorus is the principle concern in the reservoir, which supplies water to the city of Denver. **Resources at Risk:** Site reclamation and water treatment at Climax has improved water quality in Tenmile creek, but failure to continue treatment would endanger the aquatic community in Tenmile Creek (which support game fish species including brook, brown, cutthroat, and rainbow trout) and the quality of water in Dillon Reservoir, approximately 18 miles northeast of the mine.

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	**State**	**Annual Volume of Water Pollution**	**Annual Treatment Costs (Operating and Maintenance)**	**Status**	**Land Ownership**	**Impacted Resources / Resources at Risk**
Eagle Mine[28]	CO	Actual (2011): 152.5 million gallons.	Estimated (2009): more than $1 million.	Closed 1984. Superfund.	Private	**Impacted Resources:** Water Quality in the Eagle River below the mine is impaired by high levels of zinc, copper, and cadmium, which impair aquatic life. A brown trout population is somewhat impaired by heavy metals, sculpin do not inhabit the Eagle River from Belden down to the confluence with Gore Creek, and few rainbow trout are found in this reach. **Resources at Risk:** Same as impacted.
Keystone / Mt. Emmons[29] **(U.S. Energy)**	CO	Estimated: 260 million gallons.	Actual (2012): $2 million.	Inactive and proposed mines.	U.S. Forest Service, private patented and fee land.	**Impacted Resources:** Historic mining and natural mineralization have impaired Elk and Coal Creeks and Slate River. Elevated levels of zinc, cadmium and lead are found in stretches of these creeks. Seeps and surface waters in the vicinity of the Keystone mine, as well as effluent from the treatment plant and interceptor ditch contribute metals loading to the creeks. **Resources at Risk:** Same as impacted.
Leadville Mine Drainage Tunnel/ California Gulch [30]	CO	Actual (2008): Approximately 525.6 million gallons.	Operating cost (2008): Close to $1 million.	Historic mining. Superfund.	Federal and private patented claims.	**Impacted Resources:** Prior to construction of the water treatment plant, the tunnel discharged directly into the East Fork of the Arkansas River. The tunnel effluent contains concentrations of heavy metals that exceed water quality standards. **Resources at Risk:** Up to 1 billion gallons of water are trapped in mine, creating a build-up of pressure. A sudden release could send a large amount of water containing elevated levels of zinc, lead and other metals through the tunnel into the Arkansas River, or cause the subsurface migration of contaminated water.
San Luis Gold Mine[31] **(Newmont/ Battle Mtn. Resources)**	CO	Actual (between Dec. 2011 and Dec. 2012): 63.4 million gallons.	Operating costs (2011): $208,000 per month, $2.5 million per year.	Post-closure reclamation.	Private	**Impacted Resources:** Discharges and seeps from the operation exceeded surface and ground water quality standards for total dissolved solids and sulfate, and manganese, affecting Rito Seco Creek. **Resources at Risk:** Treatment plant discharges to mainstem of Rito Seco Creek. Values along the stretch from outlet to Salazar Reservoir include aquatic life, recreation and water supply.
Summitville [32]	CO	Actual (2012): 235 million gallons. Projected (2016): 380 million gallons.	Actual (2012): $1,800,000.	Abandoned in 1992. Superfund.	Patented and unpatented claims in National Forest.	**Impacted Resources:** Contamination of Wightman Fork and the Alamosa River. The Alamosa River system below the site cannot currently support aquatic life. There has been some uptake of metals in livestock, and some agricultural soil degradation from irrigation. **Resources at Risk:** In addition to aquatic impacts in the Alamosa River, there are potential adverse effects to agriculture and livestock that regularly use river water.

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	**State**	**Annual Volume of Water Pollution**	**Annual Treatment Costs (Operating and Maintenance)**	**Status**	**Land Ownership**	**Impacted Resources / Resources at Risk**
Wellington Oro Mine[33]	CO	Actual: (2009) 26 million gallons, (2010) 19 million.	Estimated: $90,000.	Closed. Superfund.	Public	**Impacted Resources:** Acid mine water flowing through the mine workings becomes highly contaminated with dissolved metals, exits the mine in the form of seeps, and enters French Creek. The Wellington-Oro mine pool is the major contributor of zinc and cadmium from French Creek into the Blue River. The zinc concentration is primarily responsible for the absence of fish populations in the downstream portion of French Creek and a segment of the Blue River. The Blue River is on Colorado's 303(d) List of Impaired Waters for metals, and drains into Dillon Reservoir, a key water supply for the Front Range. **Resources at Risk:** During spring runoff, flows are expected to exceed the pumping rate of contaminated water to the treatment plant. It is expected that flows exceeding 150 gallons per minute will bypass the treatment process and flow into the Blue River. The brown trout fishery is the resource at most risk.
Yak Tunnel /California Gulch[34] **(Resurrection Mining Co.)**	CO	Actual (2011): 425 million gallons.	O&M Cost: $500,000 (estimated, 2004).	Closed. Superfund.	Private and public.	**Impacted Resources:** Prior to Superfund activities, the Yak Tunnel was discharging 201 tons of metals every year to the Arkansas River via California Gulch. **Resources at Risk:** Untreated Yak Tunnel discharge would be acutely toxic to freshwater aquatic life in the Arkansas River.
Blackbird Mine[35]	ID	Actual (2012): 145 million gallons. Possible that an additional 105 million gallons will need to be treated.	2012: $300,000. O&M costs for additional treatment are estimated at $487,000.	Closed in 1982. Superfund.	Patented and unpatented claims in National Forest.	**Impacted Resources:** Fisheries and aquatic resources, including threatened and endangered fish species in Blackbird and Panther Creeks, have been impacted by arsenic, cobalt and copper in water and sediments. In past decade, despite remedial activities, arsenic and copper have seeped from tailings into groundwater and Blackbird Creek. Overflow events have deposited arsenic and cobalt in Panther Creek above cleanup levels. In 1999, a human health risk assessment showed unacceptable risks associated with arsenic at many properties along Panther Creek. **Resources at Risk:** The main environmental concerns at the mine are cobalt, copper and arsenic released into Blackbird Creek, the South Fork of the Big Deer Creek, Big Deer Creek, and Panther Creek. Water treatment should help to reduce contaminants to levels that are protective of aquatic organisms.
Grouse Creek[36] **(Hecla Mining)**	ID	Estimated (1999): Average 236.5 million gallons.	No information found.	Reclamation/ Closure.	Private patented mining claims and federal land.	**Impacted Resources:** In 1995 cyanide was detected in surface water and groundwater monitoring sites at the mine. In 1999, cyanide was detected in Jordan creek at levels exceeding Idaho aquatic life criteria. In 2003, it was determined that contaminants from the mine site may present "an imminent and substantial endangerment to human health and the environment." **Resources at Risk:** In addition to cyanide, pollutants of concern include arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc total suspended solids and pH. Jordan Creek is a tributary to the Salmon River, which supports threatened/endangered species such as Snake River sockeye salmon, Snake River steelhead trout, and Columbia River bull trout, and is designated critical habitat for endangered Chinook salmon.

Table 1. Existing mines known to generate perpetual water pollution

Site name (Owner, if any)	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Thompson Creek[37] **(Thompson Creek Metals)**	ID	Estimated (2009): 52.5 to 105 million gallons. A new treatment plant is being proposed for reclamation.	Projected long-term O&M: $2 million.	Operating	BLM, Forest Service and private patented.	**Resources at Risk:** Discharges occur in the Salmon River watershed (Squaw Creek, Thompson Creek, Salmon River). Protected uses for Thompson and Squaw Creeks include salmonid spawning, cold water biota, agricultural water supply and secondary contact recreation. Water quality from waste rock seepage has declined since 1999, with low pH and elevated metals such as zinc, cadmium, copper and manganese, and erratic concentrations of selenium.
Upper Coeur d'Alene & Bunker Hill Mines[38]	ID	Existing: 788 million to 1.3 billion gallons. Planned expansion: Approx. 6 billion gallons.	Actual operating costs (2006): $834,000. Estimated O&M costs for expanded plant: $2,500,000.	Abandoned. Superfund.	Private and National Forest.	**Impacted Resources:** Both surface water and groundwater in the Upper Basin are severely contaminated. Levels of metals are so high in certain areas that some stream life cannot survive. In some places, zinc levels are over 50 times higher than Idaho's standards allow. **Resources at Risk:** South Fork of Coeur d'Alene River. Untreated AMD exceeds water quality standards developed to be protective of aquatic organisms and human recreational uses, including fishing, boating, wading, and swimming. Given the pervasive nature of the subsurface contamination, Superfund remediation may not achieve the drinking water standards for groundwater at all locations.
Buck Mine[39]	MI	Estimated: average 164 to 166 million gallons.	O&M: Average of $20,000.	Closed	Likely private.	**Impacted Resources:** Untreated acid water drainage contained concentrations of inorganic contaminants that exceeded Michigan's Water Quality Standards (WQS) and was acutely toxic to aquatic life in the Iron River. **Resources at Risk:** Iron River.
Berkeley Pit Continental Mine Complex[40] **(ARCO/ Montana Res.)**	MT	Actual (2009): 1.852 billion gallons.	Estimated: $2 million. May eventually increase to $4.5 million.	Closed (Berkeley Pit) and active (Continental) Superfund.	Private	**Impacted Resources:** AMD from mining contaminated groundwater, surface water and soils with arsenic and other heavy metals. **Resources at Risk:** If pit water is not treated, contaminated water could enter groundwater and alluvial aquifers and potentially harm water quality in local wells and Silver Bow Creek.
Golden Sunlight[41] **(Barrick Gold)**	MT	Maximum (not actual): 52.6 million gallons/yr.	Estimated (1999): $628,355.	Operating	State school trust land, BLM, private.	**Resources at Risk:** Groundwater due to faults within the pit; potential groundwater flows into Ratttlesnake Gulch drainage and the Jefferson River.
Upper Blackfoot Mining Complex[42]	MT	Approx. 26 million gallons.	No information.	MT State Superfund.	National Forest and private patented.	**Impacted Resources:** Seeps from the tailings and waste rock dumps along with acid mine drainage from old adits have contaminated surface water, sediments, soils and groundwater. **Resources at Risk:** Upper Blackfoot River.

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	**State**	**Annual Volume of Water Pollution**	**Annual Treatment Costs (Operating and Maintenance)**	**Status**	**Land Ownership**	**Impacted Resources / Resources at Risk**
Upper Ten Mile Creek.[43]	MT	Estimated (2012): 7 million gallons. Future additional treatment may be required depending on success of source controls.	Estimated O&M: A few $1,000.	Abandoned and inactive mines. Superfund.	National Forest and private patented mining claims.	**Impacted Resources:** Arsenic, cadmium, copper, lead, zinc, and other hazardous substances are present in the groundwater, surface water, stream sediments, mine waste material, and residential soils, and often exceed established regulatory standards for drinking water and aquatic life and levels in soil considered protective of public health and terrestrial ecological receptors such as plants and animals. Tissue samples from Tenmile Creek fish have shown elevated levels of arsenic. **Resources at Risk:** City of Helena's drinking water, aquatic resources in Upper Tenmile Creek, Monitor Creek, Banner Creek, Ruby Creek, Beaver Creek, Minnehaha Creek, Bear Gulch and Walker Creek.
Zortman & Landusky[44]	MT	Approximate (2012): average of between 308 and 321 million gallons.	Approximate (2012): $1.5 million.	Reclamation & Closure under CERCLA.	BLM and patented private.	**Impacted Resources:** In 1995, EPA alleged that discharges from the mine site in seven drainages were in violation of the federal Clean Water Act. 1999, significant deterioration of water quality in Swift Gulch. Swift Gulch flows into South Bighorn Creek and King Creek, which are on the Fort Belknap Indian Reservation. **Resources at Risk:** A dozen streams in Little Rocky Mountains; groundwater; Fort Belknap Reservation. Existing mine drainage water treatment plants do not always meet chronic aquatic standards at their discharge points (e.g., Montana Gulch, which flows into Rock Creek.)
Anaconda/ Yerington[45]	NV	Still delineating plume of groundwater contamination. Hope to begin Feasibility Study for remediation in 2014.		Abandoned. Superfund.	BLM and private.	**Impacted Resources:** Groundwater. **Resources at Risk:** Groundwater.
Phoenix Mine[46] **(Newmont Mining)**	NV	Estimated: Maximum of 9 million gallons total for first 30 years, decreasing to a maximum of 5.3 million gallons from years 150 to 500.	No cost estimates.	Operating	BLM and private patented mining claims.	**Resources at Risk:** Groundwater resources.
Rain Mine[47] **(Newmont Mining)**	NV	Estimated: 10.5 million	Estimated: $90,750.	Closure	Private and BLM.	**Resources at Risk:** Groundwater, surface water, and springs

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	**State**	**Annual Volume of Water Pollution**	**Annual Treatment Costs (Operating and Maintenance)**	**Status**	**Land Ownership**	**Impacted Resources / Resources at Risk**
Jerritt Canyon[48] **(Veris Gold)**	NV	Estimated: 18.4 million	Estimated: Greater than $15,000	Active	Private, BLM and U.S. Forest.	**Impacted Resources:** Groundwater and surface water, including intermittent flow to North Fork of the Humboldt River **Resources at Risk:** Groundwater and surface water
Chino & Cobre Mines[49] **(Freeport-McMoran)**	NM	Estimated: 771 million gallons per year, decreasing to 515 by year 100.	Estimated: Average $2.7 million per year.	Operating (Chino), Inactive (Cobre).	Patented private, fee and federal public lands.	**Impacted Resources:** Mimbres watershed. Groundwater quality exceedences: sulfate, cadmium, copper, lead. Groundwater plume is currently 13,935 acres from Chino and 528 acres from Cobre. Most or all the alluvial aquifers at the mine site have been injured from mining. **Resources at Risk:** Same as impacted.
Tyrone Mine[50] **(Freeport-McMoran)**	NM	Estimated: 319 million gallons per year, decreasing to 252 by year 100.	Estimated: $3.28 million.	Operating.	Patented private, fee and federal public lands.	**Impacted Resources:** Gila River Basin. Groundwater quality exceedances: Sulfate, cadmium, copper. Most or all the alluvial aquifers at the mine site have been injured from mining activity. (p.3-13) Groundwater plume currently 6,280 acres. **Resources at Risk:** Same as impacted.
Questa Mine[51] (Chevron)	NM	Estimated: 289 million gallons. Treatment yet to be determined for 562 million gallons.	Estimated: $3.8 million.	Operating. Superfund.	Private	**Impacted Resources:** Groundwater, surface water, sediments, soils and biological resources on and around the Molycorp site and Red River Corridor. E.g., elevated metals in fish and other organisms; contamination of seeps and springs in Red River Gorge; drinking water aquifer; Eagle Rock Lake. **Resources at Risk:** The release of untreated water would harm the Red River, the state fish hatchery, fish and wildlife habitat, public health, and groundwater drinking supplies.
Almeda Mine[52]	OR	Estimated: 1.6 to 13.1 million gallons.	Treatment studies underway. One proposed option: O&M $18,750.	Abandoned.	BLM	**Impacted Resources:** Acid Mine Drainage (AMD) generated by this abandoned mine currently flows directly to the Rogue River downstream from Galice, OR. **Resources at Risk:** Rogue River.
Brewer Gold Mine[53]	SC	Actual (2010): 72 million gallons. Proposed options for new treatment plant vary from a 56 to 80 million gallon plant.	Actual (2010) costs: $388,000. Proposed options for final remedy range in O&M costs from: $167,000 to $234,000.	Abandoned. Superfund.	Private	**Impacted Resources:** Surface and ground water have been contaminated with acid mine drainage and metals from prior site mining operations. **Resources at Risk:** Aquatic life in Little Fork Creek. Lynches River is an important fishery resource. Several miles downstream, it is designated as a State Scenic River. Groundwater at the site is a major transport medium for acid and metals that would enter Little Fork Creek if treatment were to cease; aquatic life in the Little Fork Creek would be at serious risk given a sustained interruption of the existing treatment system.

Table 1. Existing mines known to generate perpetual water pollution

Site name (Owner, if any)	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Brohm/Gilt Edge Mine[54]	SD	Actual: Varies between 100 and 160 million gallons.	Actual: $2 to 2.3 million.	Abandoned. Superfund.	Private patented claims.	**Impacted Resources:** Strawberry Creek and Ruby Gulch have been affected by acid mine drainage. Ground water beneath the Site is not suitable as a drinking water source without treatment. **Resources at Risk:** Discharge of water without treatment poses a potential risk to the environment because contaminant concentrations are greater than the Surface Water Quality Criteria for Strawberry Creek and Bear Butte Creek. Strawberry Creek and Bear Butte Creek are coldwater fisheries. Without containment and treatment, ARD water would flow into drainages that ultimately discharge into the Madison Aquifer, a source of public drinking water
Copper Basin Mining District (Glen Springs Holding, Inc.)[55]	TN	Total from two treatment plants, actual (July 1, 2011 to June 30, 2012): 4.17 billion gallons	Actual treatment costs (July 1, 2011 to June 30, 2012): $8.57 million.	Abandoned/ Closed. Superfund.	Private	**Impacted Resources:** The Tennessee Copper Basin is the site of what has been described as the "largest man-made biological desert in the world." Acid rock drainage and mine drainage have polluted streams in the North Potato Creek and Davis Mill Creek watersheds and parts of the Ocoee River with high concentrations of iron, copper, manganese, aluminum, and zinc. Also, acidic conditions and leaching metals have impaired water quality and deforestation has resulted in severe erosion. **Resources at Risk:** Same as impacted.
Bingham Canyon[56] **(Rio Tinto)**	UT	Actual (2011): Treated 1.5 billion gallons. With addition of a new treatment plant, should soon be treating approximatel y 2.7 billion gallons.	Estimated Zone A O&M costs: $1.2 million per year. No data on O&M costs for Zone B.	Operating.	Private	**Impacted Resources:** High levels of lead and arsenic were found in Bingham Creek and Butterfield Creek. Neighborhoods were built on contaminated flood plains and creek beds. Acid waters, from the leaching of wastes, escaped from the collection system and contaminated the groundwater under the site. A plume of contamination has spread in the groundwater to the nearby Jordan River. **Resources at Risk:** Drinking water, Jordan River, Great Salt Lake watershed.
Holden Copper Mine[57] **(Intalco)**	WA	Estimated: 620 million gallons.	Estimated average cost: $615,000.	Inactive	National Forest and private patented claims.	**Impacted Resources:** Surface water (e.g., Railroad Creek) continues to be degraded, and there are exceedances of water quality standards for aquatic life for 12 miles from mine site to Lake Chelan. Metals in groundwater and soils exceed health criteria for humans. **Resources at Risk:** Lake Chelan, area trout streams, drinking water source for residents. Concentration of contaminants in soils creates potential risk for birds and mammals. Without water capture and treatment, seasonal metal concentrations would continue to be toxic to aquatic life for the foreseeable future.

