TRACK RECORD

Montana Modern Hardrock Mining

WATER QUALITY IMPACTS AND RECLAMATION BONDING

SEPTEMBER 2018

EARTHWORKS

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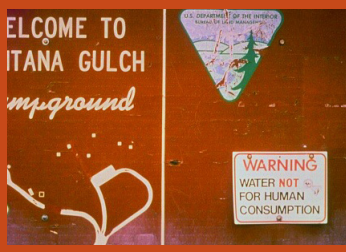

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EXECUTIVE SUMMARY

INADEQUACY OF WATER QUALITY PREDICTIONS AND RECLAMATION BONDS AT MODERN HARDROCK MINES

This report evaluated the adequacy of water quality predictions and reclamation bonds at modern hardrock mines in Montana. Based on a review of government documents, water quality predictions made during mine permitting were wrong at 11 out of 12 mines (91.7% of mines). Not only were water quality predictions incorrect in nearly every case, but the water quality impacts were often severe, including contamination of drinking water, loss of fish and wildlife habitat, harm to private property and agricultural lands, and the formation of acid mine drainage that will cause lasting pollution that requires water treatment in perpetuity.

This research also found that reclamation bonds are inadequate to cover clean-up costs at 42% of the mines (Beal, Zortman Landusky, Basin Creek, Kendall, Montana Tunnels). This has resulted in roughly $50 million in expenditures of state and federal funds and another $20 million set aside in a state trust for Zortman Landusky. It has also resulted in an ongoing liability for unfunded clean-up costs of $78.9 - $103.8 million, with an additional $1.9 million per year in perpetuity for ongoing water treatment costs at Zortman and Beal.

These results paint a clear picture. The laws that govern mining are inadequate to protect our clean water from mine pollution. Stronger laws and oversight are needed to keep our waters safe, protect public health, and safeguard taxpayers.

Water pollution from the Beal Mountain Mine near Anaconda requires costly treatment.

METHODS

This study reviewed state and federal government documents for all major hardrock mines in Montana that began production after 1980. By 1980, the primary state and federal laws established to regulate mining, the Montana Metal Mine Reclamation Act of 1971, the National Forest Management Act of 1976, the Federal Land Policy and Management Act of 1976 and the Bureau of Land Management 3809 regulations of 1980, were established. The report reviewed Environmental Assessments (EAs) or Environmental Impact Statements (EISs) required during mine permitting and compared the water quality predictions in those documents with actual water quality impacts as a result of mine operations. This included a review of a 2006 report by Jim Kuipers, P.E. and Ann Maest, which compared water quality predictions with mine impacts at some Montana mines.[1]

This study also reviewed financial assurance data at these mines, including the total reclamation bond for each mine, any current liability to the public for documented unbonded clean-up costs, and public expenditures that resulted from inadequate bonding in the event of mine bankruptcy.

Table 1

Reclamation bonds, public expenditures and public liabilities at major hardrock mines in Montana that began production post-1980

TABLE 1 – RECLAMATION BONDS / PUBLIC LIABILITIES					
Mine	**Owners (sequential)**	**Total Bond**	**Bond Expenditure**	**State and Federal Expenditures (after bond spent)**	**Ongoing Liabilities**
Basin Creek	Pegasus Gold	~ $3.75 million[2]	~ $3.75 million	USFS & State expenditures ($2 million[3] + $3.6 million[4]): ~ $5.6 million	After Pegasus Gold filed for bankruptcy, the mine was incorporated into the federal Superfund program. The State anticipates that another $3 million is needed for reclamation, clean-up and long-term O&M at Basin Creek Mine.[5] Total: $3 million
Beal Mountain	Beal Family, MT Gold Mtn. Mining, Pegasus Gold	~ $6.2 million[6]	~ $6.2 million	State and USFS expenditures: ~ $15 million[7]	The U.S. Forest Service is still determining final reclamation costs. The most recent estimate is $39,530,139 for partial clean-up.[8] Another $1 million is needed by the State for long-term O&M.[9] Ongoing long-term water treatment costs are currently $400,000 per year.[10] Total: $40,530,139 + $400,000/year for long-term water treatment
Montana Resources Continental Pit	Anaconda Mining Company, Montana Resources	$57,577,902[11]	None identified	None identified	None identified.
CR Kendall	Greyhall Resources, Canyon Resources Corp., Atna Resources.	$2,345,000[12]	Currently $30,000/ month for long term water treatment.	None identified	Atna Resources filed for bankruptcy in 2015. In 2016, DEQ filed a claim in bankruptcy court for $6,274,245 - the shortfall in the reclamation costs at Kendall (calculated to be $8,496,886 for long-term water treatment).[13] The claim was denied due to lack of funds. Based on current expenditures of $30,000 a month, DEQ anticipates that the bond will be spent, and public funds will be needed to cover water treatment costs in five years.[14] Total: $6,274,245
Diamond Hill	Pegasus Gold, Apollo Gold, Elkhorn, Eastern Resources	$763,000[15]	None identified	None identified	None identified
Golden Sunlight	Placer Dome, Barrick Gold	$146,564,163[16]	None identified	None identified	None identified, but the site will require water treatment in perpetuity.[17]

