

U.S. Copper Porphyry Mines Report

THE TRACK RECORD OF WATER
QUALITY IMPACTS RESULTING FROM
PIPELINE SPILLS, TAILINGS FAILURES
AND WATER COLLECTION AND
TREATMENT FAILURES.

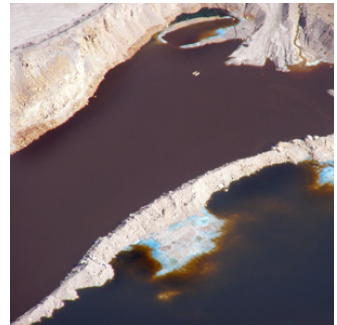
JULY 2012



U.S. COPPER PORPHYRY MINES:

The track record of water quality impacts resulting from pipeline spills, tailings failures and water collection and treatment failures.

EARTHWORKS, July 2012

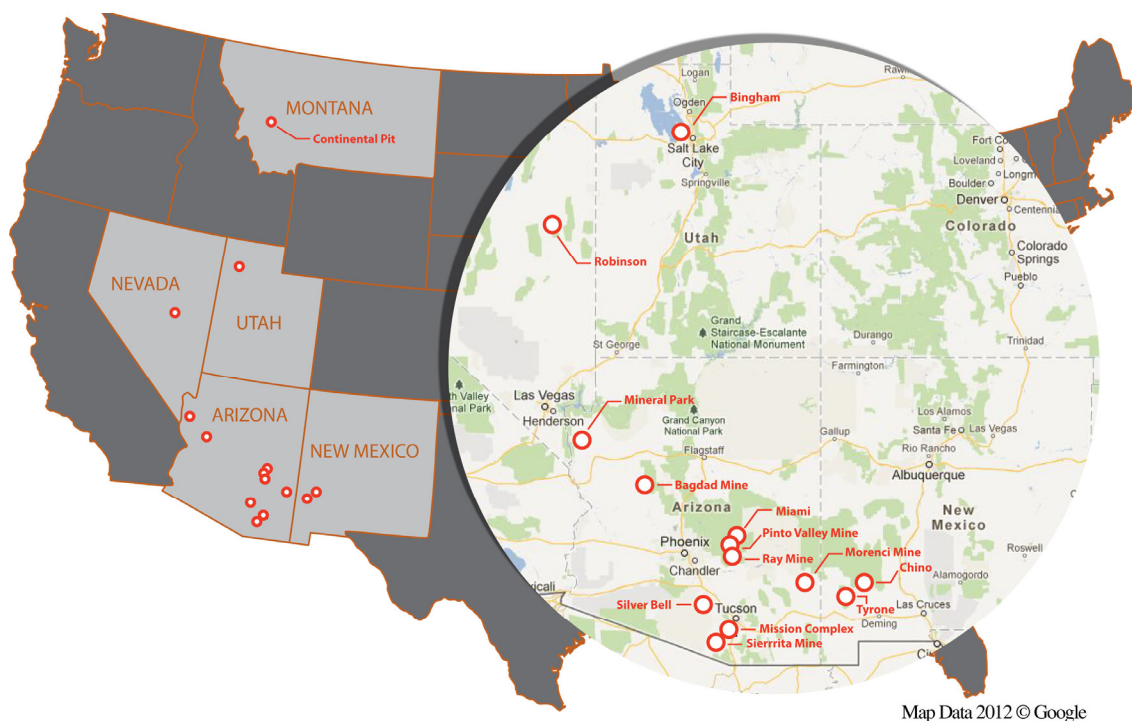


Photos, top to bottom:

Yankee Doodle tailings pond by Ecoflight
Chino Mine by Gila Resource Information Project (GRIP)
Sierrita Mine by Ecoflight
Bird fatality at Tyrone Mine by Jim Kuipers

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EXECUTIVE SUMMARY:

The Pebble Mine is proposed for development at the headwaters of the Bristol Bay watershed in southwest Alaska, which supports the world's largest wild sockeye salmon fishery.

According to current ore estimates, the Pebble Mine would be the largest copper porphyry mine in the U.S., if constructed.

Copper porphyry is a form of copper deposit that is often characterized as low-grade, and often containing other minerals such as gold and molybdenum. Copper porphyry deposits are almost all mined in industrial-scale open pit operations.

Currently, the U.S. Environmental Protection Agency (EPA) is completing a watershed assessment to evaluate the potential impacts of large-scale mining on water quality and fishery resources using a mine scenario that reflects the expected characteristics of mining operations at the Pebble deposit.

We reviewed state and federal documents for fourteen U.S. operating copper porphyry mines to assess the impacts associated with pipeline spills, tailings impoundment failures and water capture and treatment failures.

Our research shows that copper porphyry mines are often associated with water pollution resulting from acid mine drainage and/or metals leaching. Drainage from porphyry deposits commonly have concentrations of aluminum, cadmium, copper, iron, manganese, lead, and zinc that exceed US drinking-water limits to protect public health, and aquatic life standards are also commonly exceeded for cadmium, copper, lead and zinc.¹

We reviewed state and federal documents and a federal database for fourteen copper porphyry mines representing 87% (14 out of 16) of currently operating copper porphyry mines, and 89% of U.S. copper production in 2010 – the most recent data on copper production available from the U.S. Geological Survey. The fourteen mines were chosen based on an operating record of more than five years. These mines provide a representative view of the types of environmental impacts resulting from the development of copper porphyry deposits, focusing on pipeline spills, tailings failures and water collection and treatment failures.

We found that all of the mines (100%) experienced pipeline spills or other accidental releases.

The most frequent spills were reported at the Ray Mine in Arizona, where over fifty pipeline spills occurred from 1988 to 2012. Examples of recent pipeline spills include a 2012 spill at the Ray Mine which washed tailings into the Gila River, a 2008 pipeline spill at the Morenci Mine of 186,000 gallons of sulfuric acid along two miles of Chase Creek - a tributary of the San Francisco River, and a 2009 spill of 2 million gallons of process water at the Bagdad Mine.

At 13 of the 14 mines (92%), water collection and treatment systems have failed to control contaminated mine seepage, resulting in significant water quality impacts. The development of acid mine drainage was associated with the most severe and lasting impacts. For example, the Tyrone and Chino mines – the two largest copper porphyry mines in New Mexico, will generate an estimated 2 billion gallons of acid and metals contaminated seepage every year, requiring water treatment in perpetuity. These two mines have resulted in severe surface and groundwater contamination, and the State of New Mexico and U.S. Department of Justice have filed natural resource damage claims against the company for damages to water and wildlife resources.

The Bingham Canyon Mine, the largest copper porphyry mine currently operating in the United States, will also generate water pollution in perpetuity from the mine's waste rock piles. Mine operations have resulted in a plume of contaminated groundwater extending over 70 square miles, and the State of Utah filed a natural resource damage claim against the mine in 2008 for impacts to water and wildlife resources.

Tailings spills have occurred at nine operations, and a partial failure of the tailings impoundment occurred at four out of fourteen mines (28%). These included a 1997 partial failure of the tailings impoundment at the Pinto Valley Mine, where the creek bed and surrounding upland were buried under material as deep as 42 feet. In 1993, heavy precipitation caused the Gila River to flood and breach the tailings impoundment at the Ray Mine, carrying pollutants 11 miles downriver. And in 1980, 2.6 million cubic yards of tailings were released at the Tyrone mine, and flowed 8 kilometers downstream.

Many of the currently operating copper porphyry mines are located in the arid southwest, where precipitation is limited, and communication between surface and groundwater resources is limited. **More significant impacts could be expected at mines in wetter climates, with abundant surface water and shallow groundwater, such as is the case in the Bristol Bay region.** Research shows that mines with high acid generating potential and in close proximity to surface and groundwater are at highest risk for water quality impacts.²

Additional impacts at these mines, particularly water collection and treatment failures, are likely to occur after mining operations cease and groundwater pumps are no longer keeping the mine area dewatered.