Table 1. Existing mines known to generate perpetual water pollution						
Site name (Owner, if any)	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Midnite Mine[58] **(Dawn Mining)**	WA	Currently, approx. 60 million gallons. By 2022, after some remediation work has been completed, it is expected 10 million gallons will need to be treated/yr.	Estimated (2009): O&M $238,600. This is likely to increase significantly due to increased costs for disposing of radioactive sludge.	Inactive. Superfund Site.	Federal government lands held in trust for Spokane Tribe.	**Impacted Resources:** Metals, including arsenic, cadmium, manganese, and uranium, and radioactive isotopes substances have migrated from on-site source areas (i.e., open pits, ore/ waste rock piles) into local groundwater and surface waters. **Resources at Risk:** Radioactivity and heavy metals mobilized in acid mine drainage pose a substantial risk to aquatic ecosystems. The site drains to Blue Creek, which enters the Spokane Arm of Franklin D. Roosevelt Lake. Exposure to mine site contaminants is a public health hazard for individuals who use the mining-affected area for traditional and subsistence activities such as drinking water from drainages and seeps, eating plants and roots, or eating fish fro Blue Creek.
Monte Cristo Mining Area[59]	WA	Estimated: at least 64 million gallons.	Estimated: at least $13,000.	Mostly abandoned. CERCLA cleanup.	Private and National Forest.	**Impacted Resources:** MCMA was ranked as a site with the highest level of concern for threat to human health and the environment on the WA Ecology's state Hazardous Sites List. Arsenic concentrations in Monte Cristo Lake and streams associated with the Site commonly exceed apparent background and Human Health screening criteria by up to 17 and 1522 times, respectively; barium, copper and lead exceed apparent background and aquatic screening criteria less commonly. Concentrations of seven different metals (antimony, arsenic, cadmium, chromium, copper, lead and zinc) in stream and Monte Cristo Lake sediments commonly exceed apparent background concentrations and ecological screening criteria.
TOTAL		17 – 27 billion gallons	$57 to 67 billion			

Table 2. Existing mines likely to generate perpetual water pollution

Mine	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Pinal Creek[60] **(Pinal Creek Group)**	AZ	Actual: Average of 2.4 billion gallons.	No information available.	Closed and active.	Unknown	**Impacted Resources:** Widespread groundwater and surface water contamination has been documented. Contamination is found in the alluvial aquifer of Bloody Tanks Wash-Miami Wash-Pinal Creek, locally in the regional Gila Conglomerate aquifer, in the perennial reach of Pinal Creek proper, and on-site at the various mines. Contamination generally consists of groundwater and/or surface water impacted by acidity and heavy metals (i.e., acid mine drainage). Soil and stream sediment contamination is also locally present within the Site. The site is in the Pinal Creek watershed, which is located in the Salt River Lakes Sub-Basin of the Salt River Basin. **Resources at Risk:** Metals pose risk to aquatic life and wildlife along the perennial reach of Pinal Creek.
Jamestown Mine/ Harvard pit[61]	CA	Not yet treating. Estimated requirement: 55 million gallons.	Treatment options vary in O&M costs from: $234,000 - $556,000/yr.	Closed	Private	**Resources at Risk:** The water in the Harvard Pit is highly contaminated with arsenic and sulfates and poses a serious threat to down-gradient water supplies including Woods Creek, a tributary to the Tuolumne River, which drains to the San Joaquin River. Also, at least 179 wells are immediately down the hill from the mine and could be contaminated.
Cement Creek[62]	CO	Estimated required treatment capacity: approximately 526 million gallons.	Various active water treatment options examined in 2012. O&M costs to treat 526 million gallons ranged from: $876,000 – 930,000.	Mining in this historic mining area ceased in 1991.	Private and BLM land.[63]	**Impacted Resources:** Despite progress from remediation efforts in areas of the watershed, water quality in Upper Cement Creek has deteriorated and is negatively impacting the Animas River. After a tunnel was plugged in approximately 2004 and water treatment stopped, flows from upgradient mines have increased significantly. The current lack of treatment also allows metals-laden water to be directly released to the creek and the Animas River. EPA believes metals loading in Upper Cement Creek may also explain the loss of three species of trout (brown, rainbow and cutthroat) in the past several years.
Nelson Tunnel[64]	CO	157 million gallons.	EPA still studying cleanup options. Estimated costs for two treatment options: $104,500 or 145,000.	Mining in this historic mining area ceased in 1985. Superfund.	Private	**Resources at Risk:** The Nelson Tunnel discharge flows untreated directly into West Willow Creek. It is responsible for 75% of the heavy metals contaminants in Willow Creek. Due to contamination, Willow Creek cannot support a fishery, and contamination is detrimental to the valuable fisher in the Rio Grande River, a state-designated gold-medal fishery.

Table 2. Existing mines likely to generate perpetual water pollution

Mine	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Pennsylvania Mine[65]	CO	In 2005, estimated at approximately 1 million gallons per year.	No treatment yet. Full-scale conventional water treatment plant would cost approx. $1 million per year. Lower-cost passive treatment also an option.	Abandoned	Private	**Impacted Resources:** Peru Creek and the Snake River watershed. In 2007, a surge of contaminated water from the mining adit killed hundreds of stocked trout in the Snake River. Since then, concentrations of metals have been increasing during certain times of year (fall and spring).
Schwartzwalder Mine[66] (Cotter Corp.)	CO	2010: up to 105 million gallons.	No data.	Closed (2000)	Private	**Impacted Resources:** The CDPHE Water Quality Control Division also found Cotter in violation of the Clean Water Act. Before the treatment system was re-activated, Ralston Creek at the lower mine property boundary in the years 2003-2010 frequently exceeded the drinking water criterion. In 2012 Ralston Creek was rerouted around the mine, but tests showed that water from the underground mine was migrating into the creek, with uranium concentrations remaining around 30 ppb / 1000 times the health standard. **Resources at Risk:** Ralston Creek feeds into Ralston Reservoir, which supplies drinking water to Denver metro residents.
Standard Mine[67]	CO	Estimated requirement: 11.2 to 17.1 million gallons.	If treatment is necessary, O&M would be approximately $25,000.	Abandoned. Superfund.	Patented claims and Gunnison National Forest.	**Impacted Resources:** The Standard Mine was called the most environmentally-degraded mine site in the entire Ruby Mining District by a report from the Colorado Geological Survey. Mineralized waste rock exposed to air and water causes acidic conditions to mobilize the release of heavy metals to the surrounding environment. These heavy metals are deposited into Elk Creek, which flows into Coal Creek and eventually to downstream water users.
Sunshine Mine[68] (Sunshine Silver Mine Corp.	ID	Estimated: 121 to 484 million gallons.	Estimated: $50,000.	Exploration/ Re-develop.	Patented and unpatented claims.	**Impacted Resources:** Iron and manganese have impacted surface stream water (e.g., stream, rivers, runoff, drainage) and surface pool water (e.g., lakes, ponds, and pools). In 2007 and 2008, the company operating the treatment plant exceeded allowable discharge limits, primarily for manganese, 185 times. **Resources at Risk:** Same as impacted.
Liberty Mine–Tonopah (General Moly)[69]	NV	Estimated: 305 thousand gallons in 2012. Predicted to drop to 52.6 thousand per year through 2016, and less than that over time.	Estimated (2012): $137,000. Will decrease to $87,000 or less over the longer term.	Closure with a possible return to active.	Private and unpatented claims on BLM land.	**Resources at Risk:** Groundwater

Table 2. Existing mines likely to generate perpetual water pollution

Mine	State	Annual Volume of Water Pollution	Annual Treatment Costs (Operating and Maintenance)	Status	Land Ownership	Impacted Resources / Resources at Risk
Sleeper[70] **(Paramount Gold & Silver)**	NV	Estimated: 1.3 million gallons per year.	Estimated to be in excess of $80,000.	Closure	Private and BLM.	**Resources at Risk:** Groundwater
Blue Ledge Mine[71]	OR	Estimated: 920,000 to 1.7 million gallons.	Studies to evaluate treatment of adit discharge were slated to begin in 2012.	Abandoned. Superfund.	Private land within National Forest.	Impacted Resources: Impacts include the absence of fish in Joe Creek and potential negative impacts to fisheries all the way to the Applegate Reservoir, nearly eight miles downstream. **Resources at Risk:** Sensitive, threatened and endangered species have been identified in the vicinity of the site including the northern goshawk, the Siskiyou Mountains salamander, and the northern spotted owl.
Formosa Mine[72]	OR	Estimated (2012): Average of 4 to 12 million gallons need to be treated.	Long-term passive or active treatment will be required, but is not yet in place.	Abandoned. Superfund.	Private and BLM lands.	**Impacted Resources:** Acid mine drainage from the mine has severely degraded 13 miles of Middle Creek and the South Fork of Middle Creek, affecting macroinvertebrates, resident fish, coastal steelhead trout, and Oregon coastal coho salmon. Also Cow Creek, where levels of certain contaminants are 10-100 times greater than aquatic life standards. The site poses a health risk to people eating the fish. Cow Creek is currently fished by the Cow Creek Band of Umpqua Tribe of Indians and by recreational fishermen. **Resources at Risk:** Same.
Elizabeth Mine[73]	VT	Estimated: 2.6 to 6.3 million gallons.	Estimated: $48,500.	Abandoned. Superfund.	Private	**Impacted Resources:** Elizabeth Mine is a source of acidic leachate, metals, and suspended solids to Copperas Brook and the West Branch of the Ompompanoosuc River. Fish abundance and other biological indicator species have been impacted in the Ompompanoosuc River. The entire length of Copperas Brook and several miles of the West Branch of the Ompompanoosuc River fail to meet Vermont Water Quality Standards. **Resources at Risk:** Same.
TOTAL		**3.4 to 4 billion gallons**	**$1.4 to 2.9 billion**			

Table 3.
Proposed mines predicted to generate perpetual pollution, or at high risk of perpetual pollution

Mine	State	Annual Volume of Water Requiring Treatment	Annual Treatment Costs (Operating and Maintenance)	Status	Land ownership	Resource at Risk
Donlin Creek[74] **(Donlin Gold)**	AK	Estimated: 1.7 billion gallons	Estimated: $1.9 million	Proposed	Native Corporation	**Resources at Risk:** Kuskokwim River Watershed.
Pebble[75] **(Pebble Partnership)**	AK	Potential (estimated): 13.8 billion gallons	Unknown	Proposed	State of Alaska	**Resources at Risk:** Bristol Bay salmon fishery.
Northmet Project[76] (Polymet **Mining**)	MN	Potential (estimated): 93 to 256 million gallons	Unknown	Proposed	National Forest	**Resources at Risk:** St. Louis River Basin, Partridge River, aquatic organisms and wildlife, wild rice, wetlands, groundwater.
Rock Creek[77] **(Revitt Silver)**	MT	Estimated: 1.2 billion gallons	Estimated: $1,200,000	Proposed	Forest Service and Private	**Resources at Risk:** Clark Fork River.
TOTAL		**16.7 - 16.9 billion gallons**	**$3.1 billion**			

References for Charts

[1] http://www.nytimes.com/2012/12/10/science/earth/federal-plans-for-colorado-river-include-pipeline.html

[2] Reclamation Research Group, "Acid Mine Drainage and Effects on Fish Health and Ecology: A Review," for U.S. Fish and Wildlife Service, July 2008.

[3] U.S. EPA Inspector General, "Nationwide Identification of Hardrock Mining Sites," March 2004.

[4] Higgins D.K. and Wiemeyer S.N., U.S. Fish and Wildlife Service, "Assessment of Wildlife Hazards Associated with Mine Pit Lakes," June 27, 2001.

[5] Glenn Miller Ph. D., "Precious Metal Lakes: Controls of Eventual Water Quality," Southwest Hydrology, Vol. 1/No. 3, September/October 2002. An estimated 35 pit lakes from all types of hard rock mining are expected to form, containing from less than 100 acre-feet up to about 540,000 acre-feet of water. On a statewide basis, all of the existing reservoirs within the state (excluding Lake Mead) contain approximately 600,000 acre-feet.

[6] Height and volume of a water bottle: 7.9 inches and 16.9 fluid oz. Source: http://www.amazon.com/Nestle-Bottled-Varies-By-Region/dp/B000GD653C. NUMBER OF BOTTLES: 17 billion gallons of polluted water X 128 fluid ounces per gallon/16.9 ounces per bottle = 128,757,396,449 bottles; 27 billion gallons of polluted water X 128 ounces per gallon/16.9 ounces per bottle = 2,044,907,041,420 bottles. DISTANCE TO MOON: 238,900 miles to moon (63,360 inches per mile) = 15,136,704,000 inches to moon/7.9 inches per bottle water = 1,916,038,481 bottles X 16.9 ounces of water per bottle = 32,381,050,329 fluid ounces to fill all the bottles needed to go to the moon/128 fluid ounces/gallon = 252,976,955 gallons of water to fill bottles to moon. 17 billion gallons in perpetuity/252,976,955 = 67 trips (34 trips to moon and back); 27 billion gallons in perpetuity/249,814,743 = 108 trips (54 trips to moon and back).

[7] 33 U.S.C. § 1344(c) (2006).

[8] A Joint Letter from Six Federally-Recognized Tribes in the Kvichak and Nushagak River Drainages of Southwest Alaska to Lisa P. Jackson, Administrator of the U.S. EPA (May 2, 2010). EPA later received additional requests from Ekuk Village Council, Clarks Point Tribal Council, and Twin Hills Village Council. Letter from Bristol Bay Regional Seafood Development Association to Lisa Jackson, EPA Administrator, June 10, 2010.

[9] U.S. EPA. May 2012. *External Review Draft - An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska.* Executive Summary. http://www.epa.gov/ncea/pdfs/bristolbay/bristol_bay_assessment_erd_2012_exec_summary.pdf

[10] U.S. EPA. May 2012. *External Review Draft - An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska.* Executive Summary. http://www.epa.gov/ncea/pdfs/bristolbay/bristol_bay_assessment_erd_2012_exec_summary.pdf

U.S. EPA. Sept. 17, 2012. *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska.* Final Peer Review Report. http://www.epa.gov/ncea/pdfs/bristolbay/Final-Peer-Review-Report-Bristol-Bay.pdf

[11] Ibid.

[12] U.S. Environmental Protection Agency, Toxic Release Inventory, 2011.

[13] New Mexico Mining Act at Chapter 69 - Mines, Article 36 Section 69-36-12-B, Michigan's Non-Ferrous Mining Statute and Rule (Part 632). Part 632 consists of Sections 63201 to 63223 (the "Act") and Parts 1 to 6 of the promulgated rules (the "Rules") R. 425.409(b).

[14] David M. Chambers Ph. D., "A Postion Paper on Water Treatment in Perpetuity," Center for Science in Public Participation. June 2000.

[15] Jim Kuipers, P.E. and Ann Maest, Ph. D., "Comparison of Predicted and Actual Water Quality at Hardrock Mines." December 2006. Available at: http://www.earthworksaction.org/files/publications/ComparisonsReportFinal.pdf

[16] U.S. EPA Inspector General, "Nationwide Identification of Hardrock Mining Sites," March 2004.

[17] http://yosemite.epa.gov/opa/admpress.nsf/bd4379a92ceceeac8525735900400c27/d38e604ef465557a852579a3005f4630!OpenDocument.

[18] U.S. EPA Inspector General, "Nationwide Identification of Hardrock Mining Sites," March 2004.

[19] Ibid.

[20] **RED DOG MINE**

Perpetual treatment: "Perpetual water treatment required in all options presented in the Final Supplemental EIS." [1] p. ES-10, [2] Slides 28 and 31.

Volume treated: The Final Supplemental Environmental Impact Statement said that, "Under Alternative B, the Aqqaluk Deposit would be developed and the mine would continue to treat and discharge effluent from the tailings impoundment during operations. Alternative B predicts that an average of 1,527 million gallons would need to be discharged annually until the year

2026 to maintain the water balance in the tailings impoundment. After that period, an average of 1,350 million gallons would need to be discharged annually." [1] p. 3-68. Alternative B was selected by EPA as the preferred alternative. [3] p. 7.

Treatment Costs: [2] Slide 31.

Status: Operating

Land Ownership: Nana Corp. [4]

Impacted Resources/Resources at Risk: [1] ES-5, 3-69, 3-152.

References:

[1] Tetratech. Oct. 2009. *Red Dog Mine Extension - Aqqaluk Project. Final Supplemental Environmental Impact Statement.* Available at http://northern.org/media-library/document-archive/clean-water-mining/red-dog-mine/aqqaluk-final-seis/Red_Dog_Final%20SEIS.pdf

[2] DiMarchi, J. (Alaska Department of Natural Resources). 2011. *Reclamation & Closure, Red Dog Zinc-Lead Mine, Delong Mtns.* Alaska, Mine Designs Operations and Closure Conference, May 2011. http://dnr.alaska.gov/mlw/mining/aml/nlmrws2011/proceedings/dimarchi/reddogminereclamationplan-2011sm.pdf

[3] U.S. EPA. January 8, 2010. Record of Decision, Red Dog Mine Extension Aqqaluk Project. http://www.epa.gov/region10/pdf/permits/npdes/ak/red-dog-aqqaluk-rod.pdf

[4] NANA Corporation web site: "Red Dog Mine." http://www.nana.com/regional/resources/red-dog-mine/

[21] IRON MOUNTAIN MINE

Perpetual treatment: Acid mine drainage is expected to continue for more than 2,000 years. [In 2000, "EPA, the State of California, Aventis CropSciences USA, Inc. (corporate successor to Mountain Copper Ltd. and Stauffer Chemical Co.) and Stauffer Management Co. (indemnitor to Aventis) reached a settlement agreement. Under the settlement, the PRPs provide funding to ensure that the treatment plant, "the heart of the IMM remedy," will continue to operate in perpetuity." [1], [2] p. 14.

Volume treated: [3] Attachments 5 – 8. p. 11.

Treatment Costs: Treatment plant routine costs: $296,343; Lime: $514,628; Electricity: $397,348; Sludge haul: $45,260; Total = 1,253,579. This amount does not include treatment plant non-routine costs, which totaled $385,966 in 2007. [3] p. 29.

Status: Abandoned. Superfund Site. [4]

Land Ownership: Private. The mine's owner, Ted Arman, 88, of Shasta Lake, continues to argue that the EPA's cleanup is unnecessary. He filed lawsuits saying the EPA is trespassing at the mine he's owned since 1976." [5]

Impacted Resources/Resources at Risk: [2] p. 4, 6, [4], [6], [7], [8], [9]

References:

[1] Kempton, H., Bloomfield, T.A., Hanson, J.L. and Limerick, P. "Policy guidance for identifying and effectively managing perpetual environmental impacts from new hardrock mines." Environmental Science and Policy. Vol. 13, No. 6, 2010. p. 11. http://centerwest.org/wp-content/uploads/2010/10/Kempton-et-al-Policy-Guidance-2010.pdf

[2] EPA. 2006. "Iron Mountain Mine Iron Mountain Mine: Success through planning, partnerships and perseverance." Abandoned Mine Lands Case Study. http://www.epa.gov/aml/tech/imm.pdf

[3] EPA. July 2008. Iron Mountain Mine. Fourth Five-Year Review Report for Iron Mountain Superfund Site. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/0debbf5424a57c908825774900824131/$FILE/IMM%20-%204th%205YR%20Att%205-8%207-14-08.pdf

[4] EPA Region 9 web site: Superfund. "Iron Mountain Mine." http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/db29676ab46e80818825742600743734/b32731488ba88e8788257007005e943d!OpenDocument

[5] Darling, D. Aug. 21, 2010. "EPA, scientists tour Iron Mountain Mine cleanup project," The Redding Record Searchlight. http://www.redding.com/news/2010/aug/21/decades-of-decay/

[6] Swenty, S. 2013. "Restoring resources damaged by the Iron Mountain Mine." U.S. Fish and Wildlife Service. http://www.fws.gov/sacramento/outreach/Featured-Stories/IronMountainMine/outreach_featured-stories_Iron-Mountain-Mine-Restoration.htm

[7] Interstate Technology and Regulatory Council (ITRC). "Stowell Mine, Shasta County, California." Case Study as part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs23_stowell.htm

[22] KEYSTONE, RISING STAR AND BULLY HILL MINES

Perpetual treatment: Passive treatment (constructed treatment wetlands). "Approximately 5–10 gpm from Keystone Mine have been treated for eight years using CTW and will continue indefinitely." [1]

Volume treated: 5 - 10 gpm is 2.6 to 5.3 million gallons. Keystone mine, only. [1]

Treatment Costs: "Operation and maintenance (O&M): $10,000 per year indefinitely. A similar cost is assumed for both Keystone and Rising Star mines." No cost estimates for Bully Hills. "A 250-square-foot pilot passive treatment system was constructed on the Bully Hill waste rock pile to evaluate the feasibility of using sulfate-reducing bacteria (SRB) to treat residual ARD from the main Bully Hill portal. This pilot study is ongoing." [1], [3]

Status: Inactive. [2]

Land Ownership: [1], [3]

Impacted Resources/Resources at Risk: [1], [2], [4] p. 2. [5]

References:

[1] Interstate Technology and Regulatory Council (ITRC). "Keystone & Rising Star Mines, Shasta County, California." Case Study as part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs22_24_keystone_rising.htm

[2] California Regional Water Quality Control Board. 2005. "Waste discharge requirements for Millennium Holdings, LLC. Closure of the Rising Star Waste Rock Containment Facility, Shasta County." Order No. 5-05-xxx. p. 1. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/0506/rising_star/rising-star-wdrs.pdf

[3] VESTRA web site: "NPDES compliance, characterization and remedial design." http://www.vestra.com/project/environmental-services/mine-remediation-evaluations-permitting/npdes-compliance-characterization-and-remedial-design.html

[4] Mining Remedial Recovery Company Inc. 2004. MRRC Shasta Area Mines – threatened, endangered and sensitive species of special concern. http://www.waterboards.ca.gov/rwqcb5/water_issues/basin_plans/w-squaw-cr-staff-rpt-b.pdf

[5] Bureau of Land Management, Bureau of Reclamation, Forest Service and National Park Service. 1997. Interlakes Special Recreation Management Area Final Plan and Environmental Impact Statement 1997. p. 3-32. http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/redding.Par.49366.File.dat/Interlakes_SRAMP_EIS.pdf

[23] **LAVA CAP**

Perpetual treatment: In 2011, USGS wrote, ". . . at the time of this writing, the Environmental Protection Agency (EPA) was still working on its final remedy for contaminated areas and its plan for treating the mine adit water in perpetuity." According to EPA, the remedy includes "a water treatment plant to treat surface water collected from the mine working and/or adit and from the mine tailings, with treatment consisting of a ferric chloride coagulation/filtration process or an alternative innovative technology." [1], [2] p. 4.

Treatment Volume: Adit discharge flow rates are in the 50-75 gpm range during much of the year, but increase into the 200-300 gpm range during the wetter winter and early spring period. Estimated volume: assumed 50 – 75 gpm for three-quarters of the year (20 to 30 million gallons) and 200 – 300 gpm for ¼ of the year (26 to 39 million gallons). Thus, a rough estimate for the entire year would be a minimum of 46 to a maximum of 69 million gallons. [2] p. 4.