TABLE 1 – RECLAMATION BONDS / PUBLIC LIABILITIES					
Mine	**Owners (sequential)**	**Total Bond**	**Bond Expenditure**	**State and Federal Expenditures (after bond spent)**	**Ongoing Liabilities**
Mineral Hill	Jardine, TVX Gold, Kinross, Jardine Land and Livestock	$1,800,276[18]	None identified	None identified	None identified
Montana Tunnels	Centennial Minerals and U.S. Minerals Exploration Co., Pegasus Gold, Apollo Gold, Elkhorn, Eastern Resources	$19,783,826[19]	None identified	None identified	New bond calculation in process, expected to total ~ $38.9 million, leaving a shortfall of ~ $19 million.[20] In June 2018, DEQ suspended operations at the mine because Eastern Resources has failed to post the increased bond amount.[21] The State plans to move forward with bond forfeiture to pay for reclamation. Total: ~$19 million
Stillwater East Boulder	Stillwater Mining Co., Sibanye Gold Ltd	$17,486,836[22]	None identified	None identified	None identified
Stillwater Nye	Stillwater Mining Co., Sibanye Gold Ltd	$21,518,836[23]	None identified	None identified	None identified
Troy Mine	Asarco, Revett Mining Co., Hecla	$24,687,842[24]	None identified	None identified	None identified
Zortman-Landusky	Pegasus Gold	~ $47.5[25] million	~ $47.5 million	BLM expenditures: $17,479,312 State expenditures: $12,208,510 Total: $29,687,822 Plus, $840,000 invested in first trust and $19,300,000 in second trust established by state legislature to be used for long-term water treatment.[26] Total trust amount from state investments: $20,140,000	DEQ projects an ongoing liability of $1.5 million annually for long-term water treat costs in excess of trust. This site will require water treatment in perpetuity. In addition, DEQ predicts that major investments in upgrades may be necessary during the next ten years, including an estimated $5 million for a new seepage interception system in Swift Gulch and either another $5 million for replacement of the Landusky treatment system or $30 million to cap the leach pad to avoid water treatment of Landusky discharge.[27] Total: $10-$35 million + $1.5 million in annual water treatment costs.
TOTALS				**$50,287,822 in state and federal expenditures + $20,410,000 in state trust**	**$78,804,414 - $103,804,414 in one-time expenditures, plus an ongoing estimated $1.9 million a year for perpetual water treatment (Beal and Zortman).**

Table 2

Comparison of predictions of water quality impacts during mine permitting versus actual water quality impacts resulting from mine operations