A review of the track record of water quality impacts from copper porphyry mines found severe impacts to drinking water aquifers, contamination of farmland, contamination and loss of fish and wildlife and their habitat, and risks to public health. In some cases, water quality impacts are so severe that acid mine drainage will generate water pollution in perpetuity.

Table 1**2010 copper production amounts for mines reviewed in this report.**

Mine	Location	Company	2010 Copper production (Metric Tons)
Bingham Canyon	UT	Kennecott/Rio Tinto	250,000 ³
Morenci	AZ	Freeport	233,146 ⁴
Ray	AZ	ASARCO	105,051 ⁵
Bagdad	AZ	Freeport	92,079 ⁶
Mission	AZ	ASARCO	83,415 ⁷
Sierrita	AZ	Freeport	66,678 ⁸
Robinson	NV	Quadra	49,400 ⁹
Tyrone	NM	Freeport	37,194 ¹⁰
Silver Bell	AZ	ASARCO	21,000 ¹¹
Chino	NM	Freeport	15,400 ¹²
Mineral Park	AZ	Mercator	14,605 ¹³
Miami	AZ	Freeport	8,100 ¹⁴
Pinto Valley	AZ	BHP	6,000 ¹⁵
Continental Pit	MT	Montana Resources	Not available
Total production of 13 mines			982,068
Total U.S. production			1,100,000
Percent of total production			89%

Table 2

Synopsis of pipeline spills, tailings spills and impoundment failures, and water capture and treatment failures for 14 copper porphyry mines (1986-2012).

Mine	Number of reported pipeline spills and other accidental releases*	Water collection and treatment failures	Tailings dam failures	Affected surface and/or ground water
Morenci	21	Yes		San Francisco River, Gila River, Chase Creek, groundwater aquifer
Bingham Canyon	28	Yes		72 square mile plume of contaminated groundwater; fish and wildlife habitat in the Great Salt lake ecosystem
Ray	54	Yes	Partial	Mineral Creek, Gila River, groundwater aquifer
Chino	10	Yes		Hanover/Whitewater Creek, contaminated groundwater will require water treatment in perpetuity
Bagdad	7	Yes		Boulder Creek, Burro Creek, Butte Creek, Bridle Creek
Sierrita	19	Yes		Demetrie Wash and its tributaries; groundwater aquifer including drinking water wells in Green Valley
Pinto Valley	3	Yes	Partial	Pinto Creek
Mission	3	Yes	Partial	Tributaries of the Santa Cruz River, groundwater aquifer
Robinson	8	Unknown		2.3 miles of downstream drainage bed
Tyrone	7	Yes	Partial	Mangas Creek, groundwater contamination will require water treatment in perpetuity
Mineral Park	3	Yes		Groundwater aquifer and surface water
Miami	8	Yes		Pinal Creek alluvial aquifer
Silver Bell	3	Yes		Cocio Wash
Continental Pit	2	Yes		Silver Bow Creek, groundwater aquifer

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

CASE STUDIES:

MORENCI MINE, AZ (Freeport McMoRan) The Morenci Mining District is located in southeastern Arizona, near the towns of Clifton and Morenci. It is located near the Gila River, the San Francisco River and Eagle Creek.	
Reports of pipeline failures and other accidental releases*	<p>2008: Report of pipeline spill releasing 186,000 gallons of sulfuric acid and heavy metals into a tributary (Chase Creek) of the San Francisco River, resulting in a \$150,000 settlement with the State of Arizona.¹⁶ The highly acidic material traveled downstream more than 2 miles. The pollutants in the discharge exceeded Arizona surface water quality standards for copper, zinc and pH in Lower Chase Creek.</p> <p>2007: Report of release of 1,200,000 gallons of pregnant leach solution released due to power failure.¹⁷</p> <p>2006: Report of release of 3,000 pounds of sulfuric acid from pipeline break.¹⁸</p> <p>2006: Report of 1,127 pounds of material from PLS pipeline.¹⁹</p> <p>2006: Report of release of rich electrolyte (acid content 1,057 pounds) from an underground process pipeline.²⁰</p> <p>2004: Report of release of 8,920 pounds of sulfuric acid and water from process pipeline due to failure of valve.²¹</p> <p>2001: Report of release of 6,350 pounds of sulfuric acid released from pipeline.²²</p> <p>2000: Report of release of 72,000 gallons of sulfuric acid released from pipeline.²³</p> <p>1998: Report of release of 66,200 pounds of sulfuric acid released from pipeline.²⁴</p> <p>1996: Report of release of unknown amount of pregnant leach solution spilled from pipeline, affecting Chase Creek, leading to San Francisco River.²⁵ At the time of report, 20 gpm were being released.</p> <p>1996: Report of release of 160,000 gallons of process solution spilled due to pipeline weld failure.²⁶</p> <p>1996: Report of release of 50,000 pounds of sulfuric acid spilled due to backhoe hitting pipeline.²⁷</p> <p>1996: Report of 12,435 pounds of sulfuric acid released from pipeline.²⁸</p> <p>1995: Report of 2,980 pounds of sulfuric acid released from pipeline.²⁹</p> <p>1994: Report of 203,400 gallons of raffinate released due to ruptured pipe.³⁰</p> <p>1994: Report of 5,400 pounds of sulfuric acid released due to fractured weld in pipeline.³¹</p> <p>1993: Report of unknown amount of copper sulfate released into San Francisco River due to storm event.³²</p> <p>1993: Report of 180,000 gallons of pregnant leach solution spilled due to plugged drain line, affected 1 acre.³³</p> <p>1992: Report of 2,500 gallons of electrolyte released.³⁴</p> <p>1992: Report of 15,000 pounds of copper sulfate spilled due to valve failure.³⁵</p> <p>1992: Report of 7,500 gallons of electrolyte spilled due to failure of pipeline weld.³⁶</p>
Water collection and treatment failures	<p>In 2012, the U.S. Dept of Justice and the State of Arizona released a consent decree which found that “mine tailings exposed to air and precipitation released hazardous substances on the surface of the tailings or that can percolate through the tailings to groundwater.” The consent decree found that “releases of hazardous substances at or from the Morenci mine site have occurred and allege that such releases have caused injuries to natural</p>

	<p>resources at and in the vicinity of the site including surface water, sediments, soils, terrestrial habitats and terrestrial receptors.”³⁷</p> <p>A settlement followed an investigation of natural resource injuries related to the release of hazardous substances into the environment from acid mine drainage and process solution, among other sources.</p> <p>The investigation found that the main ore minerals are sulfide minerals, which have resulted in the development of acid mine drainage. According to the report, “Surface water has been, and most likely continues to be, exposed to hazardous substances released from the Morenci Mine through a variety of pathways.” Concentrations of hazardous substances measured in groundwater at the Morenci Mine and measured in the San Francisco and Gila Rivers downstream of the mine provide further indications that hazardous substances present in the source materials at the Morenci Mine have been released to the environment. The report found that “Concentrations of total and dissolved zinc have exceeded 1,000 ug/l in the Gila River and concentration of dissolved copper have exceeded 100 ug/l in the San Francisco River.” Contaminated groundwater is also released to surface water via seeps and springs.³⁸</p>
Tailings spills and impoundment failures	Failure to control seepage from tailings impoundment (see above).
Impacts to water, fish and wildlife	<p>In 2012, the US Department of Justice and Department of Interior have jointly announced that Freeport McMoRan has agreed to pay \$6.8 million to settle federal and state natural resource damages related to the Morenci Mine. According to the complaint, the hazardous substance release, which included sulfuric acid and metals, injured, destroyed or led to the loss of “surface waters, terrestrial habitat and wildlife, and migratory birds.”³⁹</p> <p>As described above, metals contamination occurred in the San Francisco and Gila Rivers downstream of the mine, and to groundwater supplies.</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

BINGHAM CANYON MINE and SMELTER, UT (Kennecott)
The Bingham Canyon Mine is the deepest open pit mine in the world, located southwest of Salt Lake City, Utah.