Treatment Costs:

Status: [3], [4] p. I-1.

Land Ownership: [4] II-3, II-4.

Impacted Resources/Resources at Risk: [3]

References:

[1] Foster, A., Ashley, R. and Rytuba, J. (U.S. Geological Survey). 2011. "Arsenic species in weathering mine tailings and biogenic solids at the Lava Cap Mine Superfund Site, Nevada City, CA," Geochemical Transactions. 2011:12:1. http://www.geochemicaltransactions.com/content/12/1/1

[2] U.S. EPA. Sept. 2011. First Five-Year Review Report for Lava Cap Mine Superfund Site, Nevada County. http://www.epa.gov/superfund/sites/fiveyear/f2011090004155.pdf

[3] U.S. EPA web site: "Lava Cap Mine." Superfund Site Overview. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/BySite/Lava%20Cap%20Mine?OpenDocument

[4] U.S. EPA. 2004. Record of Decision - Lava Cap Mine Superfund Site Mine Area Operable Unit (OU1), Nevada City, California.. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/4e399c070c305d1a882575e5007f795c/$FILE/ATT3SH0G/ROD%20Lava%20Cap%20Mine%20Part%20I%20through%20Part%20II_4.pdf

[24] **LEVIATHAN MINE**

Perpetual treatment: There are numerous references in EPA materials regarding a "long-term remedy" to deal with acid mine drainage. The EPA Leviathan web site says that "It is expected that the decision-making and design processes will continue for the next several years before a proposed plan for a long-term, year-round remedy is developed for public comment." Kevin Mayer of EPA clarified that contaminated water will need to be treated in perpetuity, but efforts are occurring to minimize the annual volume of water that will require treatment. [1], [2]

Volume treated: 13.8 million gallons of contaminated water from the Channel Underdrain and Delta Seep high-density sludge plant were treated; and 18 million gallons from two evaporation pond treatment systems. [3]

Treatment Costs: Adit and Pit Underdrain capture and treatment, 2012: $690,000 to treat 9.8 million gallons of AMD. Delta Seep: 2011 $1.228 million plus $95,000 sludge disposal. To treat and discharge 13,000 million gallons AMD and 138 tons of sludge. Aspen Seep: $710,000 plus $541,000 sludge disposal to treat 7.2 million gallons of AMD and 86 tons of sludge. [4]

Status: Abandoned. Superfund. [1]

Land Ownership: State, national forest, patented claims. [5]

Impacted Resources/Resources at Risk: [1]

References:

[1] U.S. EPA website: "Leviathan Mine." Superfund Site Overviews. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/BySite/Leviathan%20Mine?OpenDocument

[2] Pers. Comm. Kevin Mayer, EPA Region 9. Jan. 23, 2013. 415-972-3176.

[3] Burleson Consulting. May 2012. *2011 Oversight Summary Report - Leviathan Mine Superfund Site, Alpine County, California.* Prepared for EPA and USACE. Tables 1 and 2.

http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/3dc283e6c5d6056f88257426007417a2/d84cddf9f6ca350f88257a2f005dc64b!OpenDocument

[4] Mayer, K. and Riley, G. 2012. *Leviathan Mine Water Treatment.* Presentation at the EPA 22nd Annual NARPM Training Program. http://narpm.trainex.org/materials/741/06_Mayer-Riley.pdf

[5] Interstate Technology Regulatory Council. "Leviathan Mine Site – Alpine County, California." Case Study as Part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs49_leviathan.htm

[25] **ARGO TUNNEL**

Perpetual treatment: In 2010, a new remedy was selected to treat contaminated alluvial ground water from the Gregory Incline and Gulch, and National Tunnel discharge. In response to a question regarding the choice of active water treatment as the remedy, EPA and CDPHE responded: "Active treatment of the Gregory Incline, Gregory Gulch alluvial ground water and National Tunnel flows provides greater long-term effectiveness and permanence than the combined active and passive treatment remedy in the original ROD, due to the increased reliability of a water treatment plant to effectively treat water year-round in perpetuity." [1]

Volume treated: In 2011,the Argo Tunnel Treatment Plant treated 118 million gallons. A second plant currently under design, the North Fork Water Treatment Plant, will treat contaminated mine water from Gregory Gulch, Gregory Incline and National Tunnel. [2], [3]

Treatment Costs: In 2010, ongoing operation and maintenance costs were approximately $900,000 per year. O&M costs are largely dependent on treatment flow rates. Roughly 40% of the O&M costs is for labor, which includes five full-time employees. The plant is staffed 10 hours per day, 7 days per week. The new plant is expected to cost close to $1 million a year to operate. [4], [5]

Status: [6]

Land Ownership: [7]

Impacted Resources/Resources at Risk: [6]

References:

[1] U.S. EPA and Colorado Department of Public Health and Environment (CDPHE). 2010. *Central City/Clear Creek Superfund Site. Amendment to the Operable Unit 4 Record of Decision for the Active Treatment of the National Tunnel, Gregory Incline and Gregory Gulch.* 2010. p. 44 of 44. http://www.epa.gov/region8/superfund/co/ccclearcreek/OU4_ROD_Amendment.pdf

[2] CDPHE. 2011. "Central City/ Clear Creek Superfund Site." Update Fact Sheet. http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Fact+Sheet.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251811671649&ssbinary=true.

[3] CDPHE. 2011. "Clean Water – Water treatment at mining sites." *Colorado Winnable Battles.* http://tinyurl.com/winnablebattles

[4] Interstate Technology & Regulatory Council Mining Waste Team. August 2010. "Argo Tunnel Site Clear Creek, Colorado." Case Study. http://www.itrcweb.org/miningwaste-guidance/cs41_argo_tunnel.pdf

[5] U.S. EPA and CDPHE. 2010. *Central City/Clear Creek Superfund Site. Amendment to the Operable Unit 4 Record of Decision for the Active Treatment of the National Tunnel, Gregory Incline and Gregory Gulch.* 2010. p. 7. http://www.epa.gov/region8/superfund/co/ccclearcreek/OU4_ROD_Amendment.pdf)

[6] U.S. EPA web site: "Central City/Clear Creek." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/ccclearcreek/index.html

[7] Pers. Comm. Peggy Linn, U.S. EPA. Community Involvement Coordinator. (303)312-6622 linn.peggy@epa.gov

[26] **CAPTAIN JACK**

Perpetual treatment: "The selected alternative may have long-term effectiveness without the second phase if seepage from bedrock is controlled and/or the water quality of seepage is of sufficient quality. In addition, mine-pool neutralization would likely be effective in raising the pH of in-situ water and effectively precipitating some COCs out of solution. If the second phase of the selected alternative was implemented, residual risk to potential receptors would be substantially removed while the biochemical reactor was operating. This treatment alternative is long-term and would be required in perpetuity." [1] p. 17-5.

Volume treated: 50 gpm or 26.3 million gallons. [1] p. 4-1.

Treatment Costs: 30-year O&M costs for Phase I estimated at $855,000, or $28,500 per year. 30-year O&M costs would increase by $4,408,065 to $5,262,923, which is approx. $147,885 per year. "If water within the tunnel is not adequately treated by the bulkhead and mine-pool mitigation measures and the quality of the water escaping the underground workings and surfacing (through seeps or other) is not meeting in-stream standards at the compliance point, a successive biochemical reactor will be installed as Phase II of this alternative." If Phase II is implemented, O&M costs would increase to $148,000. [1] p. 19-17, [2]

Status: [3] p. 1, [4]

Land Ownership: [3] p. 11.

Impacted Resources/Resources at Risk: [4], [5], [6]

References:

[1] Walsh Environmental Scientists and Engineers. Sept. 2008. *Captain Jack Superfund Site Record of Decision.* Prepared for EPA and Colorado Department of Public Health and Environment. http://www.epa.gov/superfund/sites/rods/fulltext/r2008080003370.pdf

[2] Walsh Environmental Scientists and Engineers. May 2008. *Captain Jack Superfund Site Feasibility Study Report.* Prepared for EPA and Colorado Department of Public Health and Environment. pp. 197, 198. ftp://ftp.epa.gov/r8/captainjack/FS_May222008.pdf)

[3] Agency for Toxic Substances and Disease Registry. April 14, 2006. *Public Health Assessment for Captain Jack Mill, Boulder County, Colorado.* http://www.atsdr.cdc.gov/HAC/pha/CaptainJackMill/CaptainJackMillPHA041406.pdf

[4] U.S. EPA web site: "Captain Jack Mill." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/captainjack/index.html

[5] U.S. EPA and Colorado Department of Public Health and Environment (CDPHE). Oct. 2010. *Captain Jack Mill Superfund Site: Status Update.* p. 2. http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Status+Update.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251811665260&ssbinary=true

[6] EPA and CDPHE. Nov. 2009. *Captain Jack Superfund Site: Community Involvement Plan Update.* p. 6. http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Community+Involvement+Plan.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251811663049&ssbinary=true

[27] **CLIMAX MINE**

Perpetual treatment: "Surface water will definitely have to be treated in perpetuity." Tony Waldron, a program supervisor in the Colorado Division of Reclamation Mining and Safety.

Volume treated: Current plant treated 10,000 acre feet in 2004, which is 3.26 billion gallons. A new water treatment plant is under construction. The new treatment plant will require a maximum capacity of 14,000 gallons per minute (gpm), to accommodate flows in wet years. Average flow is expected to be 5,433 gpm (or 2.856 billion gallons per year). Minimum flow is expected to be 2,000 gpm. [2], [3], [4]

Treatment Costs: [2]

Status: [5]

Land Ownership: The Climax operation encompasses approximately 14,339 acres of patented mining claims and other fee lands. [6]

Impacted Resources/Resources at Risk: [7]

References:

[1] Colorado Foundation for Water Education. 2012. "Climax comes back." *Headwaters.* Fall 2012. p. 11. http://coagwater.colostate.edu/docs/HW29_Ag_Final.pdf

[2] Voynick, S. July, 2004. "Climax: Two decades later," *Colorado Central Magazine.* http://cozine.com/2004-july/climax-two-decades-later/

[3] Colorado Abandoned Mine Land Program. December 4, 2012. *Nonpoint Source And Water Quality Improvement Projects.* http://tinyurl.com/av5mmm3

[4] Climax Molybdenum Co. "Reclamation Permit Number 1977-493. Technical Revision TR-19." Property discharge water treatment plant (PDWTP). p. 7. http://drmsweblink.state.co.us/drmsweblink/0/doc/952054/Electronic.aspx?searchid=40649396-d8b8-4135-9d17-0b9514614b46

[5] May 10, 2012. "Reopened Climax mine reports first shipment," Summit Daily. http://www.summitdaily.com/article/20120510/NEWS/120519971

[6] Freeport McMoran web site: "North American: Henderson Mine." http://www.fcx.com/Templates/operations/USA_Colorado_Henderson.htm

[7] Northwest Colorado Council of Governments. 2012. *Blue River Water Quality Management Plan.* pp. B-5, B-14, B-15, B-19, B-20, B-30. http://nwccog.org/docs/wss/rwqmp_2012/Blue%20River%20Watershed%202012%20208%20Plan.pdf

[28] **EAGLE MINE**

Perpetual treatment: "The current treatment of water from the mine will continue in perpetuity." [1]

Volume treated: [2]

Treatment Costs: in 1999, costs were estimated at $756,000. By 2009, this had increased to more than $1 milliion. [3], [4]

Status: [5]

Land Ownership: [6]

Impacted Resources/Resources at Risk: [7]

References:

[1] Colorado Department of Public Health and Environment web site: "Eagle Mine." http://www.colorado.gov/cs/Satellite/CDPHE-HM/CBON/1251615994993

[2] Newfields. April 2012. Eagle Mine Annual Report 2011. Prepared for CBS Operations Inc. p. 5-3. Available under "Annual Reports and Monitoring" at: http://www.colorado.gov/cs/Satellite/CDPHE-HM/CBON/1251615994993

[3] Zuzulock, S. 2003. Greens Creek Financial Assurance Review. Center for Science in Public Participation (CSP2). http://www.csp2.org/REPORTS/GC%20Attachment%203.xls

[4] Best, A. Jan. 2009. "Cleaning of tainted water continues at old mines," Colorado Central Magazine. http://cozine.com/2009-january/cleaning-of-tainted-water-continues-at-old-mines/

[5] U.S. EPA web site: "Eagle Mine." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/eagle/index.html

[6] Pers. Comm. Feb. 25, 2013. Warren Smith, Colorado Department of Public Health and Environment, State Community Involvement Coordinator. 303-692-3373.

[7] Eagle River Watershed Council. "Eagle Mine Superfund Site Monitoring." http://www.erwc.org/index.php/projects/eagle-mine-superfund-site-clean-monitoring/

[29] **KEYSTONE MINE/ MT. EMMONS**

Perpetual treatment: "Water flowing from the Keystone mine now requires costly and complex treatment before it can be discharged to Coal Creek and that treatment will be required in perpetuity." [1], also [2]

Volume treated: October through June, facility maximum outflow is 0.675 mgd; July though September flow is 0.75 mgd. So 0.675 million gallons per day x approx. 182.5 days per year = 123.2 million gallons per year, and 0.75 mgd x approx. 182.5 days per year = 136.9 million gallons per year, for a total of 260.1 million gallons per year. [3]

Treatment Costs: Treatment costs for the past four quarterly filings ($thousands) were: Sept. 2012 ($609), June. 2012 ($436), March. 2012 ($509) and Dec. 2011 ($454). Total for the ending Sept. 2012 = 609 + 436 +509 + 454 = $2,008 thousand, or $2 million. [4]

Status: [5]

Land Ownership: "U.S. Energy proposes to develop an underground molybdenum mine and associated surface facilities on patented claims and fee land owned by U.S. Energy Corp. and unpatented claims located on land administered by the USFS in Gunnison National Forest, Gunnison District." [6]

Impacted Resources/Resources at Risk: [7], [8]

References:

[1] National Wildlife Federation. "Mt. Emmons Mine, Colorado. p. 2. http://www.nwf.org/What-We-Do/Energy-and-Climate/Drilling-and-Mining/~/media/92718A414C6E4A3AB3C49929E6927A0D.ashx

[2] High Country Citizens' Alliance. March 19, 2008. "Testimony of Dan Morse on behalf of HCCA to the Colorado General Assembly House Committee on Agriculture, Livestock and Natural Resources Hearing on House Bill 08-1165." http://www.leg.state.co.us/clics/clics2008a/commsumm.nsf/b4a3962433b52fa787256e5f00670a71/168cc49ac33fd39a87257411006bb9d3/$FILE/080319%20Attach%20G.pdf

[3] Colorado Department of Public Health and Environment (CDPHE). Permit no. CO-0035394. pp. 3, 4. Available at: http://tinyurl.com/Mountemmonspermit

[4] U.S. Energy Corp. Nov. 201210-Q Filing. U.S. Securities and Exchange Commission. p. 29. http://www.sec.gov/Archives/edgar/data/101594/000010159412000069/form10_q.htm

[5] Colorado Water Control Commission. Proponent's Prehearing Statement of U.S. Energy Corp. In the Matter of Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins – Regulations No. 35. P. 3. http://tinyurl.com/USEprehearingstatement

[6] Gault Group, LLC. Oct. 2012. Plan of Operations for the Mt. Emmons Project. Prepared for U.S. Energy. p. 10. https://docs.google.com/file/d/0B28q6zodJKxPRDRnUDJuQWgwN1U/edit

[7] U.S. Energy Corp. March 31, 2010. Plan of Operations for Surface Disturbing Baseline Studies Mount Emmons Project Colorado, USA. Submitted to US Forest Service and US Bureau of Land Management. p. 24. http://www.fs.fed.us/outernet/r2/gmug/policy/minerals/MtEmmons/PoOforSurfaceDisturbingBaselineStudies03-31-10.pdf

[8] EnviroGroup Ltd. 2012. Study Plan to Evaluate Sources of Metal Loading in the Coal Creek Watershed in the Vicinity of the Keystone Mine. Prepared for U.S. Energy Corp. pp. 5, 6. http://tinyurl.com/EnviroGroupCoalCreek

[30] **LEADVILLE MINE DRAINAGE TUNNEL**

Perpetual treatment: "We are all hopeful that the current plan to pump water from the Gaw shaft, to drill a well into the [Leadville Mine Drainage Tunnel] LMDT, and to construct a pipeline to transport water pumped from the LMDT to the Bureau's treatment plant will relieve the pressure within the LMDT. . . However, as we move beyond these short- and mid-term measures we need to complete a long-term plan to address on-going drainage from the LMDT. This plan must include. . . a commitment by the Bureau to **treat the mine discharge water in perpetuity**." [1]

Volume treated: Approximately 1,000 gallons per minute treated in 2008. 1000 gallons/min x 60 min/hr x 24 hr/day x 365 days/yr = 525,600,000 gallons per year. Can treat an average of 67.3 million gallons per month (807.6 million gallons per year) under full-flow conditions. [2], [3]

Treatment Costs: The plant costs just less than $1 million annually to operate. [4]

Status: [5]

Land Ownership: "The portal site is located near the northwest corner of Section 13, T. 9 S., R. 80 W. of the 6th Principle Meridian, on the Hibschle Placer Claim, Patent Survey No. 399, owned by the Resurrection Mining Company. The Bureau of Mines purchased a portion of the Hibschle Claim in the portal area. In addition, the Ditch Placer Claim, Patent Survey No. 416, of 9.28 acres was acquired for the waste-rock dump." [6] p. 11

Impacted Resources/Resources at Risk: [6] p. 3, 189, [7], [8]

References:

[1] Letter from Bill Ritter, Governor of Colorado to Dirk Kempthorne, Secretary of the Dept. of Interior. Feb. 24, 2008. Re: Leadville Mine Drainage Tunnel.
http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1239428661240&ssbinary=true

[2] EPA. June 24, 2008. "Removal of water from Leadville Mine Drainage Tunnel underway."
http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/1bb0760b96b439f4852574720074605c!OpenDocument

[3] Pers. Comm. Kara Lamb. Bureau of Reclamation, Eastern Colorado Area Office. (970) 962- 4326. Jan. 30, 2013.

[4] Lipsher, S. and Fender, J. Feb. 25, 2008. "Flap over funding for Superfund site." *Denver Post.*
http://www.denverpost.com/news/ci_8354837

[5] U.S. EPA web site: "California Gulch." Colorado Cleanup Sites. See OU6: Stray Horse.
http://www.epa.gov/Region8/superfund/co/calgulch/

[6] U.S. Bureau of Reclamation, Dept. of Interior. Nov. 2008. *Leadville Mine Drainage Tunnel Risk Assessment.*
http://www.usbr.gov/gp/ecao/leadville/combined_risk_assessment.pdf

[7] U.S. EPA. 2003. *Final Record of Decision - Operable Unit 6, California Gulch Superfund Site, Leadville, Colorado.* p. 27.
ftp://ftp.epa.gov/r8/calgulch/OU6/RODFeasilibiltyStudiesRIFS/OU6ROD_r0803015.pdf

[8] U.S. EPA web site: "Leadville, Colorado Mine Drainage response."
http://www.epa.gov/region8/superfund/co/calgulch/mdresponse.html

[31] **SAN LUIS GOLD MINE**

Perpetual treatment: "The Division of Reclamation, Mining and Safety (DRMS), concluded in 2005 that West Pit water is at pre-mining quality. . .However, to maintain this pre-mining water quality, [Battle Mountain Resources] must maintain the current water level elevation in the West Pit." "Since waters emanate continually into the West Pit, treating poor quality water at the RO plant and/or disposal of waters will need to continue indefinitely." [1]

Volume treated: [2]

Treatment Costs: [3]

Status: [3]

Land Ownership: [4]

Impacted Resources/Resources at Risk: [5], [6]

References:

[1] McClure, J. and Lobato (Costilla County Conservancy District – CCCD), E. Feb. 26, 2013. "Memorandum Re: CCCD/[Battle Mountain Resources Inc.] – Concern Re: Storage of poor quality waters." Sent to Loretta Pineda, Director, Colorado Division of Reclamation, Mining and Safety. p. 3, 16.
http://drmsweblink.state.co.us/drmsweblink/0/doc/977443/Electronic.aspx?searchid=207a377f-6e3c-4f0b-a7f4-a7244daa88f3

[2] Information in Colorado Division of Reclamation, Mining and Safety Permits for 2011-2012. Search permit: M1988112 at http://drmsweblink.state.co.us/drmsweblink/Search.aspx. Reports found under hydrology. E.g., Feb. 7, 2012. "Monthly Report from Battle Mountain Resources to Colorado Division of Reclamation, Mining and Safety."
http://drmsweblink.state.co.us/drmsweblink/0/doc/946928/Page1.aspx?searchid=59b4c424-ae84-4398-a593-53b5b4052a1d

[3] Schneider, A. April 5, 2011. "Desert town keeps eye on cleanup," *Seattle Post-Intelligencer.* Available at:
http://protectourwaterourfuture.com/index.php/2011/04/05/desert-town-keeps-eye-on-cleanup-2/

[4] Martin, W.E. and McDonald, L. 1994. *Environmental Compliance in the Mine Permitting Process: Case Studies from Alaska, Colorado, Montana and Nevada.* Prepared for U.S. Department of Interior, Bureau of Mines. OFR 51-95. p. 23, 30.
http://www.blm.gov/pgdata/etc/medialib/blm/ak/jrmic/usbm_rpts.Par.35004.File.tmp/OFR_51-95.pdf

[5] Costilla County Conservancy District. Dec. 14, 1998. Letter to Michael Long, Director Colorado Division of Minerals and Geology. Re: Battle Mountain Resources Inc., San Luis Project, M-88-112.
http://drmsweblink.state.co.us/drmsweblink/0/doc/591115/Page1.aspx?searchid=1422c629-9852-4c64-b0be-4de38c6fce06

[6] Colorado Water Quality Control Division. Oct. 24, 2012. "Regulation 36 Issues Formulation Memo." p. 22.
http://tinyurl.com/bzxsnhz

[32] **SUMMITVILLE**

Perpetual treatment: "The mine was listed as a Superfund site in 1994; cleanup costs have exceeded $150 million and perpetual water treatment is required." [1]

Volume treated: [2], [3]

Treatment Costs: Estimated costs were $1.8 million in 2012. Actual Operating and Maintenance costs (2009): $1,980,000. [2], [4]

Status: [5]

Land Ownership: [6]

Impacted Resources/Resources at Risk: [5]

References:

[1] Woody et al. 2010. "The Mining Law of 1872: Change is Overdue." *Fisheries.* Vol 35, No. 7. p. 324.
http://www.fish4thefuture.com/pdfs/Fisheries-35-06-p321-331Hughes.pdf

[2] Pers. Comm. With Austin Buckingham. Colorado Department of Public Health and Environment (CDPHE). Summitville Mine Superfund Site Project Manager. Jan. 22, 2013.