TABLE 2 – PREDICTIONS / ACTUAL IMPACTS		
Mine	**Predicted Impacts**	**Actual Water Quality Impacts**
Basin Creek	• The environmental review documents are not available at DEQ because the mine has now been incorporated into the CERCLA program by EPA. However, it is fair to assume that water quality violations were not predicted during permitting or the mine wouldn't have received an operating permit.	• 1987 – Cyanide spill resulted in groundwater contamination.[28] • 1993 – A leak in the liner of the process pond caused up to 130,000 gallons of cyanide solution to be released over 3 days. Groundwater monitoring wells revealed 52.3 ppm cyanide – far above standards.[29] • 1997 – Nearby stream (West Clear Creek) contaminated by improper land application. Cyanide measured at levels that exceed state water quality standards.[30] • 1998 – Following the Pegasus bankruptcy, there were insufficient funds for reclamation. Consequently, DEQ negotiated for the receipt of bond from the surety and assumed responsibility for reclamation and other clean-up activities. The mine was then placed into the federal Superfund program to provide a repository (the Luttrell Pit) for mine waste from abandoned mines in the Upper Ten Mile Creek.[31]
Beal Mountain	• 1988 – Environmental Assessment completed.[32] Water quality impacts predicted to be minor.[33] • 1993 – Environmental Impact Statement was conducted for expansion. Water quality impacts predicted to be minor.[34]	• 1989 – Cyanide detected in three groundwater monitoring wells.[35] • 1992 – Cyanide seeped through holes in the liner system and contaminated natural springs. Springs were also contaminated with sulfate and nitrate levels above water quality standards.[36] • 2001 – 2006: Cyanide levels in American Gulch, Beefstraight Creek, lower Minnesota Gulch and German Gulch commonly exceeded water quality standards.[37] • 2003 – Exceedances of surface water quality standards for cyanide, TDS, sulfate and nitrates. Exceedances of groundwater water quality exceedances in nitrate, cyanide and iron.[38] • 2003 – U.S. Forest Service initiated a federal "Time Critical" cleanup program under CERCLA because conditions presented a substantial endangerment to human health and the environment.[39] • 2010 – Concentrations of selenium measured in all of the surface water samples collected during the 2003-2009 period from STA-3 and STA-3a exceeded the chronic aquatic life standard. Fish and aquatic macroinvertebrate tissue samples from the German Gulch sub-watershed contain elevated levels of selenium. Concentrations in middle German Gulch macroinvertebrates were above the range of suggested toxic effects thresholds to fish.[40] German Gulch supports 100% pure native westslope cutthroat population. • 2012 - Report shows ongoing water quality problems, including exceedances of human health standards for selenium and cyanide in springs, exceedances of chronic aquatic life standards for selenium in German Gulch, and exceedances of groundwater quality standards for selenium and cyanide.[41] Water treatment will be required for the foreseeable future.

TABLE 2 – PREDICTIONS / ACTUAL IMPACTS		
Mine	**Predicted Impacts**	**Actual Water Quality Impacts**
Continental Pit (Montana Resources)	• 1981 – An EIS was developed in response to expansion plans by the Anaconda Mining Company, which included mining of the Southeast Berkeley Pit (later renamed the Continental Pit) and plans to eventually merge it with the Berkeley Pit.[42] The EIS doesn't differentiate between water quality impacts from the two pits, but states that "Water within the disturbed area would be collected and treated until all work within the Berkeley complex is halted. Upon abandonment of the Berkeley pit, all contaminated water, including the water flowing from the permit area, would be diverted into the pit. The company expects new treatment technology to be available by the time the mine is abandoned, and as a result, has not proposed a method of treating any surface or groundwater leaving the pit."[43] The entire area was designated a Superfund site in 1983. • 1986 - Montana Resources acquired the Southeast Berkeley Pit, and renamed it the Continental Pit because it was now a distinct, separate pit, rather than an extension of the Berkeley Pit.	• This site is difficult to draw comparisons due to its integrated history with the Berkeley Pit and its incorporation into the federal Superfund program. • The Continental Pit was previously known as the Southeast Berkeley Pit under the Anaconda Copper Company in its 1981 expansion plans. The entire area was designated a Superfund site in 1983. When mining resumed under Montana Resources in 1986, the name was changed to the Continental Pit to identify it as a distinct separate pit.