Reports of pipeline failures and other accidental releases*	<p>2011: Report of malfunction of equipment that allowed the release of approximately 145,424 gallons of copper tailings.⁴⁰</p> <p>2011: Report of pipeline overflow onto soil with estimated 100,000 – 290,000 gallons of copper tailings material released from pipeline.⁴¹</p> <p>2011: Report of tailings slurry released from tailings slurry hot box. 160,000 gallons of tailings released.⁴²</p> <p>2010: Report of a release of process water due to broken pipeline.</p> <p>2010: Report of a discharge of sulfuric acid from a pipeline in the precious metal plant released between 4,000-5,000 gallons.⁴³</p> <p>2007: Report of a release of 35,000 gallons of hydromet tails containing arsenic due to pipeline break.⁴⁴</p> <p>2007: Report of 1,240,000 gallons of process water containing arsenic from pipeline break due to cold temperatures.⁴⁵</p> <p>2006: Report of 270,000 gallons of process water released because of pump failure, which resulted in overflow of containment area.⁴⁶</p> <p>2006: Report of 660,000 gallons of process water containing arsenic released due to cracked pipe.⁴⁷</p> <p>2006: Report of 1,000,000 gallons of process water released from the Magna Reservoir due to a failed level indicator.⁴⁸</p> <p>2004: Report of 4,000,000 gallons of process water with arsenic from pipeline.⁴⁹</p> <p>2004: Report of 2,000,000 gallons of process water with arsenic from broken process water line.⁵⁰</p> <p>2004: Report of 202,000 gallons of process water released due to pipeline failure.⁵¹</p> <p>2003: Report of 70,000 gallons of process water with arsenic released due to pipeline failure.⁵²</p> <p>2003: Report of 70 tons of copper concentrate released from pipeline.⁵³</p> <p>2003: Release of copper concentrate, containing 340 pounds of arsenic, 20,000 pounds of copper, and 200 pounds of lead.⁵⁴</p> <p>2003: Copper concentrate pipeline ruptured, releasing 240,000 tons of copper, 428 tons of arsenic, 253 tons of lead.⁵⁵</p> <p>2002: Report of 5,800 gallons of process water from slag pot cooling area due to plugged drain line.⁵⁶</p> <p>2001: Report of tailings pipeline failure, releasing 4 pounds of arsenic, 14 pounds of chromium and 1 pound of lead.⁵⁷</p> <p>2000: Report of 110 tons of ore slurry released due to a leak in ore line.⁵⁸</p> <p>2000: Report of 18,000 tons of sulfuric acid released from pipe due to flange failure.⁵⁹</p> <p>1999: The process water pipeline sprung a series of leaks in 1989 and 1999. It has been estimated that 100 million gallons of process water with high arsenic levels spilled before the leak was discovered.⁶⁰</p> <p>1998: Report of copper sulfate released into a canal.</p> <p>1998: Report of clogged piping system causing pipe to back up and overflow releasing acid</p>
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	<p>rock drainage into water.</p> <p>1997: Report of settling pond overflow due to clogged outlet valve. Release of copper sulfate into water.</p> <p>1997: Report of pipeline rupture releasing process water (pH 2.5-4.0) into water.</p> <p>1993: Report of 45,000 gallons of wastewater spilled due to a rupture of the transfer line.⁶¹</p> <p>1991: Report of 30,000 gallons of industrial wastewater spilled at the wastewater treatment plant due to line break.⁶²</p>
Water collection & treatment failure	<p>2011: Noncompliance in April-June 2011 for discharges of copper, zinc and total suspended solids.⁶³</p> <p>Wastewater from the mine has escaped the site's collection system, contaminating groundwater with acid, metals and sulfates. The groundwater plume extends towards the nearby Jordan River and covers more than 72 square miles – rendering water for thousands of Salt Lake City residents undrinkable.⁶⁴ Water treatment in perpetuity will be required for contaminated groundwater as a result of failure to control seepage.⁶⁵ There have been multiple tailings spills.⁶⁶</p> <p>Drainage from the waste rock piles will require water treatment in perpetuity to prevent additional groundwater pollution.⁶⁷</p>
Impacts to water, fish and wildlife.	<p>In February 2008, the United States Fish and Wildlife Service took legal action against Kennecott for the release of hazardous substances from the mine's facilities, including selenium, copper, arsenic, lead, zinc and cadmium.⁶⁸ Groundwater contaminated by mine operations has been released from the mine site through artesian springs into areas that serve as fish and wildlife habitats. According to the federal biologists, the release of these hazardous pollutants has harmed natural resources, including migratory birds and their support ecosystems, which includes wetlands, marshes, freshwater wildlife habitats, playas and riparian areas and freshwater ponds.</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

RAY MINE and HAYDEN SMELTER, AZ (ASARCO)

The Ray Mine is a copper mining facility of approximately 6,100 acres near Kelvin, Arizona which discharges into Mineral Creek, a tributary of the Gila River, and the Hayden Facility is a smelting facility located in Hayden Arizona along the Gila River.

Reports of pipeline failures and other accidental releases*	<p>2012: Potable water line ruptured, which washed tailings into the Gila River.⁶⁹</p> <p>2007: A leak from a coupling in a tailings pipeline spilled tailings onto the banks and into the Gila River. A \$20,000 civil penalty was paid.⁷⁰</p> <p>2007: Report of 1,000 pounds of sulfuric acid spilled from pipeline.⁷¹</p> <p>2006: Report of 600 gallons of sulfuric acid spilled due to piping failure inside of mine.⁷²</p> <p>2000: Report of 80.95 pounds of copper sulfate released from basin/dam into Mineral Creek.⁷³</p> <p>2000: Report of 200 gallons of copper sulfate spilled from pipe.⁷⁴</p> <p>1999: Report of 33,000 gallons of tailings water released from pipeline.⁷⁵</p> <p>Between August 1988 and November 1997, 47 separate releases of hazardous substances into Mineral Creek from the Ray Mine were reported.⁷⁶</p> <p>According to a 2012 ecological risk assessment prepared by the State of Arizona, "A large portion of these releases were uncontained and eventually entered Mineral Creek and the Gila River. Hazardous chemicals released included copper sulfate, copper tailings and leachate." In addition, the report found that multiple groundwater wells downgradient of the Ray Mine were found to be highly contaminated by a common leachate solution which was attributed to releases to shallow groundwater along Mineral Creek, and it concluded that "it is likely that the hazardous substances present in shallow groundwater will represent an ongoing source of chronic contamination to Mineral Creek (Lipton 2009)."⁷⁷</p> <p>According to a report by the U.S. EPA, at least 19 spills of hazardous materials were reported at the Ray Mine from August 1990 through November 1993.⁷⁸ The majority of spills were from dams, pipelines, and ponds. The discharges typically resulted from either accidental discharges associated with heavy rain or from chronic seepage from leaching facilities into the ground water, which then entered the creek. The report found that, "surface water quality has been significantly affected." A total of 41 violations of total copper, dissolved copper, and beryllium numeric surface water quality standards were documented by the Arizona Department of Environmental Quality (ADEQ), EPA, and ASARCO in Mineral Creek below the Ray Mine.⁷⁹</p> <p>According to the report, "Arizona's Department of Game and Fish believes that the discharges from the Ray Unit have negatively affected both the water quality and the aquatic life of Mineral Creek. The Department conducted a biosurvey of Mineral Creek in July 1993. In a report dated September 30, 1993, the Department found that although the numbers and diversity of aquatic insects and fish were high above the Ray Unit, an almost complete absence of aquatic life at sampling stations was observed directly downstream of the mine."⁸⁰</p>
Water collection and treatment failures	<p>According to an EPA report, "The mine's routine operations are chronically affecting the quality of both surface and ground waters in the mine's vicinity."⁸¹ According to the report, the Arizona Dept. of Environmental Quality reported in 1996 that approximately one-half mile of the Mineral Creek streambed below the Ray Mine was visibly affected by mine activities. The streambed was coated with a blue-green layer of copper oxides.</p> <p>In April 1995, EPA reported that six ground water wells situated downgradient of the</p>