[3] CDPHE. 2011. "Clean Water – Water treatment at mining sites." *Colorado Winnable Battles.* http://tinyurl.com/winnablebattles

[4] Colorado Department of Public Health and Environment. September 30 2010. *Summitville Mine Superfund Site, 2010 5-Year Report.* p. 4-19. http://www.epa.gov/superfund/sites/fiveyear/f2010080003754.pdf

[5] U.S. EPA web site: "Summitville." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/summitville/

[6] U.S. EPA and CDPHE. *The Mining History and Environmental Clean-up at the Summitville Mine.* http://geosurvey.state.co.us/education/Documents/The_Mining_History_and_Environmental_Clean-Up_at_the_Summitville_Mine.PDF

[33] **WELLINGTON-ORO MINE**

Perpetual treatment: "This project is unique because it addresses water quality concerns under an open-space protection effort. The two governmental entities undertook this water treatment effort in perpetuity so that a large portion of land could be protected for public recreation, natural resource protection and a scenic backdrop," said Scott Reid, town of Breckenridge open space and trails planner. [1]

Treatment Volume: "Discharge flows from the seep range from a winter low of 50 gpm up to a maximum treatment rate of 150 gpm during spring runoff." (Assuming runoff lasts for three months, this would equal approximately 39 million gallons per year). Data from BioTeq Environmental Technologies Inc. show that 10,000 m3 (26 million gallons) were treated in 2009, and 73,000 m3 (19 million gallons) were treated in 2010. [2], [3]

Treatment Costs: [4]

Status: [5]

Land Ownership: "Local governments purchased 1,842 acres from B&B Mines and entered into a three-way consent decree with the state and federal government." [6]

Impacted Resources/Resources at Risk: [5], [6], [7]

References:

[1] Wilhelm, R. Feb. 9, 2009. "Mitigating the effects of mining," *Water & Wastes Digest.* http://www.wwdmag.com/wastewater-treatment/mitigating-effects-mining

[2] "Wellington-Oro Water Treatment Plant, Summit County, Colorado". Case Study as Part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs67_wellington_oro.htm

[3] Whysner, K., Figueroa, L., Petri, E. and Holmes, M. April 5, 2012. "Economic recovery of zinc from mining influenced water." Presentation at the U.S. EPA Hardrock Mining Conference. Slide 11. http://www.clu-in.org/download/issues/mining/Hard_Rock/Thursday_April_5/Opportunities_for_Re-Use_and_Site_Management/01_Whysner.pdf

[4] Best, A. Jan. 2009. "Cleaning of tainted water continues at old mines," *Colorado Central Magazine.* http://cozine.com/2009-january/cleaning-of-tainted-water-continues-at-old-mines/ Also: Berwyn, B. Nov. 17, 2008. "New treatment plant near Breckenridge helps Blue River," *Summit Daily News.* http://www.summitdaily.com/article/20081117/NEWS/811179966

[5] U.S. EPA web site: "French Gulch." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/frenchgulch/index.html

[6] Colorado NPS Connection web site: Pate, B. (Colorado Water Control Division). "Locally sponsored abandoned mine treatment project in Summit County." http://www.npscolorado.com/29summitmine.html

[7] Wilhelm, R. Feb. 9, 2009. "Mitigating the effects of mining," *Water & Wastes Digest.* http://www.wwdmag.com/wastewater-treatment/mitigating-effects-mining

[34] **YAK TUNNEL**

Perpetual treatment: "We are all hopeful that the current plan to pump water from the Gaw shaft, to drill a well into the [Leadville Mine Drainage Tunnel] LMDT, and to construct a pipeline to transport water pumped from the LMDT to the Bureau's treatment plant will relieve the pressure within the LMDT. . . However, as we move beyond these short- and mid-term measures we need to complete a long-term plan to address on-going drainage from the LMDT. This plan must include. . . a commitment by the Bureau to **treat the mine discharge water in perpetuity**." [1]

Volume treated: [2]

Treatment Costs: In 1988, the actual cost to run the plant was $460,307. In 2004, EPA reported that Yak Tunnel and Leadville Mine Drainage Tunnel together have operating costs of $1,500,000. Given that it costs approximately $1 million to operate the LMDT, O&M costs for this site are in the range of $500,000/yr. [3] Abstract, [4]

Status: [5]

Land Ownership: "The water treatment plant is now operated by Resurrection Mining Company under a Consent Decree with EPA and the State." The Superfund site encompasses both private and public lands. [5], [6] p. 2.

Impacted Resources/Resources at Risk: [3] p. 11, [5]

References:

[1] Letter from Bill Ritter, Governor of Colorado to Dirk Kempthorne, Secretary of the Dept. of Interior. Feb. 24, 2008. Re: Leadville Mine Drainage Tunnel. ". . .**perpetual operation** of the Yak Tunnel Treatment Facility (OU1 Remedy) is required to prevent contaminated Yak Tunnel discharge from impacting Site surface waters." (EPA. 2009. Record of Decision, Operable Unit

12, California Gulch Superfund Site, Leadville, Colorado. p. DS-30. http://www.epa.gov/superfund/sites/rods/fulltext/r2009080003087.pdf

[2] Colorado Department of Public Health and Environment. 2011. "Clean Water – Water treatment at mining sites." Colorado Winnable Battles. http://tinyurl.com/winnablebattles

[3] U.S. EPA. 1988. Superfund Record of Decision - California Gulch, OU1, Leadville, Colorado. http://nepis.epa.gov/Adobe/PDF/91001QBV.PDF

[4] U.S. EPA web site: "California Gulch." FY 2004 New Construction Fact Sheet. http://www.epa.gov/superfund/accomp/factsheets04/calgul.htm

[5] U.S. EPA web site: "California Gulch." Colorado Cleanup Sites. http://www.epa.gov/Region8/superfund/co/calgulch/

[6] U.S. EPA. 2011. "California Gulch, Lake County, Colorado." Ecological Revitalization of Contaminated Sites Case Study. http://www.clu-in.org/download/issues/ecotools/californiagulch-casestudy.pdf

[35] **BLACKBIRD**

Perpetual treatment: "Long-term operation and maintenance [O&M) will be required for the facilities included in both the Early Actions and the Remedial Actions. . . O&M will be required in perpetuity." [1] p. 12-4.

Volume treated: The 2003 Superfund Record of Decision said that the plant treated an average of million gallons. Approximately 145 million gallons were treated in 2012. In 2011, it was reported that treatment may be required for seepage from West Fork Tailings Impoundment. In 2012, several commenters, including Blackbird Mine Site Group, Blackbird Mine Natural Resource Trustee Council, Idaho Department of Environmental Quality, and US Forest Service encouraged EPA to seriously consider in-stream stabilization with water treatment for flows from the West Fork seepage area. [1] p. 12-5, [2], [3] p. 39, [4] pp. A1-A5.

Treatment Costs: Actual O&M (1999-2007) averaged $457,000. In 2012, costs were $300,000. O&M costs for the existing plant are likely to increase as new sludge handling and disposal options must be found. And there may be additional O&M costs of a treatment plant is built to treat flows from the West Fork seepage area.[2], [3] p. 53, [5] pp. 51, 53.

Status: [6]

Land Ownership: [7]

Impacted Resources/Resources at Risk: Dissolved copper concentrations in Panther Creek and Big Deer Creek frequently exceeded the Idaho water quality standard for the protection of aquatic life by a factor of 10 or more. Historically, the Panther Creek drainage is reported to have supported runs of anadromous chinook salmon and steelhead trout. Water quality impacts from the mine contributed to the significant declines in chinook salmon and steelhead runs in Panther Creek. [1] p. 7-10, 13-1, and 13-2, [4] p. 3, [5] p. 14.

References:

[1] EPA Region 10. 2003. *Blackbird Mine Superfund Site Record of Decision.* http://yosemite.epa.gov/r10/CLEANUP.NSF/sites/Blackbird/$FILE/Blackbird+ROD+-+Feb+2003.pdf

[2] Personal Communication, Dan Myers, Blackbird Site Manager, February 29, 2013.

[3] Golder Associates. July 2011. *Supplemental Blackbird Creek Evaluation Report to Address Migration of Blackbird Creek Sediments.* Appendix A. Table E-6, p. 39. http://www.epa.gov/region10/pdf/sites/blackbird_mine/supplemental_blackbirdcreekevaluationreport_appendices_07_07_2011.pdf

[4] U.S. EPA. May 31, 2012. Explanation of Significant Differences for the Record of Decision for the Blackbird Mine. http://www.epa.gov/region10/pdf/sites/blackbird_mine/blackbirdmine_ESD_053112.pdf

[5] U.S. EPA. 2008. *First Five-Year Review* Report - *Blackbird Mine Site, Lemhi County, Idaho.* http://www.epa.gov/superfund/sites/fiveyear/f2008100002602.pdf

[6] U.S. EPA web site: "Blackbird Mine." http://yosemite.epa.gov/R10/CLEANUP.NSF/sites/Blackbird

[7] U.S. EPA web site: "NPL Site Narrative for Blackbird Mine." National Priorities List. http://www.epa.gov/superfund/sites/npl/nar1369.htm

[36] **GROUSE CREEK:**

Perpetual treatment: "An update of reclamation costs prepared in 2001 estimated $60 million in land reclamation (finite) and water treatment in perpetuity (SAIC 2001)." [1]

Volume treated: "Wastewater is treated prior to discharge through Outfall 002. . . The average yearly discharge rate is 450 gpm (1 cfs) based on Hecla's NPDES permit application and supplemental information." 450 gpm is equal to 236,520,000 gallons." [2]

Treatment Costs:

Status: [3]

Land Ownership: [4]

Impacted Resources/Resources at Risk: [2], [5], [6], [7]

References:

[1] Science Applications International Corporation (SAIC). 2001. *Final reclamation bond review: Grouse Creek Mine project, Salmon Challis National Forest, Idaho.* Report to U.S. Department of Agriculture Forest Service, Challis National Forest, ID. (**Cited in:** Chambers, D., Moran, R., and Trasky, L. Jan. 2012. *Bristol Bay's Wild Salmon Ecosystems and the Pebble Mine - Key*

Considerations for a Large-Scale Mine Proposal. Wild Salmon Center and Trout Unlimited. p. 33. http://www.wildsalmoncenter.org/pdf/PM-Report.pdf)

[2] U.S. EPA. Nov. 24, 1999. *EPA Proposes to Reissue a Wastewater Discharge Permit to Hecla Mining Company, Grouse Creek Unit.* Fact Sheet. p. 9. http://yosemite.epa.gov/R10/WATER.NSF/95537302e2c56cea8825688200708c9a/2978a2d617a53f36882568790059bd3c/$FILE/ATTFQ0KG/ID0026468%20FS.PDF

[3] Hecla Mining Company web site: "Responsible Reclamation." http://www.hecla-mining.com/responsibility/responsibility_stewardship_reclamation.php Accessed March 2, 2013.

[4] Environmental Appeals Board (U.S. EPA). July 11, 2002. "Re: Hecla Mining Company, Grouse Creek Unit." Order Denying Petition for Review. NPDES Appeal No. 02-02. p. 4. http://www.epa.gov/eab/orders/hecla.pdf

[5] Kuipers and Maest. 2006. Comparison of Predicted and Actual Water Quality at Hardrock Mines. Appendix B. p. B-51. Available at: http://www.earthworksaction.org/library/detail/comparison_of_predicted_and_actual_water_quality_at_hardrock_mines/#.UTKSxxk1Y1I

[6] EPA. Nov. 1999. "U.S. EPA proposes to reissue a wastewater discharge permit it Hecla Minng Company Grouse Creek Unit." Fact Sheet. http://yosemite.epa.gov/R10/WATER.NSF/95537302e2c56cea8825688200708c9a/2978a2d617a53f36882568790059bd3c/$FILE/ATTFQ0KG/ID0026468%20FS.PDF

[7] U.S. Forest Service. May 21, 2003. Removal Action Memorandum, Grouse Creek Mine Tailings Impoundment Dewatering. pp. 7, 8 and 13. Available at: http://www.docstoc.com/docs/33951388/REMOVAL-ACTION-MEMORANDUM-GROUSE-CREEK-MINE-TAILINGS

[37] **THOMPSON CREEK**

Perpetual treatment: "The Corporation believes that the long-term closure liabilities remain primarily around water quality and the plan to treat water in perpetuity." [1], See also [4] p. 1-9

Volume treated: Current treatment estimated 100 - 200 gpm. No design yet for new plant. [2], [3]

Treatment Costs: [4] p. 1-9.

Status: [5]

Land Ownership: [4] p. 4-1.

Impacted Resources/Resources at Risk: [4] 23-15, [6]

References:

[1] Thompson Creek Metals Co. Inc. 2009. Annual Report 2009. p. 18. http://www.thompsoncreekmetals.com/i/pdf/TCM_AR_09.pdf

[2] Ken Gardner, project lead, BLM, personal communication, Nov. 2011. 208-879- 6210.

[3] June 10, 2010. Memorandum from Brian Buck re: May 12, 2010 Conference Call to discuss the Thompson Creek Mine EIS with the Nez Perce Tribe representatives. p. 3. https://www.blm.gov/epl-front-office/projects/nepa/8000/41610/44010/AppendixE_20110628_508.pdf

[4] Marek, J. and Lechner, M. Feb. 2011. Technical Report Thompson Creek Molybdenum Mine. Prepared for Thompson Creek Metals Co. Inc. http://www.thompsoncreekmetals.com/i/pdf/Thompson_Creek_TechRpt_9Feb2011_FINAL.pdf

[5] Thomson Creek Metals Co. Inc. web site: "Thompson Creek Mine." http://www.thompsoncreekmetals.com/s/Thompson_Creek_Mine.asp

[6] EPA. 2001. Thompson Creek Mining Final [NPDES] Permit. Permit No. ID-002540-2. p. 1. http://yosemite.epa.gov/R10/WATER.NSF/95537302e2c56cea8825688200708c9a/2978a2d617a53f36882568790059bd3c/$FILE/ATTJK63L/ID0025402%20FP.PDF

[38] **UPPER COUER D'ALENE AND BUNKER HILL**

Perpetual treatment: "Under the Superfund funding system, Idaho has to pick up 10% of the cost of the mitigation in this area and will have to pick up -- I think it's a million dollars a year cost to run the water treatment plant at Bunker Hill -- and that will have to be run in perpetuity." [1]

Volume treated: Maco and Zaering (July 2012) report that average annual flows to the Central Treatment Plant (CTP) are between 1,500 – 2,499 gpm, which represents the range of Bunker Hill AMD flows currently being treated at the CTP. In the EPA Oct. 2012) draft implementation plan for remedial works between 2012 and 2022, the agency indicates an additional need for treatment of 4,399 gpm from Bunker Hill Box (OU 2) remedial actions and 5,452 gpm from OU 3 remedial actions in the Canyon Creek watershed (Table 3-3) for a total of 9,851 gpm additional flows to the CTP. When added to the approximately 1,500 gpm already treated at the plant, it indicates the need for a total of 11,350 gpm or 5.97 billion gallons/yr to be treated at an expanded CTP. This is less than the total flow estimated by Maco and Zaehring, which was 16,800 gpm for contaminated waters from OU 2 and OU 3 and the existing Bunker Hill flows. [2] p. 5, Table 2-1, [3] Tables 3-2 and 3-3.

Treatment Costs: 2006 reflects bid price to operate CTP. Estimated costs, including sludge disposal, for an expanded treatment plant with the capacity to treat the new and existing flows are approximately $2,500,000. [2] Attachment 1, Table A-10, and Table 3-1.

Status: The federal and state governments assumed operation of the CTP in November 1994, following the bankruptcy of the Gulf and Pintlar corporations. [5] p. 7-18.

Land Ownership: [6] p. 3-1.

Impacted Resources/Resources at Risk: [6] p. iv, [7], [8]

References:

[1] Comments from Earl Bennett, former Director of the Idaho Geological Survey. Interview with Silver Valley Rising. 2005. http://idahoptv.org/outdoors/shows/silvervalleyrising/bennett.cfm

[2] Maco, R. and Zaehring, M. (CH2M Hill) July 20, 2012. Documentation of Estimated CTP Expansion and Water Treatment Costs Presented in the Draft Final FFS Report for the Upper Basin of the Coeur d'Alene River, Bunker Hill Superfund Site. http://www.epa.gov/region10/pdf/sites/bunker_hill/bh_ctp_cost_documentation_tm_072012.pdf

[3] U.S. EPA. Oct. 30, 2012. Draft Bunker Hill Mining and Metallurgical Complex Superfund Site – Superfund Cleanup Implementation Plan, 2012-2022. p. 3.8. http://www.epa.gov/region10/pdf/sites/bunker_hill/cda_basin/Draft--Bunker_Hill_Superfund_Cleanup_Implementation_Plan_10-30-2012.pdf

[4] U.S. EPA web site: "Bunker Hill Mining and Metallurgical Superfund Site (Couer d'Alene Basin)." http://yosemite.epa.gov/r10/cleanup.nsf/sites/bh

[5] CH2MHill. August 2012. Focused Feasibility Study Report, Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site. Vol 1., Addendum to the Draft Final Report. http://www.epa.gov/region10/pdf/sites/bunker_hill/cda_basin/final_ffs_report_volume_1.pdf

[6] U.S. EPA. July 12, 2010. *Proposed Plan - Upper Basin of the Coeur d'Alene River, Bunker Hill Mining and Metallurgical Complex Superfund Site.* http://www.epa.gov/region10/pdf/sites/bunker_hill/upper_basin_final_pp_0710.pdf

[7] http://www.epa.gov/region10/pdf/sites/bunker_hill/cda_basin/epa_ad_topic6.pdf

[8] U.S. EPA. July 2001. *Proposed plan for the Bunker Hill Superfund Site.* p. 7. http://yosemite.epa.gov/R10/CLEANUP.NSF/46453efc0be3985c88256d140050c1ac/706996cf1cb732b488256d0f00706cdc/$FILE/Final%20Proposed%20Plan.pdf

[39] **BUCK MINE**

Perpetual treatment: "Periodic maintenance, especially in the final polishing area of the marsh (Site d), and oversight of the property will be required in order for this treatment system to remain effective." "The AMD is from an old mine shaft and groundwater seeping from wasterock, and there have been no efforts to control these sources, so it will be a long-term source of AMD." [1], [2]

Volume treated: Average of 312 – 316 gpm, based on flow measurements taken in May, August and November of 2011. [2]

Treatment Costs: [2]

Status: [3]

Land Ownership: "Following the closing of mines, the area of the property where the waste rock was dumped has been divided into several parcels and has gone through many ownership changes." Does not indicate public ownership. [1]

Impacted Resources/Resources at Risk: [1]

References:

[1] Taft, W. June 2012. "A biological survey of the Iron River upstream and downstream of the Buck Mine discharge, Iron County, MI." Staff Report. Michigan Department of Environmental Quality (MDEQ), Water Resources Division. Document received from MDEQ.)

[2] Pers. Comm. Steve Casey. Michigan Department of Environmental Quality, Water Resources Division MDEQ. Jan. 29 and 31, 2013.