TABLE 2 – PREDICTIONS / ACTUAL IMPACTS		
Mine	**Predicted Impacts**	**Actual Water Quality Impacts**
Kendall	• 1989 Environmental Assessment – The quality of water exiting the mine pits is expected to be good with the exception of nitrate/nitrite residues. However, use of best available control methodologies should result in minimal impacts to the groundwater quality. The proposed expansion of the Kendall mine may increase nitrate/nitrite values in both surface and groundwater from residual blasting material. In the event that blasting increases levels 0.5 mg/l, values at the permit boundary are not expected to reach the EPA drinking water standards of 10 mg/l. Cyanide has been found in some monitoring wells as a result of previous operations.[44]	• 1995 - Influences to water quality from CR Kendall's mining operation were first noted at the Section 29 Spring, located on the Shammel ranch. Increases in sulfates, nitrates, and selenium were identified after the North Muleshoe Waste Rock Dump was developed.[45] • 1997 – Violation issued for failure to comply with effluent quality limits for thallium and cyanide and failure to analyze effluent samples for the parameter suite. • 1998 – Notice of violation issued for exceeding water quality standards in five drainages, including nitrates, thallium, cyanide, antimony, arsenic, and selenium. DEQ issued a penalty for extended water quality violations.[46] • 2000 - DEQ notified Canyon Resources that it must replace water to stream drainages.[47] The mine was intercepting contaminated water from the mine, reducing flows in drainages that downstream landowners use for ranching/agriculture. • 2015 – Atna Resources filed for bankruptcy, along with affiliates CR Kendall and Canyon Resources. DEQ determined that the existing reclamation bond will not cover the full costs of long-term water treatment (see bond above).[48] • 2016 – Final EIS for mine closure documents lasting water quality impacts. Water quality standards exceeded for arsenic in 79% of groundwater samples of groundwater in Mason Canyon from 1994-2014.[49]
Diamond Hill	• No impacts from fuel spills are predicted.[50]	• 1998 – Diesel fuel released, infiltrated bedrock and contaminated groundwater, which required pumping. Approximately 670 gallons were recovered from the well.[51] • 2001 – DEQ required Diamond Hill to provide a plan for continued monitoring and/or clean-up of groundwater well from diesel fuel. Spikes of diesel fuel were still occurring in groundwater during the spring melt.[52] • Mine has been inactive since 2001.
Golden Sunlight	• 1981 EIS – Groundwater impacts predicted to be low after mitigation of tailings water. Potential for acid mine drainage minimal. The design approach was projected to achieve a zero-discharge facility. Pit not expected to go below groundwater.[53] • 1990 EA – Pit water expected to have low pH and elevated levels of metals, nitrate and salts. Mitigation expected to prevent impacts.[54] • 1998 EIS – Tailings impoundments expected to leak cyanide solution into groundwater requiring pump back system to mitigate.[55]	• 1990 – Cyanide and copper in downgradient wells.[56] • 1993 – Cyanide solution leaked from unlined tailings impoundment into groundwater, with impacts to four domestic wells and a well at a veterinary clinic.[57] • 1998 – Continued contamination of downgradient groundwater wells. Waste rock shows oxidation and potential for acid mine drainage and primary groundwater contamination from tailings.[58] • 1999 – State fines Golden Sunlight $66,000 for a violation of the Water quality Act for groundwater contamination caused by release of cyanide-contaminated materials from a mine-site tailings impoundment.[59] • Cyanide spills in 1986, 1987, 1988, 1989, 1991, 1994, 1998, 2000, and 2006.[60] • Acid drainage in waste rock dumps, pit water, and springs downgradient of waste rock.[61]

TABLE 2 – PREDICTIONS / ACTUAL IMPACTS		
Mine	**Predicted Impacts**	**Actual Water Quality Impacts**
Mineral Hill (Jardine Land and Livestock)	• 1986 EIS – No surface water impacts predicted. • 2001 EIS – No impacts predicted as long as mitigation is maintained.[62]	• 2001 EIS – Tailings leachate containing cyanide, nitrate, manganese, sulfate, arsenic, and TDS escaped the liner system and caused exceedances in alluvial groundwater and surface water. Flow from mine workings of approximately 15 gpm that contained arsenic in excess of water quality standards.[63]
Montana Tunnels	• 1986 EIS – Adverse impacts which cannot be mitigated: open pit containing large lake of poor quality water; potential for minor seepage of poor quality water from tailings impoundment and process pond into Spring Creek; no predicted water quality exceedances.[64]	• 1987 – Elevated cyanide levels found in groundwater monitoring wells below tailing impoundment.[65] • According to 2008 EIS: Groundwater quality below the tailings pond and waste rock piles have exceeded secondary maximum contaminant levels (SMCL) for sulfate and manganese and increased in concentrations over time. Average concentrations of cadmium and zinc were also above water quality standards.[66] • Concentrations of sulfates and manganese have increased over time, and significantly exceed the secondary maximum contaminant levels in Spring Creek.[67] • Clancy Creek has been diverted into a pipe since approximately 2009 to prevent creek from being entrained into the open pit.[68] • 2018 – Water quality of pit water is unknown. DEQ has been unable to sample water in the pit since 2010 because pit wall failure prevents access to pit water.[69]
East Boulder	• 1998 EIS; With mitigation, groundwater quality not expected to be diminished.[70] Historical low-flow conditions, precipitation-based system, no water quality impacts should occur to users downstream.[71]	• 2007 – A release of untreated mine adit water containing over 65 pounds of nitrogen resulted in sharp increase in nitrogen in groundwater, causing exceedance of discharge permit limit.[72] East Boulder entered into an Administrative Order on Consent with DEQ. Nitrogen concentrations in groundwater were as high as 47 mg/l in fall 2010, which is above the 7.5 mg/L groundwater quality nondegradation standard for protection of human health and the MPDES compliance limits. Groundwater salts have exceeded Class I beneficial use criteria.[73] No measurable increase in surface water nitrogen.[74]
Stillwater (Nye)	• Exceedances of groundwater quality standards were not predicted.[75]	• Increases of nitrates in the Stillwater River, but below standards.[76] • 2006 - Nitrogen concentrations above standards in groundwater due to leakage from improperly installed earthen liner within the Hertzler Ranch LAD storage pond.[77] • 2010 – Nitrogen concentrations in groundwater exceeded standards due to leaks in the Hertzler tailings impoundment underdrain pipe.[78]
Troy	• 1979 EIS – No significant impact to surface water.[79]	• September 2009 –tailings pipeline spilled 40 tons of mine waste into Thicket Creek to the confluence of Lower Stanley Creek and traveled to Lake Creek. Difficult access and high-water velocity made it impossible to remove most of the tailings. As of 2012, tailings are visibly present in slower water areas. Exceedances of copper and lead water quality standards occurred.[80] Stanley and Lake Creek are on the list of impaired streams by MTDEQ limiting the streams ability to support aquatic life, with mine tailings listed as a probably source of impairment.[81] • October 2011 – another tailings spill into Thicket and Stanley Creek.[82]