	<p>electrowinning plant and the electrowinning dam were continuously pumping PLS.⁸² Multiple groundwater wells were found to be highly contaminated by a common leachate solution which was attributed to releases by ASARCO into shallow groundwater along Mineral Creek. It concluded that it is likely that the hazardous substance present in shallow groundwater will represent an ongoing source of chronic contamination to Mineral Creek (Lipton 2009).⁸³</p>
Tailings spills and impoundment failures	<p>2012: Seepage from the tailings impoundment was released into two catch basins and into a tributary of the Gila River.⁸⁴ At the time of the report, seepage into the tributary was estimated at 75 gpm.</p> <p>2011: A report of 6,000-8,000 tons of copper ore tailings released from one of the tailings pond due to a breach in the dike.⁸⁵</p> <p>In 1993, heavy precipitation caused the Gila River to flood, and breach the AB-BC tailings impoundment containment dike.⁸⁶ According to a report by the U.S. EPA, "Continued flooding over the next several days resulted in a total of 13 separate breaches of the dike, three of which eroded through the dike and into the toe of the tailings pile. The total discharge was approximately 292,000 tons of tailings, which was about 216,000 cubic yards of material."⁸⁷ It also found that sampling of the river showed that elevated concentrations of pollutants occurred at least 11 miles downstream of the spill. The tailings formed bank and bottom deposits in the river, impairing both recreational uses and the quality of habitat for plants and animals.⁸⁸</p>
Impacts to water, fish and wildlife	<p>In April 2009, the Department of the Interior and the State of Arizona, acting as natural resource trustees (Trustees) received a monetary settlement and three parcels of land from ASARCO, L.L.C. through the Natural Resource Damage Assessment and Restoration (NRDAR) program to account for injuries to trust resources incurred through multiple releases of hazardous substances by ASARCO L.L.C. into Mineral Creek and the Gila River in Pinal County, Arizona.⁸⁹</p> <p>According to a 2012 ecological risk assessment by the State of Arizona, "The site of injury stretches from the Ray Mine and the Hayden Facility, to the Gila River from the Ashurst-Hayden Diversion Dam, upstream past the confluence of the San Pedro and Gila Rivers, and for a distance of 5 miles up each of those rivers beyond the confluence and to Mineral Creek from its confluence with the Gila River upstream to a point one mile above the Big Box Canyon Dam." The most substantial injuries occurred in the reach of Mineral Creek that extends from the tunnel outlet to the Gila River. The report finds that "Dissolved copper concentrations in the surface water of this reach have been recorded up to 130 times surface water quality standards that will sustain aquatic life, and sediment copper concentrations have been recorded to exceed up to 22 times the level beyond which injury is inflicted on sediment-dwelling organisms (MacDonald et al. 2000)."⁹⁰ These concentrations of copper caused a complete loss of aquatic life in this reach.</p> <p>Overall, the report found that "ecosystem services lost in the 117 acres that include Mineral Creek and its associated riparian habitat were estimated to be 100% from 1981-2005, and up to 50% from 2005 to the present (Lipton 2009). Hazardous releases also affected the aquatic and riparian portions of the Gila River near the Ray Mine/Hayden Smelter Complex, including approximately 2,930 acres upstream of Mineral Creek to the confluence with the San Pedro River, and approximately 1,620 acres downstream of Mineral Creek to the Ashurst-Hayden Dam. The most substantial loss of ecosystem services in these areas occurred during the three years following the release of 300,000 tons of tailings in 1993, when ecosystem service losses were estimated at 10-25% (Lipton 2009)."⁹¹</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

CHINO MINE, NM (Freeport McMoRan)

The Chino Mine is located approximately 12 miles southeast of Silver City, New Mexico. The site is east of the Continental divide and drains into ephemeral drainages in the Mimbres watershed.

Reports of pipeline failures and other accidental releases*	<p>2007: A spill involving one million gallons of acidic mine waters overflowed a containment sump into a storm water diversion channel and traveled more than two and a half miles down a surface water tributary near the mine. The spill resulted in groundwater contamination and a settlement of \$276,000 was reached with the State of New Mexico.⁹²</p> <p>Multiple other tailings spills have occurred, which are listed below:⁹³</p> <p>2000: Report of 480,000 gallons of tailings slurry discharged, with 93,000 gallons entering Whitewater creek.</p> <p>1999: Report of 3.25 million gallons of tailings spilled into Whitewater Creek.</p> <p>1997: Report of 100,000 gallons of tailings spilled into Whitewater Creek.</p> <p>1996: Report of 152,000 gallons of liquid tailings spilled into Whitewater Creek.</p> <p>1993: Report of 208 tons and 91,500 gallons of tailings accidentally released to Whitewater Creek in six separate incidents resulting from the rupture of degraded pipes.</p> <p>1992: Report of 120,000 gallons of tailings spilled into a basin.</p> <p>1991: Report of 3,200 gallons of tailings released into Whitewater Creek when a tailings pipeline ruptured.</p> <p>1988: Heavy rains led to the release of 180 million gallons of acidic wastewater into Whitewater Creek over a 35-day period. Analysis of the wastewater indicated that it had 30 times the allowed levels of the hazardous substance cadmium, as well as more than 30 times the allowed levels of sulfates.⁹⁴</p> <p>1986: Report of 16,200 gallons of acidic water spilled.</p>
Water collection and treatment failures	<p>In 2011, the U.S. Department of Justice and State of New Mexico issued a consent decree for damages to natural resources from hazardous substances from the Chino, Tyrone and Cobre mines.⁹⁵ The settlement followed an investigation of natural resource injuries related to the release of hazardous substances into the environment from acid mine drainage and process solution, among other sources.</p> <p>It found that “surface water and associated sediments are exposed to hazardous substances released from the Chino Mine through a variety of pathways, including leaks and spills of process water, tailings spills; runoff, and infiltration or percolation from tailings and waste stockpiles. Sampling at the Chino mine has indicated ongoing exposure of ephemeral surface water to hazardous substances.”⁹⁶</p> <p>It also found that “hazardous substances have been released into groundwater at the Chino mine from multiple source areas. Concentrations of hazardous substances in groundwater in exceedance of water quality standards confirm release to groundwater throughout the Chino Mine. In the South Mine area, groundwater has exceeded standards for manganese and cadmium at Middle Whitewater Creek, Hurley and Lake One, and has exceeded standards for copper at Lake One. Groundwater flow modeling for the North Mine area indicates that contaminated groundwater in four of these areas is not captured by dewatering in the main pit.”⁹⁷</p> <p>Tests demonstrated that the hazardous substances cadmium, cobalt, copper, manganese, and selenium had leached from the source material to groundwater at concentrations in excess of the State of New Mexico groundwater standards for human health and domestic water supply.⁹⁸</p>

	A 2012 assessment of groundwater impacts, concluded that contaminated seepage from the mine will require water treatment in perpetuity. ⁹⁹
Tailings spills and impoundment failures	Tailings spills (see above).
Impacts to water, fish and wildlife	<p>The 2003 ecological risk assessment reported elevated concentrations of the hazardous substances copper and zinc in surface water from five different drainages at the Chino Mine, including Hanover/Whitewater Creek, Bayard Canyon, Bolton Draw, the unnamed drainage between Bolton Draw and Lampbright Draw and Lampbright Draw.¹⁰⁰</p> <p>The areal extent of injured alluvial and regional groundwater at the Chino Mine is 13,935 acres.¹⁰¹</p> <p>According to the closure plan for the Chino Mine, roughly a half billion gallons of acid and metals contaminated groundwater will require water treatment in perpetuity.¹⁰²</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

BAGDAD MINE, AZ (Freeport McMoRan)

The Bagdad Mine is an open pit copper and molybdenum complex 100 miles northwest of Phoenix, Arizona.