[3] James, H.L. and Wier, K.L. (Michigan Geologic Survey). 1969. *Geology and Magnetic Data for Southeastern Iron River Area, Michigan.* p. 18. http://www.michigan.gov/documents/deq/GIMDL-RI06_216259_7.pdf

[40] **BERKELEY PIT / CONTINENTAL MINE COMPLEX**

Perpetual treatment: "Atlantic Richfield and Montana Resources, LLP, the Potentially Responsible Parties (PRPs), have liabilities for this operable unit, and under the selected remedy they will continue into perpetuity. A key component of the site remediation activities involved the design and construction of a two-stage, high-density sludge water treatment facility." "The plant is designed to operate forever. As long as the mine water is kept below the 5,410-foot level, scientist say it will cause no further harm to groundwater resources in the area or downstream."[1]

Volume treated: 2009 data show 1.852 billion gallons were treated. After final upgrades, the plant will be able to treat up to seven million gallons per day (2.56 billion gallons per year). [2], [3] p. 4-5.

Treatment Costs: According to CDM, "Because the operation of the HSB WTP is part of an active mining operation, MR prefers not to disclose the O&M costs of its operation." But the Berkeley Pit Public Education Committee, which includes government, Atlantic Richfield, and citizen members, estimates costs at $2 million/yr. Once Berkeley Pit water comes online, costs could be as high as $4.5 million/yr. [3] p. 4-5, [4]

Status: [3] pp. 2-1, 3-1.

Land Ownership: Within the City of Butte, Montana. [5]

Impacted Resources/Resources at Risk: [6], [7]

References:

[1] Zick, R.L., Velegol, D.A., Hess, M.W. and Foote, M. 2004. "Butte mine flooding water treatment facility: Implementation of major component of selected remedy for historic Contamination at Berkeley pit site," Paper to be presented at the Joint Conference, 21st American Society for Mining and Reclamation Meeting and 25th West Virginia Surface Mine Drainage Task Force Symposium, Morgantown, West Virginia, April 18-22, 2004. http://www.itrcweb.org/miningwaste-guidance/References/2079-ZickPA.pdf

[2] Berkeley Pit Public Education Committee (Pitwatch). 2010. "The Berkeley Pit: Treating the Water." http://www.pitwatch.org/img/PitPoster4.jpg

[3] CDM Federal Programs Corp. June 2011. Third Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site. Vol. 3. *Volume 3: Butte Mine Flooding Operable Unit.* ftp://ftp.epa.gov/r8/sbcbutte/FiveYearReviewReport-June2011/Volume3_ButteMineFloodingOU/Vol3_ButteMineFloodingOU.pdf

[4] Berkeley Pit Public Education Committee (Pitwatch) webs site: 2009. "Water treatment plant working as expected." http://www.pitwatch.org/2009.htm

[5] U.S. Department of Justice. March 25, 2002. "United States and Montana reach agreement with mining companies to clean up Berkeley Pit." http://www.justice.gov/opa/pr/2002/March/02_enrd_180.htm

[6] U.S. EPA web site: "Silver Bow Creek / Butte Area." Montana Cleanup Sites. http://www.epa.gov/region8/superfund/mt/sbcbutte/index.html

[7] Berkeley Pit Public Education Committee (Pitwatch) web site: "Could the pit ever overflow?" http://www.pitwatch.org/faq.html#q16overflow

[41] **GOLDEN SUNLIGHT**

Perpetual treatment: In the 1997 Draft EIS, government officials determined that acid drainage at the Golden Sunlight mine would continue for thousands of years. In the 2007 Final SEIS, "The dewatering system would collect water in the sump and pump it to a permanent water treatment plant." "For all alternatives, it is anticipated that pit water treatment would be required indefinitely." [1], [2] Summary, p. 2; Chapter 1, p. 1-33.

Volume treated: Although water treatment facilities with capacity to treat approximately 100 gpm currently exist in the mill building, GSM intends to replace this with a new water treatment plant after the mine closes. The new plant will be designed to treat 102 gpm from the pit area. [2] Chapter 2. p. 2-41

Treatment Costs: [3]

Status: [4]

Land Ownership: [2] Chapter 1, p. 1-5.

Impacted Resources/Resources at Risk: [2] Chapter 3. pp. 3-20 and 3-30.

References:

[1] Montana Department of Environmental Quality (DEQ). November 1997. *Draft Environmental Impact Statement Golden Sunlight Mine.*

[2] Montana DEQ and U.S. Bureau of Land Management. July 2007. *Final Supplemental Environmental Impact Statement, Golden Sunlight Mine, Pit Reclamation.* http://deq.mt.gov/eis/hardrock/GoldenSunlightSEIS/finalSEIS.mcpx

[3] Zuzulock, S. 2003. Greens Creek Financial Assurance Review. Center for Science in Public Participation (CSP2). http://www.csp2.org/REPORTS/GC%20Attachment%203.xls

[4] Barrick web site: "Golden Sunlight." http://www.barrick.com/operations/north-america/golden-sunlight/default.aspx

[42] **UPPER BLACKFOOT MINING COMPLEX**

Perpetual treatment: In April 2008, state and federal officials announced a $37 million settlement with Atlantic Richfield Co. and ASARCO LLC to remove the aging Dam and contaminated tailings, and clean up and restore the Upper Blackfoot River and Mining Complex. ASARCO paid an additional $10 million into a custodial trust for perpetual water treatment of contaminated adit discharges from the abandoned mines located at the site. According to a report prepared for the Montana Department of justice, "adit drains will remain a perpetual source of acid mine drainage" at the site. [1], [2]

Volume treated: Approximately twenty six million gallons of water from historic mining operations are collected and treated at the WTP each year. [3]

Treatment Costs: [4]

Status: [4]

Land Ownership: [5]

Impacted Resources/Resources at Risk: [4], [5] p. 32.

References:

[1] Montana Department of Justice web site: "2008 Settlement – Mike Horse Dam." Clark Fork River Lawsuit History and Settlements. https://doj.mt.gov/lands/lawsuit-history-and-setttlements/

[2] River Design Group, In. Feb. 2011. Conceptual Restoration Plan for the Upper Blackfoot Mining Complex. Report prepared for Montana Department of Justice. p. 4. https://doj.mt.gov/wp-content/uploads/2011/06/2011draftconceptualrestorationplanblackfootminingcomplex.pdf

[3] Montana Environmental Trust Group web site: "Upper Blackfoot Mining Complex (UBMC)/Mike Horse." http://www.mtenvironmentaltrust.org/upper-blackfoot-mining-project

[4] Montana Department of Environmental Quality web site. "Upper Blackfoot Mining Complex CECRA Facility (UBMC)." http://deq.mt.gov/statesuperfund/ubmc/default.mcpx

[4] Hydrometrics, Inc. July 2007. *Final Engineering Evaluation/Cost Analysis for the Mike Horse Daman and Impounded Tailings, Lower Mike Horse Creek, Beartrap Creek and the Upper Blackfoot River Floodplain Removal Areas, Upper Blackfoot Mining Complex, Lew and Clark County, MT.* Prepared for USDA Forest Service and ASARCO LLC. p. 2-1. http://prdp2fs.ess.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5354088.pdf

[43] **UPPER TEN MILE CREEK**

Perpetual treatment: The passive treatment site at Peerless Jenny King, and any treatment systems installed for areas still undergoing remediation (e.g., Lee Mountain, Susie, Red Mountain, National Extension and others) will have some O&M costs in perpetuity. [1]

Volume treated: At the present time there are two passive treatment systems for AMD in place. One, at the Luttrell repository, is likely not going to be needed in perpetuity, as the repository will eventually be capped and sealed. The Peerless Jenny King site handles flows of approximately 10 – 30 gpm (30 during spring runoff). Assuming spring runoff lasts for two months (http://pubs.usgs.gov/fs/2001/0059/report.pdf), the treatment systems handles: 10 gpm for 10 months, which is approx. 4.4 million gallons; and 30 gpm for two months, which is approx. 2.6 million gallons, for a total of 7 million gallons per year. [2]

Treatment Costs:

Status: [2]

Land Ownership: [4]

Impacted Resources/Resources at Risk: The site includes the drainage basin of Tenmile Creek upstream of the Helena water treatment plant and includes tributaries that supply water to the plant's five intake pipelines. EPA identified 150 individual mine sites, of which 70 have been prioritized for cleanup. Many of these mine features are above the five water intakes, which supply about 50 percent of Helena's water. [3] pp. 32 and 62-65.

References:

[1] Pers. Comm. Dick Sloan, Montana Department of Environmental Qualitiy. Jan. 30, 2013.

[2] U.S. EPA web site: "Upper Ten Mile Creek Mining Area." Montana Cleanup Sites. http://www.epa.gov/region8/superfund/mt/upper_ten/index.html

[3] U.S. EPA. June 28, 2002. *Superfund Record of Decision, Upper Ten Mile Creek Mining Area*. p. 40. http://www.epa.gov/superfund/sites/rods/fulltext/r0802068.pdf

[44] **ZORTMAN AND LANDUSKY**

Perpetual treatment: "The current Engineering Evaluation and Cost Analysis (Spectrum Engineering, Inc., 2006) assumes that perpetual operation of the treatment plants is needed to minimize environmental damage and prevent exposure to toxic metal concentrations from untreated mine discharges." [1] p. 2-11

Volume treated: Zortman treats an annual average of about 70 million gallons of wastewater collected from three drainage capture systems. The Landusky plant treats an annual average of about 225 million gallons from four drainage capture systems, a historic mine adit discharge, an artesian well, and leach pad drainage. Swift Gulch Creek plant operates June through November at a capacity of 50 to 100 gpm. That works out to be 13 to 26 million gallons per year. [1] p. 2-11.

Treatment Costs: [1] p. 5-17.

Status: [2] p. 2.

Land Ownership: [2] p. 3.

Impacted Resources/Resources at Risk: [3], [4], [5]

References:

[1] Montana DEQ. March 2012. *Landusky Metals and Cyanide Total Maximum Daily Loads and Framework Water Quality Restoration Plan*. http://deq.mt.gov/wqinfo/TMDL/Landusky/LanduskyTMDL.pdf

[2] BLM. 2004. *Action Memorandum for Zortman and Landusky Mines Time-Critical Removal Operable Unit 1 and Operable Unit 2.* http://www.blm.gov/pgdata/etc/medialib/blm/mt/field_offices/lewistown/zortman.Par.60926.File.dat/actionmemo2.pdf

[3] U.S. Bureau of Land Management and Montana Department of Environmental Quality. 2002. *Record of Decision for Reclamation of the Zortman and Landusky Mines*. p. 2. http://www.blm.gov/pgdata/etc/medialib/blm/mt/field_offices/lewistown/zortman.Par.80150.File.dat/ROD.pdf

[4] Kill Eagle, J. *ARD treatment of Swift Gulch Drainage in the Little Rocky Mountain Mountain of North Central Montana*. Slide 5. http://www.mtech.edu/research/highlights/grad_student_research/images/Presentation%20new%20Jonny%20Killeagle.ppt

[5] Interstate Technology Regulatory Council. "Zortman Landusky-Swift Gulch Site, Phillips County, Montana." Case Study as part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs60_zortman.htm

[45] **ANACONDA**

Perpetual treatment: This site is located in Yerington, NV. According to EPA, the site will require long-term or perpetual treatment. [1]

Volume treated: [2]

Treatment Costs:

Status: [2]

Land Ownership: [3]

Impacted Resources/Resources at Risk: [2]

References:

[1] Pers. Comm. Jere Johnson, EPA Site Manager, Anaconda Mine Superfund Site. Jan. 28, 2013. 415-972-3094.

[2] U.S. EPA web site: "Anaconda Mine." Superfund Site Overviews. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/NVD083917252

[3] U.S. EPA. August 5, 2008. "Memorandum - Request for a Time Critical Removal Action at the Anaconda Yerington Mine Site." p. 3. http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/cf0bac722e32d408882574260073faed/3b9a1f56ae33f6dc882574a50072c99d/$FILE/2159673.pdf

[46] **PHOENIX MINE**

Perpetual treatment: According to the Draft EIS, during the early stages of closure draindown of heap leach facilities (HLF) "would be managed by active evaporation at the top of the copper heap leach pads using evaporators. Once draindown flow rate is reduced to relatively low flow rates, the draindown would be managed by passive evaporation in a series of specially designed E-ponds." According to the *New York Times*, "EPA believes the [Phoenix] project will likely create a perpetual and significant acid mine drainage problem requiring mitigation for hundreds of years." EPA has written that, "According to the Draft EIS, the mine is expected to operate for 24 years, followed by 13 years of reclamation, after which drain down fluids from the proposed copper leach pads would be managed in evaporation ponds for at least 500 years...The Draft EIS clearly states that following closure, long-term care will be necessary to protect water quality and wildlife at the Phoenix Mine." [1] Chapter 3.2, p. 19, [2], [3]

Volume treated: The Draft EIS has two HLF closure options. For both options 1 and 2, evaporation at HLF will begin once flow rates reach approximately 15 gpm of leachate (7,884,000 gallons per year) for Phoenix HLF and 2 gpm for Reona HLF (1,041,200 gallons per year) for Reona HLF, or a total of 8,935,200 gallons. Flows will gradually reduce over time. Based on options 1 or 2, flows for Phoenix HLF will be 8.6 or 10.2 gpm (4.5 million or 5.3 million gallons) from years 30 to 500, respectively. Flows for closure options 1 or 2 for the Reona HLF will be 0.9 or 1.2 gpm (473,000 to 630,000 gallons), respectively for years 30 to 150. [4] p. 15.

Treatment Costs:

Status: [5]

Land Ownership: [1] p. ES-1.

Impacted Resources/Resources at Risk: [2] Chapter 3.2, p. 12.

References:

[1] Bureau of Land Management (BLM). Oct. 2011. Draft Environmental Impact Statement for the Phoenix Copper Leach Project. Available at: http://www.blm.gov/nv/st/en/fo/battle_mountain_field/blm_information/national_environmental/phoenix_copper_leach.html

[2] Barringer, F. March 8, 2004. "Mine's pollution fund is focus of federal agencies' duel," New York Times. http://www.nytimes.com/2004/03/08/national/08GOLD.html

[3] EPA. Jan. 19, 2012. Letter to Bureau of Land Management re: Draft Environmental Impact Statement (EIS) for the Phoenix Copper Leach Project, Lander County, Nevada. Available in: BLM. April 2012. Final Environmental Impact Statement for Phoenix Copper Leach Project. p. 63. http://www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/battle_mountain_field/blm_information/nepa/final_environmental.Par.28322.File.dat/Final_EIS_April_2012.pdf

[4] BLM. June 18, 2012. Record of Decision and Amendment to the Plan of Operations Approval, Newmont Mining Corporation, Phoenix Copper Leach Project Final Environmental Impact Statement. 2012. p. 15. http://www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/battle_mountain_field/blm_information/nepa/phoenix_copper_leach.Par.18656.File.dat/ROD%20Phoenix%20Copper.pdf

[5] Newmont Mining Corp. Feb. 22, 2013. Form 10-K Filing. U.S. Securities and Exchange Commission. p. 28. http://www.sec.gov/Archives/edgar/data/1164727/000119312513070256/d462654d10k.htm

[47] **RAIN MINE**

Perpetual treatment: "I have reviewed the data that [Earthworks] provided, and I agree that the Sleeper Mine, the Jerritt Canyon Mine and the Rain Mine all will require *In perpetuity* treatment and/or very long term management of contaminated water draining from these mines. In addition, the former Equatorial Tonopah and the Paradise Peak mines are very likely to also require very long term treatment and or management of pit lakes or heap drainage also." [1]

Volume treated: The central treatment needs are from the acidic drainage (pH less than 3 since 2007) of the North Waste Rock Facility. Since 2004, this facility has discharged seepage at a typical rate of 20 gpm (range was 12.4 to 97.5, reflecting dry and wet years, respectively. A rate of gpm is equivalent to 10.5 million gallons per year. Given the consistency of seepage from this facility, it is likely that active treatment will be required long-term, unless additional measures are taken to reduce infiltration of water into the waste rock. Some remediation attempts at the site have not successfully reduced the seepage rate. [2]

Treatment Costs: Newmont reported using 605 tons of lime in 2011 to treat the acidic drainage. Seepage is partially neutralized with lime and then sent to the tailings impoundment. Newmont does not include information for treatment cost, however, based on a feasibility analysis of acid rock drainage treatment for the Liberty-Tonopah mine, the cost per ton of lime is approximately $150/ton. Therefore, the cost to treat seepage from the Rain waste rock facility is approximately 605 tons x $150 per/ton = $90,750 per year. This is a conservative estimate, as it does not include the O&M costs to carry out the treatment or pump seepage to the tailings facility. [2], [3]

Status: "The Rain Mine is currently in reclamation and closure phases." [4]

Land Ownership: [5]

Impacted Resources/Resources at Risk:

References:

[1] Pers.Comm. Glenn Miller, Professor, Dept. of Natural Resources and Env. Science, University of Nevada. Feb. 27, 2013.

[2] Nevada Department of Environmental Protection. "Water Pollution Control Permit No. NEV87011, Rain Water Quality Report" (Annual reports 2004 – 2011); NDEP. (First Quarter 2012 Report)

[3] Knight Piesold. October 20, 2100. Liberty Moly, LLC Liberty Mine Focused Feasibility Analysis of the Water Treatment Options for the Acid Heap Leach Draindown Water. Appendix A, see "Cost Estimate for alternative 3d."

[4] Bureau of Land Management. June 2012. *Draft Environmental Impact Statement for the Hollister Underground Mine Project.* Chapter 3.2 – Past, Present and Reasonably Foreseeable Actions." p. 3.2-8. http://www.blm.gov/nv/st/en/fo/elko_field_office/blm_information/nepa/hollister_deis__6.html

[5] U.S. EPA. 1994. *Site Visit Report: Newmont Gold Company Rain Facility.* p. 5-5. http://www.epa.gov/osw/nonhaz/industrial/special/mining/techdocs/gold/goldch5.pdf

48 JERRITT CANYON

Perpetual treatment: "I have reviewed the data that [Earthworks] provided, and I agree that the Sleeper Mine, the Jerritt Canyon Mine and the Rain Mine all will require *In perpetuity* treatment and/or very long term management of contaminated water draining from these mines. In addition, the former Equatorial Tonopah and the Paradise Peak mines are very likely to also require very long term treatment and or management of pit lakes or heap drainage also." [1]

Volume treated: The primary water contamination issue at this site is seepage from waste rock dumps (high in TDS, Sulfate, and magnesium). According to NDEP [2009 letter), an average of 35 gpm (18.4 million gallons per year) seeps from the waste rock dumps. This seepage rate has been consistent over the past several years. Unless the company undertakes significant remediation of the waste rock dumps this seepage volume is likely to continue for an indefinite period of time. [2], [3], [4]

Treatment Costs: The method of treatment is evaporation of contaminated waters. Cost estimate is based on an analysis done for the Sierrita Mine in Arizona. In Nevada, electric rates are generally lower than in the Sierrita estimate, but the pan evaporation rate is higher in NM (which means in Nevada there will be more seepage to pump to the evaporation ponds than in Arizona). It was assumed that these factors would roughly compensate for each other. Based on the Sierrita analysis, the long term evaporative treatment of waste rock seepage from Jerritt Canyon would have costs of approximately $15,000/yr. This <u>does not</u> include the costs to pump the water from the waste rock seepage collection areas to the evaporation ponds. Given that seepage has to be pumped uphill for a distance at the Jerritt Canyon site, the pumping costs for 18 million gallons of water could be significant. [5]

Status: [6]

Land Ownership: [7]

Impacted Resources/Resources at Risk:

References:

[1] Pers.Comm. Glenn Miller, Professor, Dept. of Natural Resources and Env. Science, University of Nevada. Feb. 27, 2013.

[2] Nevada Department of Environmental Protection (NDEP). July 14, 2009. Letter from Rob Kuczynski (NDEP), "EDC Approval, Temporary DASH RDA Seepage Diversion, Jerritt Canyon Mine, Elko County, NV, Water Pollution Control Permit NEV0000020."

[3] NDEP. Pers. Comm. with staff (Rob Kuczynski). February 25, 2013.

[4] NDEP. July 27, 2011. "Water Pollution Control Permit NEV0000020 (renewal 2010) Fact Sheet." p. 27.

[5] MWH. October 14, 2008. "Memorandum, Sierrita Mine Groundwater Treatment Alternative Evaluation." Table 15, p.28. http://www.fcx.com/sierrita/pdf/2008/20081023_001_Appendix_D.pdf

[6] Veris Gold web site:" Jerritt Canyon." http://www.verisgold.com/s/JerrittCanyon.asp?ReportID=531219

[7] USDA Forest Service. 1979. *Draft Environmental Impact Statement, Jerrit Canyon Project Gold Mine and Mill, Elko County, Nevada.* See Abstract. http://www.nbmg.unr.edu/scans/2420/24200056.pdf

49 CHINO & COBRE

Perpetual treatment: Current or completed Remedial Actions. . . [Chino Mine and Tyrone Mine]: "Groundwater pumping (in perpetuity, with future treatment)." [1] p. 2-14.