TABLE 2 – PREDICTIONS / ACTUAL IMPACTS		
Mine	**Predicted Impacts**	**Actual Water Quality Impacts**
Zortman-Landusky	• 1979 EIS – predicted low acid drainage in initial EIS • 1990 EA – as mitigation, ZLM to put high sulfide rock waste on leach pad. • 1993 EA – because ore contained oxide and sulfide rock, substantial mitigation measures (engineered caps, pump back, water treatment plant, slurry cut-off walls, leach pad under drains) were imposed. • 1996 EIS – Static tests showed strong potential to generate acid. More substantial mitigation measures were imposed (reclamation covers, adit bulkheading) WQ improvement plan. Volume of water to be treated over next 20 years predicted to be 211-419 gpm. • 2001 EIS – Constituents of concern include sulfate, low pH, iron, aluminum, zinc, arsenic, copper, cadmium, cyanide, nitrate.[83]	• 1993 - BLM and Department of State Lands found that approved operating and reclamation plans were not preventing acid mine drainage. Mill Gulch and upper Sullivan Creek had become acidic. • 1996 - Acid drainage being generated from pit walls and floors, leach pads and pad foundations, and waste rock piles. • 2001 - Acid drainage is common in groundwater at site and is impacting surface water.[84] • Acid mine drainage will require water treatment in perpetuity. An average of 400 million gallons treated per year. • 2011 – A major storm event released 56 million gallons of untreated acid mine drainage from Zortman and 19 million gallons from Landusky into downstream drainages.[85] • 2012 – Twelve streams in the Little Rocky Mountains do not meet water quality standards due to cyanide, pH, or metals. These include Alder Gulch, Beaver Creek, South Bighorn Creek, King Creek, Lodge Pole Creek, Mill Gulch, Montana Gulch, Rock Creek, Ruby Creek, Sullivan Creek and Swift Gulch Creek.[86] Impaired uses include drinking water, aquatic life, recreation, warm and cold-water fish, and agriculture.

Table 3

Summary of water quality prediction accuracy

Mine	Were water quality impacts accurately predicted?
Basin Creek	NO
Beal Mountain	NO
Continental Pit	Not applicable (See Table 2 for Continental Pit details)
CR Kendall	NO
Diamond Hill	NO
Golden Sunlight	NO
Mineral Hill	NO
MT Tunnels	NO
Stillwater East Boulder	NO
Stillwater Nye	NO
Troy Mine	NO
Zortman-Landusky	NO
Percent that did not meet predictions	**91.7 %**

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[83] Kuipers, J.R., Maest, A.S., MacHardy, K.A., and Lawson, G. 2006. Comparison of Predicted and Actual Water Quality at Hardrock Mines: The reliability of predictions in Environmental Impact Statements.

[84] Id.

[85] Warren McCullough, Wayne Jepson and Spectrum Engineering, "Zortman: Dealing with Extreme Weather Events", Presented at MT Tech., Available at: http://www.mtech.edu/mwtp/conference/2012_presentations/Warren%20McCullough.pdf

[86] MTDEQ, Landusky Metals Total Maximum Daily Loads and Framework Water Quality, Improvement Plan, March 2012.