Reports of pipeline failures and other accidental releases*	<p>2009: A report of a broken pipeline causing a release of 2,378,500 gallons of sulfuric acid.¹⁰³</p> <p>2007: a report of 22,500 gallons of raffinate solution containing sulfuric acid spilled from a pond.¹⁰⁴</p> <p>2004: A report of 7,484 pounds of sulfuric acid released due to malfunction of pipe.¹⁰⁵</p> <p>2004: A report of 354 pounds of sulfuric acid released due to crack in pipe.¹⁰⁶</p> <p>1999: Report of 12,000 gallons of process water with residual chlorine spilled into Bridle Creek.¹⁰⁷</p> <p>1997: Report of 1,500 pounds of sulfuric acid due to pipeline failure.¹⁰⁸</p> <p>1997: Report of 7,200 pounds of sulfuric acid overflowed from pond due to drain blockage.¹⁰⁹</p>
Water collection and treatment failures	<p>In 1996, the EPA and the state of Arizona announced that Cyprus Bagdad Copper Corp., a subsidiary of Cyprus Mineral Corp., paid penalties totaling \$760,000 for discharging contaminated water from the Bagdad Copper Mine.¹¹⁰ The discharges involved various facilities including tailings ponds, leach dumps, and a sewage treatment plant, but by far the major discharges came from the Copper Creek Leaching Basin, in which acidic, copper-tainted underground seepage entered Boulder Creek.¹¹¹</p> <p>According to an EPA report, seepage of pregnant leach solution from the Copper Creek Leaching System was discovered in a receiving pool in Boulder Creek in 1991.¹¹² Studies indicated that instead of being contained by the Copper Creek Flood Basin, the heavily contaminated solution seeped under the dam. The concentration of total copper in samples collected in the pool in Boulder Creek were as high as 76.4 mg/l. On March 29, 1993, U.S. EPA issued a Finding of Violation and Order against Cyprus.¹¹³</p> <p>According to a 2006 study that compared the water quality predictions made during mine permitting with water quality impacts during operations, although no water quality impacts were predicted during the permitting process, the following water quality violations occurred: Water quality monitoring (1998-2002) in Boulder Creek, found water quality exceedences for arsenic, lead, mercury, and selenium. In Burro Creek, there were water quality exceedences for copper and mercury. In Butte Creek, there were water quality exceedences for mercury and selenium.¹¹⁴</p>
Impacts to water, fish and wildlife	<p>Copper and low pH releases to ground and surface waters, hazards to aquatic life from solution releases beneath and over containment system dam. Water quality impacts to Boulder Creek, Burro Creek and Butte Creek.</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

SIERRITA MINE, AZ (Freeport McMoRan)

The Sierrita Mine is an open pit copper and molybdenum mining complex 20 miles southwest of Tucson, Arizona.

Reports of pipeline failures and other accidental releases*	<p>2011: Report of 849 gallons of sulfuric acid spills from a pipeline leak.¹¹⁵</p> <p>2008: Report of 1,100 gallons of sodium hypochlorite spilled due to loose pipe.¹¹⁶</p> <p>2005: Report of 1,000 pounds of sulfuric acid from broken pipeline.¹¹⁷</p> <p>2005: Report of 8,058 pounds of sulfuric acid released from broken pipeline.¹¹⁸</p> <p>2003: Report of 8,722 pounds of sulfuric acid from cracked pipeline.¹¹⁹</p> <p>2002: Report of 39,375 pounds of sulfuric acid spilled from pipeline from separated flange.¹²⁰</p> <p>2001: Report of 1,209 pounds of sulfuric acid spilled from pipeline.¹²¹</p> <p>2000: Report of 5,350 gallons of leach solution spilled from pipe.¹²²</p> <p>1998: 160,000 gallons of mill tailings spilled into water due to overflow resulting from power failure.¹²³</p> <p>1998: Report of 40,000 gallons leach solution spilled from pipeline.¹²⁴</p> <p>1998: Report of 120,000 gallons of leach solution spilled from pipeline.¹²⁵</p> <p>1997: Report of 2,798 pounds of sulfuric acid spilled due to pipeline rupture.¹²⁶</p> <p>1997: Report of release of 8,000 pounds of sulfuric acid due to pipe joint failure.¹²⁷</p> <p>1996: Report of release of 3,000 gallons of sulfuric acid due to pipeline failure.¹²⁸</p> <p>1994: Report of another pipeline break allowed a discharge into Demetrie Wash of approximately 120,000 gallons of reclaim water.¹²⁹</p> <p>1994: Report of approximately 5,000 gallons of reclaim water were released as a result of a pipeline break.¹³⁰</p> <p>1993: Report of a leak in a pipeline transporting process water discharged approximately 200,000 gallons of a mixture of process wastewater and storm water run-off to an unnamed tributary of Demetrie Wash.¹³¹</p> <p>1993: Report of Cyprus Sierrita discharging approximately 2,700,000 gallons into the same wash as a result of another pipeline break.¹³²</p> <p>1993: Report of approximately 450,000 gallons released to the wash in October 1993 by a broken pipeline.¹³³</p>
Water collection and treatment failures	<p>From the summer of 1992 until December 1994, Sierrita discharged contaminated process water and storm water run-off to Demetrie Wash and its tributaries from various overflows, seepages, and pipeline leaks and breaks.¹³⁴</p> <p>On March 25, 1996, the U.S. Department of Justice issued a civil claim against Cyprus Sierrita on behalf of the State of Arizona and the United States pursuant to the Clean Water Act.¹³⁵ Cyprus Sierrita entered into a binding Consent Decree to pay a total civil penalty of \$88,000 for numerous violations.</p> <p>According to a 2011 report, seepage from an unlined tailings pond at Phelps Dodge's Sierrita mine has sent a plume of contaminated groundwater toward the city of Green Valley, causing drinking water wells to record high levels of sulfates.¹³⁶ In 2006, the company signed a mitigation order on consent with the State of Arizona to address sulfate in drinking water. It requires the company to develop a mitigation plan to be submitted in 2009.</p>

Impacts to water, fish and wildlife	Ground water and surface water contamination have occurred from pipeline leaks and breaks, overflows, and underground seepage from process wastewater, wastewater, and storm water surface impoundments. Drinking water wells have been affected.
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*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