Volume treated: Cobre: "Currently contributes 171 million gallons per year to the Chino water treatment plant. This should decrease to 72 million per year in 100 years. If mine expansion occurs, treated water will increase to 441 million gallons decreasing to 77 million gpy at year 100. If mine expansion occurs, 514.8 gpm (270.5 million gpy) will go to Chino via LS/Raffinate Pipeline and 325 gpm (170.8 gpy) will go to Chino via BullFrog Pipeline in year one, and in year 14 the PLS/Raffinate pipelines will no longer be in use. At that point, all contaminated water will go to Chino via Bullfrog pipeline. By year 100, the amount of water is predicted to decline to 145.8 gpm (76.6 gpy)." [2]

Chino: Volume declining with time. High of 1,143 gpm (600 million gallons per year) in year 1 to low of 824 gpm (433 gallons per year) in years 40-100. [3] Table 1.

Total: Current = 171 +600 = 771 million gallons. Year 100: 72 + 443 = 515 million gallons.

Treatment Costs:

Total O&M costs estimated at $268,008,000 for 100 years. This includes operation of Lake One Hurley treatment, which is the smelter site. If O&M costs for this site are removed ($13,200,000) the total O&M costs are $254,808,000. Divided by 100 years, it comes to $2.548 million per year. [3] Table 15.

Status: [4] pp. 12, 14.

Land Ownership: [4] p. 13.

Impacted Resources/Resources at Risk: [1] pp. 3-8, 3-13, S-1.

References:

[1] New Mexico Office of Natural Resources Trustee. Jan. 2012. *Final Groundwater Restoration Plan for the Chino, Cobre, and Tyrone Mine Facilities*. Available at: http://www.gilaresources.info/pdfs/Final.Groundwater.Restoration.Plan.Chino.Cobre.Tyrone_1.4.2012.pdf

[2] Telesto Solutions Inc. Aug. 2009. 2009 Cobre Closure/Closeout Plan. Prepared for Freeport-McMoran, Inc. Table C.5. http://www.emnrd.state.nm.us/mmd/marp/permits/documents/GR002RE_20090810_Cobre_2009_Closure_Closeout_Plan.pdf

[3] Golder Associates. Aug. 2007. *Chino Closure/Closeout Plan - 2007 Update. Basis Of Cost Estimate For Water Treatment With Commingling.* http://www.emnrd.state.nm.us/mmd/marp/permits/documents/GR009RE_20081121_Chino-ClosureCloseoutPlan-AppendixD-08282007.pdf

[4] Freeport-McMoran. "Form 10-K Filing for Fiscal Year Ending Dec. 31, 2012." U.S. Securities and Exchange Commission. p. 13. http://www.fcx.com/ir/downloads/2012_Form_10-K.pdf

[50] **TYRONE**

Perpetual treatment: Current or completed Remedial Actions. . . [Chino Mine and Tyrone Mine]: "Groundwater pumping (in perpetuity, with future treatment)." [1] p. 2-14.

Volume treated: Approx. 606 gpm (319 million gallons per year) initially, after cessation of mining. Then, by year 25 will decrease to approx. 480 gpm (252 million gallons per year). [2] Tables 4 - 10.

Treatment Costs: Estimated $328 million for 100 years, so $3.28 million per year. [2] p. 12.

Status: [3]

Land Ownership: [3]

Impacted Resources/Resources at Risk: [1] pp., 3-8, S-1.

References:

[1] New Mexico Office of Natural Resources Trustee. Jan. 2012. *Final Groundwater Restoration Plan for the Chino, Cobre, and Tyrone Mine Facilities*. Available at: http://www.gilaresources.info/pdfs/Final.Groundwater.Restoration.Plan.Chino.Cobre.Tyrone_1.4.2012.pdf

[2] Golder & Associates. Oct. 2007. *Tyrone Closure/Close-out Plan 2007 Update - Basis of Cost Estimate for Water Management and Treatment.* http://www.emnrd.state.nm.us/mmd/marp/permits/documents/GR010RE_20071011_Closeout_Plan_Update_AppendixD_Water_Treatment_Cost_Estimate.pdf

[3] Freeport-McMoran. "Form 10-K Filing for Fiscal Year Ending Dec. 31, 2012." U.S. Securities and Exchange Commission. p. 12. http://www.fcx.com/ir/downloads/2012_Form_10-K.pdf

[51] **QUESTA**

Perpetual treatment: "For the Mine Site Area, EPA is selecting two similar remedial alternatives." Both include "perpetual underground mine dewatering, ground water extraction, and water treatment." (p. 2-615) "Water treatment plants will have to be operated at the mine site and tailing facility for decades; the mine site water treatment plant to be operated possibly in perpetuity." [1] p. 2-688.

Volume treated: "The conceptual total estimated flow of water to be collected by the remedial system is approximately 1,070 gpm [562 million gpy]. . . Of the 1,070 gpm of collected water, approximately 550 gpm [289 million gpy] will be treated at the water treatment plant. The other 520 gpm of estimated flow will be disposed in a manner to be determined by the NPDES regulatory authority." [1] p. 2-661.

Treatment Costs: Estimated costs for water treatment at the mine site ($41 million) and tailings facility area ($73 million) total $114 million over 30 years, or $3.8 million per year. Estimated O&M costs for entire site over a 30-year period were between $203 and 206 million or approximately $6.8 million per year. [1] Table 12-2, p. 2-690.

Status: Chevron Questa Mine site was added to the Superfund National Priorities List for federal cleanup in September 2011. [2]

Land Ownership: The mine is situated on patented mining claims within the Carson National Forest. [3] , [4] p. 1.

Impacted Resources/Resources at Risk: [1] pp. 2-5, 2-631, 2-365 and 2-693, [2], [4] pp. 2 and 3, [5] pp. 6 to 15.

References:

[1] U.S. EPA. December 20, 2010. *Record of Decision Molycorps Inc., Questa, New Mexico.* Available at: http://www.amigosbravos.org/images/uploaded/fck/file/MOLYCORP%20ROD%20FINAL%2012-20-2010.pdf

[2] U.S. EPA web site: "Chevron Questa Mine site (formerly Molycorp, Inc. site)." http://www.epa.gov/region6/region-6/nm/nm_molycorp.html

[3] Bureau of Land Management. 1987. *Draft Taos Resource Management Plan.* p. 3-2. http://books.google.com/books/download/Taos_resource_management_plan_and_enviro.pdf?id=zcTuAAAAMAAJ&output=pdf&sig=ACfU3U0GrrX-Sn15XwH9hzDAwmVCQLPoaQ

[4] U.S. EPA. July 2012. Chevron Questa Mine. http://www.epa.gov/region6/6sf/pdffiles/molycorp-nm.pdf

[5] New Mexico Office of Natural Resources Trustees. 2003. Molycorp Pre-assessment Screen and Determination. http://www.fws.gov/southwest/es/Documents/R2ES/Molycorp_PAS-Final_for_Signature.pdf

[52] **ALMEDA MINE**

Perpetual treatment: A permanent cure will be elaborate and require perpetual maintenance." Jim Berge, BLM's Almeda Project Manager. [1]

Volume treated: "The Bureau of Land Management (BLM) began investigating the AMD emanating from the 520 adit in 2001. The estimated flow rate of the AMD discharge ranges from 3 to 25 gallons per minute." [2] p. 2.

Treatment Costs: [2] p. 32.

Status: [3]

Land Ownership: [3]

Impacted Resources/Resources at Risk: [3]

References:

[1] Dietz, D. "Almeda mine still dumping pollutants into Rogue," *Eugene Register-Guard.* http://www.thefreelibrary.com/Almeda+mine+still+dumping+pollutants+into+Rogue+River.-a0170246728

[2] Ionic Water Technologies, Inc. 2010. *Treatability Report and Feasibility Assessment for a Caustic Drip System at the Almeda Mine, Josephine County, Oregon.* Submitted to BLM. http://www.blm.gov/or/districts/medford/plans/files/almedatreat.pdf

[3] Bureau of Land Management web site: "Almeda Mine." Abandoned Mine Program. http://www.blm.gov/or/landsrealty/aml/almeda.php

[53] **BREWER**

Perpetual treatment: The 2013 Feasibility Study found that, "Although EPA recommends development of at least one alternative that would eliminate the need for any long-term management at the site, no feasible remedial alternatives were identified for treating the source of contamination (i.e., the backfilled material in the pit) or permanently eliminating the discharge pathway to the creek." (p. 78) All alternatives except "no action" require water treatment. Alternative 3 "would require treatment of groundwater/seeps/runoff indefinitely." As discussed in Section 5.1.1, a remedial action that would eliminate discharge of groundwater, seeps and runoff with metals and high acidity without continued human intervention is not feasible." In other words, long-term treatment and management are required at this site. [1] pp. 78, 96.

Volume treated: Existing treatment plant has reached end of its useful life. Two treatment plant options were developed [1] p. 82

Treatment Costs: Lowest cost for smaller plant (56 million gallon/yr) with solar electricity, highest cost for larger plant (80 million gallons). Tables E-1, 6.1, 6.2.

Status: [2]

Land Ownership: [3]

Impacted Resources/Resources at Risk: [1], pp. 21, 22, [2], [4]

References:

[1] Black & Veatch. Jan. 2013. *Revised Final Feasibility Study – Brewer Gold Mine Site, Surface Water Protection Operable Unit 1, Chesterfield County, South Carolina.* Prepared for U.S. EPA. Received from EPA/FOIA request.

[2] U.S. EPA web site: "Brewer Gold Mine." http://www.epa.gov/region4/superfund/sites/npl/southcarolina/brewgldmisc.html

[3] U.S. EPA. 1994. *Mine Site Visit: Brewer Gold Mine.* p. 2-4. http://www.epa.gov/osw/nonhaz/industrial/special/mining/techdocs/gold/goldch2.pdf

[4] Skeo Solutions. 2011. *First Five-Year Review Report for Brewer Gold Mine Superfund Site.* Prepared for EPA. pp. 16. 21. http://www.epa.gov/superfund/sites/fiveyear/f2011040004100.pdf

[54] **BROHM/GILT EDGE**

Perpetual treatment: According to EPA Project Manager for the Gilt Edge Superfund Site, Ken Wangerud, "Although much of the cap work is designed to be a permanent solution. . .some water treatment would have to be done at the site in perpetuity to reduce toxic-water flows to "as close to zero as possible." The EPA web site says that there are "150 million gallons of acidic heavy-metal-lade water in three open pits, as well as millions of cubic yards of acid-generating waste rock that requires clean up and long-term treatment." [1], [2]

Volume treated: [3] Appendix D. p. D-11.

Treatment Costs: [3] p. 17.

Status: [2]

Land Ownership: [4]

Impacted Resources/Resources at Risk: [3] p. 8-10

References:

[1] Velder, T. May 2002. "EPA plans to cap abandoned mine," *Rapid City Journal.* http://rapidcityjournal.com/epa-plans-to-cap-abandoned-mine/article_93887549-0061-5486-8106-81fcdacffebc.html

[2] U.S. EPA web site: "Gilt Edge Mine." South Dakota Cleanup Sites. http://www.epa.gov/region8/superfund/sd/giltedge/index.html

[3] EPA. 2012. *Second Five-Year Review Report for Gilt Edge Mine Superfund Site.* http://www.epa.gov/region8/superfund/sd/giltedge/GiltEdge_2FYRJun2012.pdf

[4] U.S. EPA. 2008. *Gilt Edge Mine Superfund Site: Proposed Plan for Public Comment.* p.2. http://www.epa.gov/region8/superfund/sd/giltedge/Gilt519.pdf

[55] **COPPER BASIN**

Perpetual treatment: According to EPA, the responsible party, Glen Springs Holdings Inc., installed lime treatment plant near the mouth of North Potato creek to temporarily alleviate the contaminant discharge while long-term actions under the state Voluntary Clean-up Plan proceed. The Cantrell Flats treatment plant treats acid and metal laden water from Davis Mill Creek, underground mine waters and contaminated storm water." When an EPA project manager for the site was asked if AMD will continue for 100 year or beyond, he responded, "Probably." [1], [2]

Volume treated: [3]

Treatment Costs: Costs for water treatment for the fiscal year ending June 30, 2012 totalled $8,566,650. [3]

Status: Mining activities that took place from the late 1800s until the 1987. [4]

Land Ownership: The Copper Basin Mining District Site is located in Polk County, Tennessee. The subject area covers 30 square miles and includes the now defunct Tennessee Chemical Company (TCC) and other areas that have been impacted by mining activities. The TCC ceased mining activities in the basin in 1987 and declared bankruptcy in 1989. Much of the land formerly owned by TCC was auctioned off and is now in private hands. [4], [5]

Impacted Resources/Resources at Risk: [6], [7]

References:

[1] U.S. EPA. "Copper Basin Mining District Case Study." 2005. p. 4. http://www.epa.gov/aml/tech/copperbasin.pdf

[2] Pers. Comm. Loften Carr, Remedial Project Manager, U.S.EPA, Region 4. Feb. 25, 2013.

[3] Glen Springs Holdings, Inc. July 12, 2012. *Annual Report for Site ID 70-508, North Potato Creek Site.* Submitted to Tennessee Department of Environment and Conservation. (Received by Earthworks from FOIA request EPA-R4-2013-003137).

[4] U.S. EPA web site: "Copper Basin Mining District." NPL/Caliber Sites - Tennessee. http://www.epa.gov/region4/superfund/sites/npl/tennessee/copbastn.html

[5] Agency for Toxic Substances & Disease Registry (ATSDR) web site: 1998. "Background and Statement of Issues." *Health Consultation: Copper Basin Mining District, Operable Unit 2, Copperhill, Polk County, Tennessee.* http://www.atsdr.cdc.gov/hac/pha/pha.asp?docid=1353&pg=1

[6] Faulkner, B., Wyatt, E.G., Chermak, J.A. and Miller, F.K. 2005. "The largest acid mine drainage treatment plant in the world." Paper presented at the 26th West Virginia Surface Mine Drainage Task Force, April 19-20, 2005. p. 2. http://wvmdtaskforce.com/proceedings/05/faulkner.pdf

[7] ATSDR. 2001. "Sulfide in well water." *Health Consultation, Copper Basin Mining District.* http://www.atsdr.cdc.gov/hac/pha/pha.asp?docid=1357&pg=1

[56] **BINGHAM CANYON**

Perpetual treatment: "ARD from the south Eastside dumps typically has a pH of 3 to 4, acidity of 2000 mg/L, sulfate of 15,000 mg/L and TDS of 20,000 mg/L. Although these values are less than a quarter of the concentrations currently discharging from the old leach water application areas, they will still need to be collected and treated in perpetuity." [1]

Volume treated: In 2011, 4.763 acre feet (equivalent of 1.55 billion gallons) of contaminated water was extracted from Zone A barrier wells and sent to the RO treatment plant. Another plant in Zone B, being constructed by the Jordan Valley Water Conservancy District, will yield 3,500 acre feet of drinking water (1.14 billion gallons). So together, the plants should treat approximately 2.69 billion gallons. [2], [3]

Treatment Costs: Given that the plants will treat a similar volume of water, O&M costs for the Zone B plant are likely similar to the Zone A treatment plant. [4]

Status: [5]

Land Ownership:

Impacted Resources/Resources at Risk: [6]

References

[1] Borden, R.K, Peacey, V. and Vinton, B. 2006. "Groundwater response to the end of forty years of copper heap leach operations, Bingham Canyon, Utah. 2006. " Proceedings, 7th International Conference on Acid Rock Drainage, March 26–30, St. Louis, MO. Available at: http://www.imwa.info/docs/imwa_2006/0214-Borden-AU.pdf

[2] Kennecott Utah Copper Environmental Restoration Group. April 2012. South Facilities Groundwater 2011 Remedial Progress Report. p. 2-3. http://www.kennecott.com/sites/kennecott.com/files/cleanup/South%20End/Remedial%20Action%20Progress%20Report%202011.pdf

[3] Rio Tinto. 2008. *Reclaiming the environment from a century of mining: A status report on the Last Century Cleanup Program.* p. 6. http://www.kennecott.com/library/media/Final_Sept_Remediation_LoRes.pdf

[4] Interstate Technology Regulatory Council. 2010. "Bingham Canyon Water Treatment Plant Kennecott South Zone." Case Study as part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs48_kennecott_south.htm

[5] Rio Tinto web site: "Kennecott Utah Copper." http://www.kennecott.com/operation

[6] U.S. EPA web site: "Kennecott South Zone/Bingham," Utah Cleanup Sites. http://www.epa.gov/region8/superfund/ut/kennecottsouth/

[57] **HOLDEN COPPER MINE**

Perpetual treatment: "Alternative 14 [the selected remedy] would require continued operation and maintenance of the water treatment system for groundwater within the WMAs for hundreds of years." [1] p. 2-62

Volume treated: "Alternative 14 would use active treatment to reduce the toxicity and mobility of an estimated average of 620 million gallons of contaminated water per year." [2] p. 101

Treatment Costs: These are annual OM&M (operations, maintenance and monitoring) costs, not just operations and maintenance costs. [1] p. 2-62.

Status: The USDA Forest Service, in cooperation with the United States Environmental Protection Agency and the Washington State Department of Ecology (collectively "the Agencies") are providing cleanup oversight under the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and state's Model Toxics Control Act (MTCA). [3]

Land Ownership: [1] p. 1-1.

Impacted Resources/Resources at Risk: [1] pp. 1-2, 2-56, [4]

References:

[1] USDA Forest Service. January 2012. *Record of Decision Holden Mine Site, Chelan County, Washington.* http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5350463.pdf

[2] USDA Forest Service. June 2010. *Addendum to the Supplemental Feasibility Study, Holden Mine Site, Chelan County, Washington.* http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5350259.pdf

[3] USDA Forest Service web site: "Holden Mine Site Cleanup." URL shortened to: http://tinyurl.com/holdenminecleanup

[4] Day, N., Einan, D. and Klasner, L. 2010. *Holden Mine Cleanup Project – Agencies Proposed Plan.* Slides 13, 24, 25. https://fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev3_053400.pdf

[58] **MIDNITE MINE**

Perpetual treatment: "It is anticipated that treatment of contaminated water will be necessary in perpetuity." [1] p. 2-104.

Volume treated: Proposed treatment: 55 million gallons [2], [3]

Treatment Costs: In the 2006 Record of Decision, annual costs associated with the water treatment plant included $54,600 O&M plus 184,000 for sludge disposal starting in 2009. An Ion Exchange water treatment plant design proposed in 2010 would have annual costs of $379,000 O&M to treat 55 million gallons, plus $403,368 to dispose of sludge = $782,368. [1] p. 2-95, [3]

Status: [4]

Land Ownership: [1] p. 2-1.

Impacted Resources/Resources at Risk: [4], [5], [6]

References:

[1] U.S. EPA Region 10. September 2006. *Midnite Mine Superfund Site, Spokane Indian Reservation, Washington, Record of Decision.* http://www.epa.gov/region10/pdf/sites/midnite_mine/midnite-mine-rod-06.pdf

[2] U.S. EPA. 2012. "Midnite Mine Water Treatment Plant." Presentation at Community meeting, July 16, 2012. Slides 19, 38, 39. ftp://ftp.epa.gov/reg10ftp/sites/midnitemine/2-technical-documents/water-treatment-plant/Water_Treatment_Presentation_given_on_July_16_2012.pdf

[3] TetraTech. June 28, 2010. *Ion Exchange Treatability Testing Evaluation Report, Rev. 1.* Prepared for Dawn Mining Co. and Newmont USA Ltd.

pp. 15, 16. ftp://ftp.epa.gov/reg10ftp/sites/midnitemine/2-technical-documents/water-treatment-plant/MM_IX_Data_Evaluation_June28_2010.pdf

[4] U.S. EPA web site: " http://yosemite.epa.gov/r10/cleanup.nsf/sites/midnite

[5] Lockheed Martin. 2005. *Final Report Midnite Mine Site Ecological Risk Assessment.* Prepared for EPA. p. xx. http://www.epa.gov/region10/pdf/sites/midnite_mine/ecological_risk_assessment_sept2005.pdf

[6] Agency for Toxic Substances and Disease Registry (ATSDR). May 19, 2010. *Public Health Assessment for Midnite Mine Site.* p. 1. http://www.atsdr.cdc.gov/HAC/pha/MidniteMineSiteFinal/MM-FinalReleasePHAFINAL05172010ATSDRwebsite.pdf

[59] **MONTE CRISTO MINING AREA**

Perpetual treatment: According to the US Forest Service, Pride of the Woods and Sidney mines may require water treatment (pending other remedial action). Justice mine will require treatment. "Once completed, operation and maintenance of the repository and water treatment facilities will continue indefinitely." [1] pp. 24, 27.

Volume treated: Won't know potential volume to be treated from Pride of the Woods and Sidney mines until after other remediation measures are conducted. Justice, which requires treatment, has a flow of 122 gpm [2] p. 9.

Treatment Costs: No cost estimates for Pride of Woods or Sidney. Justice Mine costs are an "Engineer's Opinion of Probable Cost." [2] Attachment 3.

Status: Limited funding is available to complete removal and remedial investigations and actions at MCMA from the ASARCO Bankruptcy settlement. ASARCO is a former owner/operator in the MCMA and a CERCLA Potentially Responsible Party (PRP). [1] p. 2

Land Ownership: [1] pp. 2, 3.

Impacted Resources/Resources at Risk: [1] p. 12, [3]

References:

[1] Mt. Baker-Snoqualmie National Forest. Sept. 28, 2012. *Removal Action Memorandum: Non-Time Critical Removal Action, Monte Cristo Mining Area (MCMA) Site.* http://fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5392906.pdf

[2] Cascade Earth Services. August 29, 2012. Forest Service – MCMA. Water Treatment Technologies. Attachment 3. Engineer's Opinion of Probable Cost - Justice Mine. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5400116.pdf

[3] WA State Department of Ecology. Hazardous Sites List. http://www.ecy.wa.gov/programs/tcp/mtca_gen/hazsites.html

[60] **PINAL CREEK MINING AREA**

Perpetual treatment: No absolute expression of "perpetual" treatment found in any Pinal Creek Group literature or other documents reviewed. According to Ed Pond, Remedial Projects Manager with the Arizona Department of Environmental Quality, the water treatment plants "will need to be operated until they meet aquifer water quality standards in groundwater. That could be a long time." Freeport-McMoran says that its remediation at the Pinal Creek site, which includes groundwater remediation, "is expected to continue for many years in the future." Given that this is a complex site that pumps and treats acidic drainage from many different mining sites, we feel confident in our assumption that this is indeed a site that could require in perpetuity treatment. [1], [2] p. 95, [3]

Volume treated: Average of actual gallons treated in 2010, 2011 and 2012. [4]

Treatment Costs: No public information.

Status: Closed and Active. The Pinal Creek WQARF Site includes the entire mine sites of Freeport-McMoRan Copper & Gold, Inc. (FCX), formerly the Phelps Dodge Miami Mine and the Inspiration Mine. It also includes the mine sites of BHP Copper, Inc. (the Miami Mine aka the Miami Unit), the Copper Cities Mine, the Old Dominion Mine and related properties and the Solitude Tailings. There are still active operations that are within the WQARF boundaries. Freeport-McMoran's Miami mine is still operating within the site boundaries - produced 66 million pounds of copper in 2011, and BHP's Miami Unit's residual SXEW in situ leach production continues. The operations are located within the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) site but the facilities are not part of WQARF cleanup operations. [2] p. 35, [3], [5], [6]

Land Ownership: Unclear.

Impacted Resources/Resources at Risk: [3], [7]

References:

[1] Pers. Comm. Jan. 13, 2013. (602)771-4575. Pond.Ed@azdeq.gov

[2] Freeport-McMoran. *2011 Annual Report.* p. 35. http://www.fcx.com/ir/AR/2011/FCX_AR_2011.pdf

[3] Arizona Department of Environmental Quality. (No date). *Pinal Creek WQARF Site.* Site Registry Report. http://www.azdeq.gov/environ/waste/sps/download/state/pnlckb.pdf

[4] Arizona Water Quality Assurance Revolving Fund (WQARF) Annual Reports for 2010, 2011 and 2012. Available at: http://www.azdeq.gov/function/forms/reports.html

[5] Arizona Department of Environmental Quality. Jan. 2011. *Pinal Creek Water Quality Assurance Revolving Fund.* p. 1. http://www.azdeq.gov/environ/waste/sps/download/state/pinal.pdf

[5] BHP-Billiton Annual Report. 2012. p. 64. http://www.bhpbilliton.com/home/investors/reports/Documents/2012/BHPBillitonAnnualReport2012.pdf

[6] Sept. 17, 2008. "Public comment sought on water quality permits for Gila County mining operations," *Arizona Free Press.* http://azfreepress.com/index.php?pg=mp&cat=topic_news&catid=8&art=3278&past=Y

[7] Department of Interior. Jan. 3, 2013. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Southwestern Willow Flycatcher; Final Rule.* U.S. Federal Register. Vol. 78, No. 2. p. 432. http://www.gpo.gov/fdsys/pkg/FR-2013-01-03/pdf/2012-30634.pdf

[61] **JAMESTOWN MINE, HARVARD PIT**

Perpetual treatment: Groundwater and tailings leachate flow into the Harvard Pit at the Jamestown mine. Water balance models predict that after 2018 approximately 55 million gallons need to be removed from Harvard Pit every year to avoid migration of water into Woods Creek. If nothing is done, the pit would spill over in 2029. According to the California Regional WQCB, "The Harvard Mine Pit must be maintained as a groundwater sink and must not release waters to un-impacted downgradient groundwater. . . In the future and if necessary, funds from the Settlement may be used to control water levels either by natural or enhanced evaporation, or by removal, treatment, and discharge of excess water." [1] p. 9, [2]

Treatment Volume: Shaw evaluated a number of water treatment and water balance options that were applicable for the Harvard Pit and selected the ones that were most appropriate for the site. All options provide a net removal of 55 million gallons of water per year from the Harvard Pit. [1] p. 11.

Treatment Costs: [3]

Status: [4]

Land Ownership: [2]

Impacted Resources/Resources at Risk: [1] p. 9, [2], [5]

References:

[1] Isham, J. 2008. Capping the Tailings Impoundment at the Jamestown Mine. p. 11. 2008 U.S. EPA/NGWA Remediation of Abandoned Mine Lands Conference. October 2-3, 2008, Denver, Colorado. Pp. 443-455. http://info.ngwa.org/GWOL/pdf/080183578.pdf

[2] California Regional Water Quality Control Board. Central Valley Region. 2007. "Closure waste discharge requirements for the Jamestown Trusts I & II." p. 1. http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/0706/jamestown_mine/jamestown-wdr.pdf

[3] Mullenmeister, E. (Shaw E&I, Inc.) May 20, 2009. "Jamestown Mine Harvard Pit Water Balance Model." Characterizing, Predicting and Modeling Water at Mine Sites, SWRCB Training Academy Short Course. Jamestown, CA. http://www.waterboards.ca.gov/academy/courses/ard/day2/day2_sec6c_harvard_pit_water_balance_model_gm_jci.pdf

[4] Ashley, R.P., and Savage, K. (US Geological Survey). 2001. *Analytical Data for Waters of the Harvard Open Pit, Jamestown Mine, Tuolumne County, California.* Open-File Report 01-074. http://geopubs.wr.usgs.gov/open-file/of01-074/

[5] Nickles, J. Sept. 16, 1999. "Mine fouling water," *San Joaquin Record.* http://www.recordnet.com/apps/pbcs.dll/article?AID=/19990916/A_NEWS/309169982

62 CEMENT CREEK

Perpetual treatment: According to Peter Butler, coordinator for the Animas River Stakeholders Group, there are four draining mine adits that discharge about 600 to 800 gallons of acid mine drainage in Cement Creek. "There are not many sites in Colorado with that kind of discharge." One method for controlling acid mine drainage (AMD) production is by flooding and sealing mines. According to Johnson and Hallberg, "this is only effective where the location of all shafts and adits is known and where influx of oxygen-containing water does not occur. This was tried at the American Tunnel portal, which was discharging into Cement Creek. But sealing the tunnel resulted in AMD finding its way out through the other mine adit openings. Consequently, as is the case at other mine sites (e.g., adits in the Blackfoot Mining Complex in Montana are perpertual sources of AMD) it seems almost certain that perpetual treatment will be required for at least some of the mine discharges in Cement Creek. [1], [2], [3], [4]

Treatment Volume: A recent evaluation by MWH of conventional water treatment plant designs for Cement Creek estimated that a treatment flow of at least 1,000 gpm would provide for the combined average maximum (discounting a peak event) flow from the combined flow of the Red & Bonita adit, Gold King Mine adit, and American Tunnel drainage, as well as a significant (but varying) portion of the upper Cement Creek flow that could be diverted for treatment. 1,000 gpm is equal to approximately 525.6 million gallons per year. [5] p. 23.

Treatment Costs: Treating the entire flow of upper Cement Creek was not viewed as being economical due to the higher seasonal flow (2,000 gpm average). So assuming a conventional AMD treatment plant was sized for 1,000 gpm (525.6 million gallons per year) the three options presented by MWH have a range in annual costs from $876,000 to $930,000. **Note:** the evaluation of conventional AMD treatment was done to provide a basis for cost comparison for other treatment options. It is possible that alternative treatments may be used at the site, but to date, no treatment has been selected. [5] pp. E-1, 23, 40.

Status: [6]

Land Ownership: [7]

Impacted Resources/Resources at Risk: [8]

References:

[1] Esper, M. Sept. 20, 2012. "Study puts higher price on Cement Creek cleanup," *Durango Herald.* http://www.durangoherald.com/article/20120920/NEWS01/120929933/Study-puts-higher-price-on-Cement-Creek-cleanup--

[2] Johnson, D.B. and Hallberg, K.B. 2005. "Acid mine drainage remediation options: a review," *Science of the Total Environment.* 338:3-14. p. 5. http://www.hsph.harvard.edu/mining/files/Acid_mine_drainage_remediation_options_-_a_review_JOHNSON_20.pdf

[3] Esper, M. Sept. 23, 2010. "Animas River Stakeholders Group focuses on problems at Cement Creek," *Silverton Standard.* http://www.silvertonstandard.com/news.php?id=227&type=print

[4] River Design Group, In. Feb. 2011. *Conceptual Restoration Plan for the Upper Blackfoot Mining Complex.* Report prepared for Montana Department of Justice. p. 4. https://doj.mt.gov/wp-content/uploads/2011/06/2011draftconceptualrestorationplanblackfootminingcomplex.pdf

[5] MWH. July 2012. *Evaluation of Certain Selected Conventional Treatment Methodologies – Cement Creek.* p. 40. (Report received from Peter Butler, Animas River Stakeholders Group)

[6] Office of Surface Mining and Enforcement web site: "Earth Vision Software to Model Acid Mine Drainage Issues in Upper Cement Creek, Colorado." http://www.tips.osmre.gov/newsroom/success_stories/2012/2012jun-28.shtml

[7] Rodebaugh, D. May 12, 2011. "Leaking mines eyed for cleanup," *Durango Herald.* http://durangoherald.com/article/20110513/NEWS01/705139919/-1/s

[8] U.S. EPA web site: "Upper Cement Creek." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/uppercement/index.html

64 NELSON TUNNEL

Perpetual treatment: No information yet. But given that the widespread presence of sulfide minerals in mine workings and waste rock, and the discharge of AMD from the Nelson Tunnel portal, the need for long-term treatment is definitely a possibility for this site. [1] pp. 5-1, 172.

Treatment Volume: "Approximately 300 gpm of water contaminated with heavy metals flows from the Nelson Tunnel portal into West Willow Creek. Leaching from the Commodore Waste Rock pile may contribute to contamination of the Creek." But no estimate of waste rock leachate was provided. 300 gpm equals 157 million gallons per year. [1] p. 4-3.

Treatment Costs: EPA is still in Superfund Feasibility Study stage to determine preferred cleanup remedy. A 2006 study estimated O&M costs for a chemical precipitation or electrocoagulation plant at $104,500 or 145,000 per year, respectively. These costs include O&M and sludge handling costs. [2], [3] Page II-11.

Status: [2]

Land Ownership: [4]

Impacted Resources/Resources at Risk: [3] p. 1.

References:

[1] HDR Engineering. Nov. 2011. *Remedial Investigation Report Nelson Tunnel/Commodore Waste Rock Pile Site.* Prepared for EPA. p. 4-3 http://www.epa.gov/region8/superfund/co/nelsoncommodore/NT_RI_Nov2011.pdf

[2] U.S. EPA web site: "Nelson Tunnel / Commodore Waste Rock." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/nelsoncommodore/

[3] McLaughlin Rincon. 2006. *Nelson Tunnel Water Management Feasibility Study.* Prepared for Willow Creek Reclamation Committee, Creede, Colorado. http://www.willowcreede.org/component/phocadownload/category/11-ongoing-watershed.html?download=58:nelson-tunnel-water-treatment-feasibility-study-28-page-pdf

[4] Neubert, J. and Wood, R.H. 2000. *History, Geology and Environmental Setting of Selected Mines near Creede, Rio Grande National Forest, Mineral County, Colorado.* Colorado Geological Survey Open-File Report 99-18. p. 23. http://cgsdocs.state.co.us/Docs/Pubs/2000%20OF%2099-18.pdf

65 **PENNSYLVANIA MINE**

Perpetual treatment: "Because of the perpetual cost concerns related to active water treatment alternatives, [Division of Reclamation Mining and Safety] DRMS, state and county efforts have been focused on developing other alternative approaches to addressing the mine discharge." [1]

Treatment Volume: In 2005, estimated to be "a couple of hundred gallons per minute." 2 gpm is approximately 1 million gallons per year. [2]

Treatment Costs: [3], [4]

Status: The mine operated from the late 1880s to the 1930s. [5], [6]

Land Ownership: "The Transpacific properties include at least two draining mine adits, one at the site of the Pennsylvania Mine and the other at Shoe Basin." [6]

Impacted Resources/Resources at Risk: [7], [8]

References:

[1] Colorado Abandoned Mine Land Program. Dec. 4, 2012. "Nonpoint Source and water quality improvement projects." p. 5. http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22DRMS+Exhibit+1.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251841812129&ssbinary=true

[2] Limerick, P.N. and Ryan, J.N. 2005. *Cleaning Up Abandoned Hardrock Mines in the West.* Center of the American West Report #7. p. 26. http://www.centerwest.org/publications/pdf/mines.pdf

[3] Finley, B. Sept. 9, 2012. "Risk of lawsuits preventing cleanup of abandoned mines in Colorado," *Denver Post.* http://www.denverpost.com/environment/ci_21499958/risk-suits-preventing-vital-cleanup-abandoned-mines-colorado

[4] Peronard, P. Feb. 2013. "Pennsylvania Mine Removal Strategy." Presentation to the Snake River Core Group Meeting. http://www.snakerivertaskforce.org/Snake_River_Watershed_Task_Force/February_2013_files/Peronard.pdf

[5] Berwyn, B. May 26, 2012. "Colorado: Pennsylvania Mine cleanup moves ahead," *Summit County Citizens Voice.* http://summitcountyvoice.com/2012/05/26/colorado-pennsylvania-mine-cleanup-moves-ahead/

[6] Trust for Land Restoration. 2004. *Peru Creek Basin Brownfield Assessment, Summit County, Colorado.* Final Report. Prepared for Summit County, Colorado. http://www.restorationtrust.org/pdfs/peru-creek-bf.pdf

[7] Berwyn, B. March 19, 2008. "Pennsylvania mine could become Superfund site," *Summit Daily.* http://www.summitdaily.com/article/20080319/NEWS/265889981

[8] Berwyn, B. August 22, 2010. "Heavy metal pollution worsening in Snake River." *Summit County Citizens Voice.* http://summitcountyvoice.com/2010/08/22/heavy-metal-pollution-worsening-in-snake-river/

66 **SCHWARTZWALDER MINE**

Perpetual treatment: State mining inspectors say uranium-laced water inside the mine shaft, "is finding other ways out of the mine pool" and into groundwater and the creek beyond the mine. "The only way to fix that," accoding to Loretta Pineda. Director of Colorado's Division of Reclamation, Mining and Safety, "is to draw down the mine pool and treat it." Such a project would require construction of a large plastic-lined waste pond, with the cost likely to exceed $10 million, and perpetual pumping of groundwater that would continue to fill up the mine shaft and turn toxic through contact with exposed minerals. [1]

Treatment Volume: "In early July and mid-August 2010 Sumps 1 and 4 respectively were reconditioned and brought online to again provide alluvial water to an updated water treatment plant employing ion exchange columns for the removal of uranium. . . Three new sumps, 5, 8, and 9, were constructed in the late fall and have been operational to varying degrees and to stay within treatment capacity of 200 gallons per minute since November 2010." 200 gpm equals 105 million gallons per year. [2]

Treatment Costs:

Status: [2]

Land Ownership: In 1953, surface and mineral rights to the property were owned by Paul White of Golden, Colo. Presumably, these rights continue to be privately held. [3]

Impacted Resources/Resources at Risk:

References:

[1] Finley, B. March 6, 2012. "Cotter rerouting tainted creek near leaking uranium mine," *Denver Post.* http://www.denverpost.com/news/ci_20109465/cotter-rerouting-tainted-creek-near-leaking-uranium-mine

[2] Caine, J.S., Johnson, R.H. and Wild, E.C. (U.S. Geological Survey). 2011. *Review and Interpretation of Previous Work and New Data on the Hydrogeology of the Schwartzwalder Uranium Mine and Vicinity, Jefferson County, Colorado.* p. 9. http://pubs.usgs.gov/of/2011/1092/pdf/OF11-1092.pdf

[3] Adams, J.W., Gude, A.J. and Beroni, E.P. 1953. *Uranium Occurrences in the Gold Gate Canyon and Ralston Creek Areas, Jefferson County, CO.* Geological Survey Circular 320. p. 13. http://pubs.usgs.gov/circ/1953/0320/report.pdf

[4] Colorado Abandoned Mine Land Program. December 4, 2012. *Nonpoint Source And Water Quality Improvement Projects.*

http://tinyurl.com/av5mmm3

[5] Finley, B. Oct. 3, 2012. "Colorado makes legal peace with Cotter Corp. in push for mine cleanup," Denver Post. http://www.denverpost.com/environment/ci_21684619/colorado-makes-legal-peace-cotter-corp-push-mine

[6] Denver Board of Water Commissioners. April 13, 2011. Minutes. pp. 12, 13. http://www.denverwater.org/docs/assets/672110E7-AA86-2558-FB578323C596DB46/BoardMinutesApril13.pdf

[67] STANDARD MINE

Perpetual treatment: A 2007 underground site assessment stated that, "The Micawber vein appears as the primary conduit for movement of water into the Standard Mine complex. Controlling the volume of water reaching the mine workings developed in the vein could be an opportunity to minimize the quantity of discharge requiring perpetual treatment at Level 1." The report did not say that discharge requiring perpetual treatment could be eliminated, suggesting that some volume would require perpetual treatment. [1]

Treatment Volume: EPA says that the site releases from 5-20 gpm to 70 gpm, seasonally. Assuming the lower flow (5 -20 gpm) occurs for ¾ of year and high flow (70 gpm) for ¼ of the year, i.e., around the time of spring runoff, then total amount to be treated ranges from: 11.2 to 17.1 million gallons per year. Example calculation: 5 gpm x 60 min/hr x 24 hr/day x (3/4 x 365 days/yr) = 1.97 million gallons ; 70 gpm x 60 min/hr x 24 hr/day x (1/4 x 365 days/ yr) = 9.2 million gallons; together, there would be 11.2 million gallons per year. [2]

Treatment Costs: EPA is undertaking Phase I remedial actions. If water treatment is needed after remediation, passive biological treatment would be used. Phase II treatment O&M would be approximately $25,000, with additional costs of $41,000 every 5 years, and $186,000 every 15 years. [3] Table 22 and 23.

Status: [2], [3] p. 1.

Land Ownership: [4]

Impacted Resources/Resources at Risk: [2]

References:

[1] Renner, S., Graves, J. and Amundson, A. Feb. 2007. Underground Assessment of the Standard Mine Superfund Site Gunnison County, Colorado. Prepared for Colorado Department of Public Health and Environment, and EPA. p. 26. http://www.epa.gov/region8/superfund/co/standard/SM_DRMSUndergroundAssessment1207.pdf

[2] U.S. EPA web site: "Standard Mine." Colorado Cleanup Sites. http://www.epa.gov/region8/superfund/co/standard/

[3] U.S. EPA, U.S. Forest Service and Colorado Department of Public Health and Environment. 2011. *Record of Decision - Standard Mine Superfund Site Gunnison County, Colorado.* p. 1. ftp://ftp.epa.gov/r8/temp/SM_ROD093011.pdf

[4] U.S. EPA web site: "NPL Narrative for Standard Mine, Gunnison National Forest, Colorado." National Priorities List. http://www.epa.gov/superfund/sites/npl/nar1740.htm

[68] SUNSHINE MINE

Perpetual treatment: Chemical precipitation has been operating since May 2007 and is expected to be in operation for as long as mine dewatering continues. [1]

Volume treated: 230-920 gpm, which equals 121 to 484 million gallons. [1]

Treatment Costs: Current costs are $50,000/yr. "The Company believes that it will incur significant costs to upgrade the existing wastewater treatment facility to meet more stringent permit limits, including those relating to total dissolved solids." But does not indicate if operating costs will also increase. [1], [3] p. 90.

Status: [2], [3] p. 74

Land Ownership: [3] p. 71.