PINTO VALLEY MINE, AZ (BHP Billiton) The Pinto Valley Mine is an open pit copper and gold mine located about 126 km east of Phoenix, AZ. Formerly owned by Magma Copper Company.	
Reports of pipeline failures and other accidental releases	<p>2010: A storm event caused 5,362 tons of tailings spilled to soil and Pinto Creek, including 214 pounds of arsenic and 11 pounds of lead.¹³⁷ 500 cubic yards were released into water. Pinto Creek is a tributary to Roosevelt Lake.</p> <p>2010: Report of an unknown amount of mine tailings released onto land, with a potential release to water, due to heavy rains.¹³⁸</p> <p>2001: Report of 1,725 pounds of sulfuric acid released due to pipeline break.¹³⁹</p>
Water collection and treatment failures	<p>A portion of Pinto Creek from its headwaters to Spring Creek was first listed as water quality limited in 1992 (ADEQ, 1992) based on elevated copper concentrations and pH values that were related to discharges from the Pinto Valley and Gibson Mines. The remaining portions of the stream were added to the 303(d) list in 1994 (ADEQ, 1994).¹⁴⁰</p> <p>Since 1989, extreme storm events caused releases of copper bearing sediments and liquids to Pinto Creek from Pinto Valley operations. These releases resulted from partial tailings dam failures, pipeline breaks, seepage flows, conveyance blockages, and storm water overflows. Recent significant release events occurred in August 1989, July 1990, January 1991, August to September 1991, January to February 1993, and October 1997. In each of these events, materials were released in quantities sufficient to impact Pinto Creek or its tributaries.¹⁴¹</p> <p>Based on EPA's review of discharge monitoring reports between January 1990 and September 1991, Magma (now Pinto Valley) reportedly discharged effluent to Pinto Creek or its tributaries in excess of allowable effluent limitations on numerous occasions, and/or did not collect and analyze samples, in violation of permit conditions.¹⁴²</p> <p>During the first episode, a total of approximately 3,000 gallons of effluent containing total suspended solids and copper of unknown concentrations was discharged from the ditch. A similar discharge of 24,000 gallons occurred on September 5, 1991. An estimated 39,000 gallons of effluent in exceedance of Arizona Surface Water Quality Standards and Aquifer Water Quality Standards for copper, zinc, and lead were discharged from the ditch on September 23, 1991.</p>
Tailings spills or failures	<p>In 1997, a partial tailings failure deposited an estimated 276,000 cubic yards of tailings in Pinto Creek.¹⁴³ It buried 8.1 acres of creek bed and surrounding upland with material as deep as 42 feet.¹⁴⁴</p> <p>Another incident occurred in 1993, when heavy rainfall overwhelmed the mine's water management capabilities. During the rainfall event, a reservoir overflowed the tailings pile, tore out a levee, and carried tailings to Pinto Creek.¹⁴⁵ In addition, a retention pond that held storm water and mineral wastes from the mine's acidic leaching process discharged material into the creek after its dam was breached. According to an EPA report of the incident, "Critical water containment structures in place at the mine in 1992 were reportedly designed to hold a 100-year, 24-hour storm event. Nonetheless, the mine discharged hundreds of tons of tailings and millions of gallons of contaminated water into Pinto Creek."¹⁴⁶ Water quality sampling during January and February 1993 indicated 286 exceedances of daily and monthly water quality parameters. Fish surveys collected before and after the discharges showed a marked decline in populations of the desert sucker (<i>Pantosteus clarki</i>) following the discharges. Though abundant in 1992, a summer survey in 1993 found only one adult in Pinto Creek. Several months later, a small number of young were found.¹⁴⁷</p> <p>On January 4, 1991, the face of Tailings Dam No. 3 failed, allowing 150 to 250 tons of</p>

	<p>tailings to enter Pinto Creek.¹⁴⁸ The tailings discharge was accompanied by approximately two million gallons of water, which were released over a period of 16 hours.</p> <p>Beginning on March 1, 1991, another large quantity of tailings was released from the same pile.¹⁴⁹ This release occurred from an over-saturation of the tailings face benches due to heavy precipitation. An estimated 3.4 million gallons of water also were discharged.</p>
Impacts to water, fish and wildlife	Extensive impacts to surface water quality and fish habitat in Pinto Creek resulting from tailings spills, and other mine related impacts.

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

MISSION COMPLEX MINE, AZ (ASARCO)

The Mission Mine complex is an open pit copper mine and underground copper mine located near Sahuarita, Arizona (18 miles south of Tucson). The Mine covers approximately 29.7 square miles, and a portion of the mine occupies tribal lands.

Reports of pipeline failures and other accidental releases*	<p>2011: Report of a backup of a tailing line resulting in release of tailings into a dry wash.¹⁵⁰</p> <p>2002: A violation involving the discharge of primarily copper laden stormwater runoff and process water discharge to ephemeral tributaries of the Santa Cruz river near Tucson in violation of the facilities. Multi Sector General Permit Case # 09-2002-0064.</p> <p>2001: Report of a 36-inch distribution tailings line releasing 200 tons of tailings into a dry stream channel.¹⁵¹</p>
Water collection and treatment failures	<p>According to EPA fact sheet released in 2008, discharges from mine (outfall 001A) contain significant levels of copper and lead, and TSS, which have been out of compliance since October, 2003.¹⁵² Outfalls from the Mission complex discharge to ephemeral streams that are tributaries to the Santa Cruz River.</p> <p>Three large tailings ponds and several mine dumps are located on land leased from the Indian landowners approximately 1 mile south of the Arroyos project area. Leachate from these tailings has contributed to elevated levels of sulfate, TDS, and hardness in the aquifer below and adjacent to the ponds.¹⁵³</p>
Tailings spills or impoundment failures	<p>Surface drainage from a break in a tailings pond dike in 1990 released large volumes of material into wash complexes that drain toward the SCR.¹⁵⁴</p>
Impacts to water, fish and wildlife	<p>Ground and surface water pollution.</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

ROBINSON MINE, NV (Robinson Nevada Mining Co.) Formerly owned by BHP Copper, Magma Nevada Mining Company The Robinson Mine is an open pit copper and gold mine located in eastern Nevada approximately 11 km west of Ely, Nevada.	
Reports of pipeline failures and other accidental releases*	1996: The mine experienced eight reported spills during 1996. Most of these spills involved tailings solution and reclaim water releases do to equipment failures. The five spills resulting in releases of copper flotation tailings had spill volumes ranging from 1,500 gallons to 66,000 gallons. Four of these spills resulted in contamination of relatively small areas of soil. The largest spill resulted in contamination of a downstream drainage bed for 2.3 miles with an average flow path width of 3 ft. Two spills resulted in a combined release of 76,000 gallons of reclaim water. ¹⁵⁵
Water collection and treatment failure	In 2010, the State of Nevada issued a Finding of Alleged Violation and Order for the failure to comply with permit and regulatory requirements regarding stabilization of spent ore and associated acid rock drainage at the Intera and Green Springs area. ¹⁵⁶ The Order requires the mine to “submit a plan by May 11, 2010 stating whether the Mill-Water Ponds, the overhead standpipe near the Mille-Water Ponds, and any other leaking pipes or tanks in the area, will remain on the Liberty Dump or be moved off the Liberty Dump (and any other potential sources). If the Mill-Water Ponds will remain on the Liberty Dump, specify whether they will be replaced, or tested and repaired to demonstrate integrity of primary and secondary liners. If the ponds will be tested and repaired to demonstrate integrity, include a complete description of the proposed methods to be used for NDEP review and approval.”
Tailings spills and impoundment failures	Tailings spill (see above)
Impacts to water, fish and wildlife	Contamination of downstream drainage bed for 2.3 miles from mine tailings process water. (See above)

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

TYRONE MINE, NM (Freeport McMoRan)

The Tyrone Mine is located approximately 10 miles southwest of Silver City, New Mexico.
The mine straddles the Continental Divide.

Reports of pipeline failures and other accidental releases*	<p>2006: Report of a spill occurring when a CTI tanker truck loaded with about 3,000 gallons of acid collided with a pickup truck, spilling about 500 gallons of the acid on the highway and adjacent property.¹⁵⁷ (non pipeline)</p> <p>2003: Report of approximately 2,600 gallons of 16% sulfuric acid solution spilled at the Tyrone mine during maintenance activity on a pipeline system.¹⁵⁸</p> <p>2001: Report of 500-1000 gallons of solution leaked from the pipeline.¹⁵⁹</p> <p>2001: Report of 300 gallon spill of raffinate and organic solution from pipeline.</p> <p>2001: 150 gallons from the Seep 5# pond overflowed with 75 gallons entering Deadman Canyon. Seepage had a pH of 4 and Deadman Canyon was flowing at approximately 50 gpm at the time.¹⁶⁰</p> <p>1997: Report of 65,000 gallons of raffinate leaked from a ruptured weld in a raffinate pipeline.¹⁶¹</p> <p>1997: Report of a transfer line rupture due to cold weather.</p> <p>1994: Report of No. 2 diesel fuel oil from two broken pipes detected in groundwater.¹⁶²</p> <p>2012 report identifies diesel fuel contaminant concentrations in groundwater from a leak in distribution pipeline at diesel tank farm, which migrated to regional aquifer.¹⁶³</p>
Water collection and treatment failures	<p>In 2011, the U.S. Department of Justice and State of New Mexico issued a consent decree for damages to natural resources from hazardous substances from the Tyrone, Chino, and Cobre mines.¹⁶⁴</p> <p>The settlement followed an investigation of natural resource injuries related to the release of hazardous substances into the environment from acid mine drainage and process solution, among other sources.¹⁶⁵ According to the investigation, "groundwater in both the regional aquifer and the perched groundwater aquifers at the site have been exposed to hazardous substances through a variety of pathways." The Supplemental Groundwater Study at the Tyrone Mine identified 14 different mine area sources that have affected water quality, including seepage from tailings impoundments, leach stockpiles and waste rock stockpiles.¹⁶⁶</p> <p>Test results showed that the hazardous substances arsenic, cadmium, copper, iron, lead, manganese, and zinc had leached into groundwater from the source material at concentrations in excess of State of New Mexico groundwater standards for human health and domestic water supply.¹⁶⁷</p> <p>A 2007 Closure Plan developed for the mine, estimates that 1 billion gallons of year of acid and metals contaminated seepage from the mine, will require water treatment in perpetuity.¹⁶⁸</p>
Tailings spills and impoundment failures	<p>There have been multiple spills of tailings, releasing hazardous substances.</p> <p>The largest event occurred at the No. 3 tailings dam in 1980, spilling 2.6 million cubic yards of tailings into the Mangas Valley.¹⁶⁹ Tailings flowed 8 kilometers downstream and inundated farmland.¹⁷⁰ The failure occurred due to a dam wall breach. Additional tailings spills were reported in 1990, 1992, and 2001. After the breach, tailings were removed from Mangas Creek, deposited in small canyons adjacent to the creek, and covered with alluvial material. However, inspections in 1989 and in 2001 noted that the reclaimed tailings area had eroded, removing the soil cover and exposing tailings.</p>

	<p>2001: 5 tons of tailings spilled into the Mangas Wash from the stormwater containment dike at the tailings dam.¹⁷¹</p> <p>1990: Minor tailings spills from the No. 1 tailings pond in January 1990, and similar minor spills from the No. 2 tailings pond during 1990.¹⁷²</p>
Impacts to water, fish and wildlife	<p>Streams and washes in the vicinity of the Tyrone Mine facility are ephemeral – they flow only after significant precipitation events.</p> <p>According to the 2003 preliminary assessment, “surface water is exposed to hazardous substances released from the Tyrone Mine through a variety of pathways. Mangas Creek, an ephemeral stream adjacent to the Mine, which becomes perennial at Mangas Springs has been exposed to hazardous substances through spills and potentially through runoff and erosion.”¹⁷³</p> <p>According to 2005 report, “fugitive PLS originating from leach stockpiles and impacted seepage originating from the waste rock pile have created perched zones of poor water quality beneath Brick Kiln Gulch and the upper and lower reaches of Oak Grove Wash. Perched PLS mixed with native water extends approximately 2 miles from the vicinity of the stockpile.”¹⁷⁴</p> <p>The areal extent of the contaminated groundwater plume at the Tyrone Mine is 6,280 acres.¹⁷⁵ Groundwater impacts are so severe that an estimated one billion gallons of mine seepage will require water treatment in perpetuity.¹⁷⁶</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

<p style="text-align: center;">MIAMI MINE, AZ (Freeport McMoRan; formerly owned by Phelps Dodge and Cyprus Amax Minerals) The Miami Mine is an open pit mine located 90 miles east of Phoenix, Arizona.</p>	
<p>Reports of pipeline failures and other accidental releases*</p>	<p>2011: Report of 1,600 pounds of sulfuric acid spilled from pipeline due to faulty weld.¹⁷⁷ 2009: Report of 1,000 pounds of sulfuric acid spilled due to pipeline break.¹⁷⁸ 2007: Report of a release of 9,450 pounds of sulfuric acid from pipeline.¹⁷⁹ 2001: Report of a release of 153 pounds and 6.4 pounds respectively of lead/arsenic from pipeline.¹⁸⁰ 2001: Report of a release of 2,070 pounds of acid plant blowdown from pipeline.¹⁸¹ 1997: Report of 10,000 gallons of copper sulfate due to overflow of tank.¹⁸² 1996: Report of 50,000 gallons of sulfuric acid due to tank failure.¹⁸³ 1996: Report of 8,995 pounds of sulfuric acid due to leaky pipe.¹⁸⁴</p>
<p>Water collection and treatment failures</p>	<p>The Pinal Creek drainage was designated a Water Quality Assurance Revolving Fund (WQARF) site by the Arizona Department of Environmental Quality in 1989 due to acidity and metals contamination in the alluvial aquifer. The WQARF program is the state equivalent of the Federal “superfund” program. The Miami Mine, inherited from the Cyprus Miami Mine (formerly the Inspiration Mine) is a member of the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) Site.¹⁸⁵</p> <p>The Pinal Creek site was listed under the Arizona Water Quality Assurance Revolving Fund program in 1989 for contamination in the shallow alluvial aquifers within the Pinal Creek drainage near Miami, Arizona.¹⁸⁶</p>
<p>Impacts to water, fish and wildlife</p>	<p>The Water Quality Assurance Revolving Fund (WQARF) program is the state equivalent of the Federal “superfund” program. The Miami Mine, inherited from the Cyprus Miami Mine (formerly the Inspiration Mine) is a member of the Pinal Creek Water Quality Assurance Revolving Fund (WQARF) Site.¹⁸⁷ The Pinal Creek drainage was designated a WQARF site by ADEQ in 1989 due to acidity and metals contamination in the alluvial aquifer.¹⁸⁸</p>