Impacted Resources/Resources at Risk: [1], [4]

References:

[1] Sunshine Mine, Shoshone County, Idaho." Case Study as Part of a Web-based Technical and Regulatory Guidance. http://www.itrcweb.org/miningwaste-guidance/cs55_sunshine.htm

[2] Jan. 23, 2013. "Sunshine Silver Mines plans to begin producing ore in Idaho in 2014," *Associated Press*. Available at: http://www.oregonlive.com/business/index.ssf/2013/01/sunshine_silver_mines_plans_to.html

[3] Sunshine Silver Mines Corp. March 1, 2013. *Amendment No. 5 to Form S-1. Registration Statement*. U.S. Securities and Exchange Commission. http://www.sec.gov/Archives/edgar/data/1517006/000119312513087993/d432844ds1a.htm

[4] Feb. 23, 2009. "Sterling Mining vacates Sunshine Mine lease," Bloomberg. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aXSWcxO_HHM4

[69] **LIBERTY - TONOPAH**

Perpetual treatment: "I have reviewed the data that [Earthworks] provided, and I agree that the Sleeper Mine, the Jerritt Canyon Mine and the Rain Mine all will require *In perpetuity* treatment and/or very long term management of contaminated water draining from these mines. In addition, the former Equatorial Tonopah and the Paradise Peak mines are very likely to also require very long term treatment and or management of pit lakes or heap drainage also." [1]

Volume treated: According to the Nevada Department of Environmental Protect (NDEP) fact sheet, there are "two EvapoTranspiration (ET) Basins. . . receiving heap leach pad long-term draindown," and the heap leach drainage has a pH of approximately 3 and high levels of salts and metals. A semi-annual report to NDEP indicates that a discharge rate of 0.58 gpm (305 thousand gallons) was treated in 2012. Based on our analysis, this will drop to 52.6 thousand through 2016, and then level off at a discharge rate below that for many years in the future. (Estimated based on data from 2006 to 2012. Our exponential regression Indicates the discharge rate of 0.2 GPM in 2016, versus the 0.1 GPM from the factsheet). [2], [3]

Treatment Costs: The *Feasibility Analysis of the Water Treatment Options for the Acid Heap Leach Draindown Water* prepared for the Liberty mine estimated O&M costs of $185,000 for five years/5 ($37,000 per year), plus the cost of lime. The feasibility study assumed the cost of active lime treatment to be approximately $300,000 when there was a discharge rate of 2 GPM. If we assume a linear relationship for lime treatment then the cost would be about $99,500 at a discharge rate of 0.58 gpm, and $75,000 per year at a discharge rate of 0.2 gpm. Thus, it is likely that costs will remain in the $50,000 to $75,000 for many years in the future for just the lime treatments. [4]

Status: [5]

Land Ownership: [6]

Impacted Resources/Resources at Risk:

References:

[1] Pers.Comm. Glenn Miller, Professor, Dept. of Natural Resources and Env. Science, University of Nevada. Feb. 27, 2013.

[2] Nevada Department of Environmental Protect (NDEP). "Water Pollution Control Permit Fact Sheet," 2008. p. 9.

[3] NDEP, "2012 Second Half Semi-Annual Report Water Pollution Control Permit No. NEV0088029," November 2012.

[4] Knight Piesold. October 20, 2011. *Liberty Moly, LLC Liberty Mine Focused Feasibility Analysis of the Water Treatment Options for the Acid Heap Leach Draindown Water*. Appendix A, see "Cost Estimate for alternative 3d."

[5] General Moly web site: "Liberty." http://www.generalmoly.com/properties_liberty.php

[6] M3 Engineering. 2011. *Liberty Moly Project Molybdenum Mine and Processing Plant.* (Technical Report. Vol. 1.) Prepared for General Moly. p. 1-8. http://www.generalmoly.com/uploads/properties_liberty_2_2369674066.pdf

[70] **SLEEPER MINE**

Perpetual treatment: "I have reviewed the data that [Earthworks] provided, and I agree that the Sleeper Mine, the Jerritt Canyon Mine and the Rain Mine all will require *In perpetuity* treatment and/or very long term management of contaminated water draining from these mines. In addition, the former Equatorial Tonopah and the Paradise Peak mines are very likely to also require very long term treatment and or management of pit lakes or heap drainage also." [1]

Volume treated: There are five heap leach pads. Water quality data from the past eight years shows a consistent low pH of less than 3 at pads 2, 3 and 4, and pH below 4 at pad 1. Data from annual monitoring reports 2006 to 2012 indicate that heap leach draindown rates are consistent at a total rate of approximately 2.5 gallons per minute (with a slight increase in discharge from 2010 to 2012). The current annual estimate of 1.3 million gallons is based on this figure. These heap leach pads have been draining for 15 years, so the draindown estimate is relatively mature. The data suggest the potential for long-term pollution at this site. [2]

Treatment Costs: No lime usage reported. We used assumptions from the feasibility analysis of acid rock drainage treatment for the Liberty-Tonopah mine (amount of lime needed to neutralize the drainage, and the estimated cost of lime), and determined that there would be annual costs of at least $80,000 at this site. The estimate is the cost of lime alone (not other operating and maintenance costs), so this should be a conservative estimate unless the draindown volume decreases significantly. [3]

Status: [4]

Land Ownership: [4]

Impacted Resources/Resources at Risk:

References:

[1] Pers.Comm. Glenn Miller, Professor, Dept. of Natural Resources and Env. Science, University of Nevada. Feb. 27, 2013.

[2] Nevada Department of Environmental Protection. "Sleeper Mine Water Pollution Control Permit No. NEV500006." Annual reports 2011, 2010, 2009, 2008, 2007, 2006; Addendum to Second Quarter 2012 Report."

[3] Knight Piesold. October 20, 2100. Liberty Moly, LLC Liberty Mine Focused Feasibility Analysis of the Water Treatment Options for the Acid Heap Leach Draindown Water. Appendix A, see "Cost Estimate for alternative 3d."

[4] Paramount Gold and Silver Corp. "Form 10-K Filing for the fiscal year ending June 30, 2012." U.S. Securities and Exchange Commission. p. 11, 14. http://www.sec.gov/Archives/edgar/data/1342854/000114036112040050/form10k.htm

71 **BLUE LEDGE MINE**

Perpetual treatment: According to URS, "The presence of acid mine drainage (AMD) from the mine had adversely impacted groundwater, surface water, soil and sediment within the Joe Creek watershed. In addition to the ongoing AMD, the wase rock has ben described as being 'highly produced in terms of creation of AMD and releases of metals and sulfuric acid'." US Forest Service work "includes removal of two of the four waste rock piles at the site to a constructed repository, and reclamation through erosion control measures, topsoil replacement, and restoration of native vegetation. However, USFS work will not address contaminated sediment in the surface water down gradient from the site, discharge from mine adits, nor long-term operation and maintenance. Despite the previous actions undertaken by both EPA and the USFS, there remain areas of contamination that still need to be addressed to ensure there are no further negative environmental or possible human health risks associated with the site." [1], [2]

Volume treated: Two sources of AMD – unnamed adit and Adit 1N. Unnamed adit discharges at 2 to 5 gpm, for six months of year (assumed), which is 525,000 to 1.3 million gallons per year; and Adit 1N discharges 1 – 2 gpm for six months of year (observed), which is approx. 397,000 gallons per year. [3]

Treatment Costs: [2]

Status: [2]

Land Ownership: [2]

Impacted Resources/Resources at Risk: [2]

References:

[1] URS Corp. 2010. *Removal Action Engineering Evaluation and Cost Analysis. Blue Ledge Mine Site, Rogue River-Siskiyou National Forest.* Prepared for USFS. p.2. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5316863.pdf

[2] EPA Region 8 web site: "Blue Ledge Mine." http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/7508188dd3c99a2a8825742600743735/adb1289b074e51718825785000066c11!OpenDocument

[3] Westons Solutions Inc. 2011. *Hazard Ranking System (HRS) Documentation Record – Blue Ledge Mine. Prepared for EPA.* pp. 16, 31. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5317114.pdf

72 **FORMOSA MINE**

Perpetual treatment: Long-term mitigation of [mine-influenced water] MIW discharge from the Formosa 1 adit will likely include some form of water treatment, which could consist of in situ or ex situ passive treatment, or active treatment. Long-term active treatment is a presumptive remedy for treatment of MIW. [1] p. 7-17.

Volume treated: "During particularly wet years, such as 2005. . . the [mine influenced water] generation rate could range between 8 and 25 million gallons per year." [1] pp. 4-22, 4-23.

Treatment Costs: [1] p. 7-17.

Status: [2], [3]

Land Ownership: [2]

Impacted Resources/Resources at Risk: [3], [4]

References:

[1] CDM Federal Programs Corporation. 2012. *Formosa Mine Superfund Site Final OU1 Remedial Investigation Report.* Prepared for EPA. ftp://ftp.epa.gov/reg10ftp/sites/formosa/final_formosa_mine_superfund_site_OU1_RI_report.pdf

[2] U.S. Department of Interior web site: "Formosa Mine." Abandoned Mine Program. http://www.blm.gov/or/landsrealty/aml/formosa.php

[3] U.S. EPA web site: "Formosa Mine: Douglas County, Oregon." Region 10 Cleanup Page. http://yosemite.epa.gov/r10/cleanup.nsf/5c8919bc41f032578825685f006fd670/2e0107830190476a882571f0006623b0!OpenDocument

[4] U.S. EPA. 2007. "EPA proposes Formosa Mine to National Priorities List." Fact Sheet. http://yosemite.epa.gov/R10/CLEANUP.NSF/0/2e0107830190476a882571f0006623b0/$FILE/Formosa%20mine%20fs%20fin%203-5-07.pdf

73 **ELIZABETH MINE**

Perpetual treatment: EPA has stated that, "Spending $3 million in capital costs to minimize long-term (perpetual) treatment costs and comply with the VTSWMR is not excessive." This suggests that although minimized, there will still be long-term/perpetual treatment costs. [1]

Volume treated: EPA's 2006 Record of Decision says that, "Some level of treatment will occur through the application of alkalinity to the mine waste to prevent acid generation and the increase in the water level of the South Open Cut pit lake to submerge exposed sulfur bearing bedrock. In addition, the NTCRA includes collection and treatment of the seeps of TP-1." In 2009, it was reported that 5 to 12 gpm (2.628 – 6.307 million gallons) was the anticipated seepage rate from [tailings dam 1] after remedial activities occur. [2] p. 70, [3] p. 4-6.

Treatment Costs: EPA has said that the majority of the remedial actions should be complete in 2013 with only the installation of the long-term passive treatment system remaining. In 2003, annual operating and maintenance costs for a passive treatment system were estimated at $48,500 per year (operating and maintenance) It is not clear if this is still an accurate estimate. [3], [4]

Status: [5]

Land Ownership: The properties comprising the Site were subsequently sold and have not been further developed. [2] p. 2.

Impacted Resources/Resources at Risk: [5], [6]

References:

[1] U.S. EPA. 2002. *Elizabeth Mine Superfund Site. Response to Comments, Non-Time-Critical Removal Action (NTCRA)*. p. 26. http://www.epa.gov/region1/superfund/sites/elizmine/35277.pdf

[2] U.S. EPA. 2006. Record of Decision. P. 40. http://www.epa.gov/region1/superfund/sites/elizmine/259304.pdf

[3] URS Corp. March 2009. *Non-Time Critical Removal Action Closure Design Elizabeth Mine South Strafford, Vermont.* Prepared for US. Army Corps of Engineers. http://www.epa.gov/region1/superfund/sites/elizmine/460435.pdf

[4] URS Corp. 2003. *Passive and Semi-Active Treatment of Acid Rock Drainage from Metal Mines – State of the Practice*. Prepared for Army Corps of Engineers. Table 2.

[5] U.S. EPA web site: "Elizabeth Mine." Waste Site Cleanup & Reuse in New England. http://yosemite.epa.gov/r1/npl_pad.nsf/51dc4f173ceef51d85256adf004c7ec8/2281487131782426852569e400719bbe?OpenDocument

[6] Arthur D. Little, Inc. 2000. *Elizabeth Mine Site Summary Report.* Prepared for U.S. Army Corps of Engineers and U.S. EPA. p. 2. http://www.epa.gov/ne/superfund/sites/elizmine/24130.pdf

[74] **DONLIN CREEK**

Perpetual treatment: "It is currently assumed that the water treatment plant will operate in perpetuity." [1] p. 5-3.

Volume treated: Estimated to be 3,200 gpm (1.682 billion gallons per year). [1] p. 6-5.

Treatment Costs: Estimated costs for water treatment for years 2012 to 2264 (252 years) is $482,300,000, or $1,913,889 per year. [2]

Status:

Land Ownership: [3]

Impacted Resources/Resources at Risk: [1]

References:

[1] Donlin Creek. Water Resources Management Plan. http://www.donlingoldeis.com/Documents/Vol%20II%20-%20%20WATER%20RESOURCES%20MANAGEMENT%20PLAN%20-%20Donlin%20Gold%20Project%20-%20July%202012%20REDUCED%20FILE%20SIZE.pdf

[2] NovaGold Resources Inc. Donlin Gold Project, Alaska, USA, NI 43-101 Technical Report on Second Updated Feasibility Study, 18 November 2011, submitted by: Tony Lipiec, P.Eng., AMEC, Gordon Seibel, R.M. SME, AMEC; and, Kirk Hanson, P.E., AMEC., Table 20-3, p. 20-8. http://www.novagold.com/upload/technical_reports/2012-01-20_NGTR_DonlinGold.pdf

[3] Donlin Gold Project EIS web site:" Project Overview. http://www.donlingoldeis.com/ProjectOverview.aspx

[75] **PEBBLE**

Perpetual treatment: : In the revised Assessment of Potential Mining Impacts on Salmon Ecosystems in Bristol Bay prepared by EPA, the assessment "largely analyzes a mine scenario that reflects the expected characteristics of mining operations at the Pebble deposit." The report found that: "Seepage and leachate monitoring and collection systems, as well as the WWTP, might need to be maintained for hundreds to thousands of years." [1] (P. 6-32) The report further states that, "As necessary water treatment and other waste management activities would continue and any failures would be remediated. Because mine wastes would be persistent, this period could continue for centuries and potentially in perpetuity." [1] (P. ES-4)

The Final Peer-Reviewed report of the draft assessment made several key recommendations, including, "Based on the hypothetical mine scenario, perpetual management of the geotechnical integrity of the waste rock and tailings storage facilities, as well as perpetual water treatment and monitoring, most likely will be necessary. Therefore, emphasize how monitoring and management of the geotechnical integrity of waste rocks and tailings. [2] p. iii.

Volume treated: Table 6-8 summarizes the water balance flows during post-closure period for all mine scenarios. It estimates that 52.5 million cubic meters (13.8 billion gallons) will released to streams each year via waste water treatment system. [1] (P. 6-34)

Treatment Costs: NA

Status: Proposed

Land Ownership: [3]

Impacted Resources/Resources at Risk: [1]

References:

[1] U.S. EPA. April 2013, An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska, Second External Review Draft. http://www.epa.gov/ncea/pdfs/bristolbay/bristol_bay_assessment_erd2_2013_vol1.pdf

[2] U.S. EPA. Sept. 17, 2012. *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*. Final Peer Review Report. http://www.epa.gov/ncea/pdfs/bristolbay/Final-Peer-Review-Report-Bristol-Bay.pdf

[3] U.S. EPA. May 2012. *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*. Vol. 1, p. 6-37. http://www.epa.gov/ncea/pdfs/bristolbay/bristol_bay_assessment_erd_2012_vol1_chapter6.pdf

[4] Alaska Department of Natural Resources web site: "Pebble Project." http://dnr.alaska.gov/mlw/mining/largemine/pebble/

[76] **NORTHMET**

Perpetual treatment: According to the draft environmental impact statement (DEIS) for the project, "Tribal cooperating agencies note that the analysis of stockpile leachate collection (Table 4.1-45) indicates that collection would be needed for 2000 years in order to avoid violations of water quality standards. Furthermore, periodic collection of wastewater from the hydrometallurgical tailings facility would have to continue in perpetuity. Therefore, it is the tribal cooperating agencies' position that the WWTF would also have to operate for a minimum of 2000 years. Tribal cooperating agencies suggest that this does not meet the Minnesota goal of maintenance free closure. "It is currently assumed that the water treatment plant will operate in perpetuity." EPA has also written that, "Management plans should recognize that long-term treatment and discharge will likely be necessary in the post-closure period. . . Given the DEIS-stated potential for long-term (>2,000yrs) leaching of solutes from waste rock to groundwater, further evaluation is necessary." (p. 5) [1] p. 4.1-67, footnote 25, [2] pp. 4, 5 of EPA detailed comments.

Volume treated: In the DEIS, Polymet stated that the wastewater treatment plant's maximum design flow would be 3,000 gpm, and that ponds that would store excess process water when the WWTF is operating at full capacity. [1] p. 4.1-6.7.

EPA responded that "According to the DEIS, all waste rock at the site is acid generating, and acidic water moving through the waste rock and tailings will mobilize metals and sulfates, leaching them into groundwater and surface water. . .The DEIS does not offer supporting data that the proposed wastewater treatment facility (WWTF) has the capacity to treat all ARD effluent and will be sufficient to address waste rock pile drainage over a long-term timeframe. The proposed WWTF is intended to capture and treat all drainage from waste rock piles and recycle the water, but 4.1-45 predicts that groundwater information in inadequate to know whether it could process all the contaminated stormwater flows during a maximum spring snow melt situation. In addition, the design capacity of the WWTF may be inadequate, since the project plan assumes that pit walls will not generate ARD." [2] p. 2 of letter and p. 4 of EPA detailed comments.

Our calculations: All data from DEIS (Ref. [1] below). Table 4.1-45 of the DEIS provides estimates of years of exceedance for different parameters. Those that will exceed standards "In perpetuity", i.e., for hundreds of years, include: Category 1 and 2 Waste Rock & Overburden (100 – 2,000 years for antimony & sulfate); West pit (550 – 2,000 years for antimony); East Pit & Category 4 Waste Rock stockpile (90 - 250 years for antimony); Category 3 lean Ore stockpile (50 - 2,000 years Nickel); Category 3 Waste Rock Stockpile (up to 2,000 years for antimony, sulfate, manganese and nickel).

Table 4.1-41 in the DEIS provides estimated post-closure leakage rates for liners from waste rock, ore, and overburden, which seems to provide estimated amounts for long-term water treatment. The only waste category that is predicted to have substantial leakage is Category 1 and 2 waste rock and overburden.

Category 1 and 2 and overburden (563.8 acres): average of 408 gallons/acre/day = 83,961,096 gallons. (See p. 3-17 for post-closure acres Cat. 1&2 and overburden)

West Pit: 18 gallons per minute = 9,460,800 gallons per year (See p. 4.1-84 for predicted West Pit groundwater outflow)

TOTAL WITHOUT TAILINGS SEEPAGE: 93,429,896 gallons per year

Tailings Basin: 290 gpm of seepage post closure = 152,424,000 per year (not predicted to exceed groundwater standards, but tribes disagree – See pp. 4.1-54, 4.1-55, 4.1-64, 4.1-94)

TOTAL WITH TAILINGS SEEPAGE: 245,853,896 gallons per year.

Treatment Costs:

Status:

Land Ownership: [1] p. S-1.

Impacted Resources/Resources at Risk: [1] S-12, S-18.

References:

[1] Minnesota Department of Environmental Conservation and U.S. Army Corp of Engineers. Oct. 2009. Northmet Project Draft Environmental Impact Statement. http://files.dnr.state.mn.us/input/environmentalreview/polymet/draft_eis/volume_i_text_and_tables_deis.pdf

[2] U.S. EPA. Feb. 18, 2010. Letter to U.S. Army Corps of Engineers Re: NorthMet Project – Draft Environmental Impact Statement." http://yosemite.epa.gov/oeca/webeis.nsf/EIS01/E1F6C4DC76FA527385257705001B9FC5?opendocument

[77] **ROCK CREEK**

Perpetual treatment: US Forest Service has stated that, "Bonding will cover water treatment in perpetuity. The mine adits will either be plugged and sealed once the mine water meets ground water or surface water standards and allowed to fill up the mine workings or sealed primarily against unauthorized access and allowed to drain or be pumped down to the river in perpetuity. In the second case, the drainage will be either pumped from within the mine or captured near its source and treated, if necessary, and discharged to the Clark Fork River in perpetuity." [1] p. 7.

Volume treated: According to the Final Environmental Impact Statement, "Mine water would be treated via settling sumps in mine, filters and oil skimmers, and a passive biotreatment system and backup ion-exchange system prior to discharge in accordance with MPDES permit limits; Mine discharge to the Clark Fork River would range from less than 500 gpm during evaluation adit and mine adit construction, to 570 gpm at year 5, to 740 gpm at year 10, to about 1500 gpm in year 20, and to 2,300 gpm at year 30 and end of mine life." Based on discharge of 2,300 gpm at year 30 and end of mine life, annual treatment equals 1,208,880,000 gallons. [2] p. S-12.

Treatment Costs: Estimated annual O&M based on anoxic treatment and reverse osmosis. [1] Attachment 5, p. 10.

Status:

Land Ownership: [1] p. 2.

Impacted Resources/Resources at Risk: [1] p. 7.

References:

[1] U.S. Forest Service. June 2003. *Record of Decision – Rock Creek Project.* http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5326112.pdf

[2] Montana Department of Environmental Quality and U.S. Forest Service. September 2001. *Final Environmental Impact Statement for the Rock Creek Project.* Summary. http://deq.mt.gov/pcd/RockCreek/Volume%20I%20Summary.pdf