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

SILVER BELL MINE, AZ (ASARCO) The Silver Bell Mine is an open pit copper mine located on the southern edge of the Silver Bell Mountains.	
Reports of pipeline failures and other accidental releases*	2010: Report of 3,983 pounds of sulfuric acid released due to pipeline failure. ¹⁸⁹ 2006: Report of 90,000 gallon release of raffinate; a mixture of 5.5 grams per liter of sulfuric acid and various metals. The release was due to equipment failure of a 24-inch mining pipeline. ¹⁹⁰ 2002: Report of 242,000 pounds of process solution (with 1300 pounds of sulfuric acid) spilled due to power failure and overflow of solution pond. ¹⁹¹
Water collection and treatment failures	<p>In 2009, Silver Bell was fined \$170,000 for three spills totaling 340,000 gallons of wastewater containing sulfuric acid and heavy metals.¹⁹² Two of the spills are described as such: Between Nov. 6 and Dec. 11, 2006, 150,000 gallons of leach solution containing sulfuric acid and metals escaped from a leaking impoundment. And between Nov. 11 and Dec. 13, 2006 another 100,000 gallons of stormwater containing sulfuric acid and heavy metals escaped from a storage pit.</p> <p>During site inspections of the mine conducted in January and March 1993, the Arizona Department of Environmental Quality (ADEQ) observed water flowing in three unnamed washes below Silver Bell Mine.¹⁹³ Samples taken from the two streams flowing under the waste rock dump showed violations of standards for total selenium, with one stream also violating standards for dissolved copper. The water in one of these streams was intermittently flowing in the subsurface in parts of the streambed and resurfacing in other parts.¹⁹⁴ The third stream, which flows from the leach dump, showed a broader range of exceedances. In addition, concentrations of dissolved copper in this stream were several orders of magnitude greater than the concentrations in the other streams. Analyses showed violations of standards for four parameters, including pH, total zinc, total cadmium, and dissolved copper. The exceedances of surface water quality standards documented in the stream flowing to El Tiro Wash, which began flowing 420 feet below the PLS pond, are listed below. The applicable standard for dissolved copper in this stream is 0.69 mg/l, which was established by Arizona to protect aquatic life and wildlife based on an ephemeral stream with a hardness of 3,500 mg/l.¹⁹⁵</p>
Tailings spills and impoundment failures	Tailings spills (See below).
Impacts to water, fish and wildlife	According to a 2000 report on native fish populations by Pima County, "The loss of native fish along Cocio Wash is a good example of the potentially damaging effects that mining can have on aquatic ecosystems. Summer floods in July and August 1981 swept gray clay sediments from a Silverbell Mine tailings pond into the wash. BLM biologist Bill Kepner later reported, Our studies indicate that the Cocio Wash topminnow population is now extinct in that habitat due to recurrent mine spills and inundations by mine tailings... (Fonseca, 2000)." ¹⁹⁶

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

MINERAL PARK MINE, AZ (Mercator) Mineral Park is an open pit copper mine in the Cerbat Mountains near Kingman, AZ.	
Reports of pipeline spills and other accidental releases*	1996: Report of 150 - 200 gallons of sulfuric acid released from acid storage tank due to equipment failure. ¹⁹⁷ 1996: Report of 200 gallons of sulfuric acid released. ¹⁹⁸ 1996: Report of 1,100 gallons of sulfuric acid spilled. ¹⁹⁹
Water collection and treatment failures	<p>According to a 1995 report by the Arizona Geological Survey, water quality samples were taken of streamflow just below the Cyprus Mineral Park place and of mine water seeping through a dam at the southwest end of the tailings.²⁰⁰ Both samples showed extremely low pH values (3.2, 2.6), extremely high TDS values (5,549 and 6,625 mg/L) and extremely high sulfate contents (4,500 and 6,000 mg/L). According to the report, "the cadmium concentration of the stream flow just downstream of the Cyprus Mineral park Mine place is 75.4 times higher than the standard, copper exceeds the standard 51 times and zinc 17.2 times." It further states that, "The discharge from the tailings ran down the washes until about two years ago, when the dam around the tailings was built. In years with very heavy rains the water could eventually reach the Sacramento Wash."</p> <p>According to a 1999 EPA report, the Mineral Park Mine collected surface water samples from seven drainages and analyzed them for metals and radio-chemicals.²⁰¹ All of these drainages, except for Golden Eagle Spring, exceeded either the federal Maximum Contaminant Levels (MCLs) and or state guidelines for gross alpha or gross beta. According to the report, "ADEQ observed that surface water runoff emanating from the drainages in the mine area were affecting the water quality of the alluvial pediment." Data showed that the plume contained high levels of beryllium, cadmium, fluoride and nickel. The report further stated that, "the data show that TENORM is discharging from abandoned mine adits and is impacting surface water and that mining operations have impacted groundwater."</p> <p>A 2006 technical feasibility report commissioned by the company also describes a plume of contaminated groundwater migrating down-gradient from the mine.²⁰²</p>
Impacts to water, fish and wildlife	See above.

*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

CONTINENTAL PIT MINE, MT (Montana Resources)

The Continental Pit is immediately adjacent to the Berkeley Pit in Butte Montana, and was initially known as the East Berkeley Pit. The Berkeley Pit and Continental Pit are included within the boundaries of the Silver Bow Creek/Butte Area Superfund site, which was established in 1983. Mining in the Berkeley Pit was discontinued in 1982, and in the East Berkeley Pit (now the Continental pit) in 1983. Mining was resumed in the Continental Pit by Montana Resources in 1986.²⁰³ Because of their proximity, management of water and mine waste at the two mine sites are closely intertwined.

Reports of pipeline spills and other accidental releases*	<p>On January 28, 2009, an incident was reported to the Department involving a broken tailings line while crews were doing maintenance. The cause was attributed to a tailings line that was plugged with ice and a weld broke. The water was shut off within five minutes and no water left the site or reached state waters.²⁰⁴</p> <p>1992: Department records show an accidental release of 0.34 million gallons in August of 1992.²⁰⁵</p>
Water collection and treatment failures	<p>According to a 1994 report, the sources of groundwater contamination in the Butte Mine Flooding Operable Unit of the Superfund Site were identified as: the underground workings; the walls of the Berkeley and Continental Pits; mine water in the underground workings; waste rock and tailings piles near the Berkeley Pit; leaking solutions from the leach pad and the Weed/MR Concentrator areas; leaking solutions from the Yankee Doodle Tailings Pond; contaminated soils and alluvium, and sulfuric acid added to the underground mines for copper leaching. Sources of water containing hazardous substances include: 1) process solutions from the historic Weed Concentrator and the current MR Concentrator.²⁰⁶</p> <p>Montana Resources suspended mining in the Continental Pit from 2000-2003 due to rising electricity costs.²⁰⁷ During that time, about 7.5 billion gallons of water, or an average of 6 million gallons per day, went into the Berkeley Pit, to be combined with the highly acidic pit water already there. Montana Resources also diverted water from the Continental Pit into the Berkeley Pit for containment during their suspension. This contributed to increased water levels in the Berkeley Pit, and triggered the need to develop a water treatment plant to treat the contaminated water from the pit, which was rising to a critical level where contaminated pit water becomes an additional source of contamination to the surrounding aquifer and Silver Bow Creek. Under a consent decree with the State of Montana and US Department of Justice, a treatment plant was constructed and the mining companies are obligated to continue water treatment in perpetuity to prevent additional groundwater contamination.²⁰⁸</p> <p>Mine tailings from the Continental Pit mine are placed in the Yankee Doodle tailings impoundment, which also contains the mine waste from previous mining at the Berkeley Pit. The tailings impoundment is unlined, and seepage from the impoundment travels through faults and fractures into the Berkeley Pit. When mining ceases, seepage from the tailings impoundment will continue to contribute contaminated water to the Berkeley pit. As noted above, a consent decree requires contaminated water from the Berkeley Pit to be collected and treated in perpetuity.</p>
Impacts to water, fish and wildlife	<p>In addition to the groundwater issues described above, the following surface water impacts have also occurred: Silver Bow Creek is the main stream drainage within the Butte Mine Flooding portion of the Superfund site. Historically, Silver Bow Creek began at the Continental Divide and flowed through the area that is now the Berkeley Pit and the Montana Resources (MR) permitted mine area. Mining activity has completely eliminated this uppermost reach of Silver Bow Creek. The creek now originates at the confluence of</p>

	<p>Blacktail Creek and the Metro Storm Drain at the base of the Butte Hill.²⁰⁹ Surface water flow above the tailings pond is intercepted by the tailings pond and used as makeup water in the milling process. From the tailings pond to the MR Concentrator, the original Silver Bow Creek channel no longer exists. Surface water in the active mining area is controlled by a series of ditches and ponds which convey runoff and mine process water to various locations, including the Berkeley Pit, leach pads, and concentrator area (Figure 2). From the MR Concentrator to the confluence with Blacktail Creek, the former creek has been reconfigured and is known as the Metro Storm Drain.²¹⁰</p>
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*Limitations in the data for pipeline spills and other accidental releases make it difficult to determine, in some cases, whether water quality impacts resulted from the spill.

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