U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PRODUCTION AND DISPOSAL OF MILL TAILINGS IN THE COEUR D'ALENE MINING REGION, SHOSHONE COUNTY, IDAHO; PRELIMINARY ESTIMATES

by

Keith R. Long[1]

Open-File Report 98-595

[1]Tucson, AZ 85719

1998

ABSTRACT

The Coeur d'Alene mining region in northern Idaho has produced 34,300 metric tons of silver, 7,288,300 metric tons of lead, and 2,870,000 metric tons of zinc since the discovery of polymetallic veins in the region during the 1880s. This output accounts for 18, 17, and 6 percent, respectively, of the nation's production of silver, lead, and zinc. The total value of this metal production exceeds 26 billion in 1997 dollars. The Coeur d'Alene mining region is the largest silver-producing mining district in the world, exceeding even that of the Cerro Rico de Potosí district in Bolivia.

Due to the relatively low grade of many of the lead-zinc-silver ores mined, methods of concentration were introduced at the beginning of commercial mining operations in 1886. About 130 million metric tons of metal-bearing material was treated by various methods of concentration from 1886 to 1997, generating 109 million metric tons of mill tailings as a waste product. Until 1968, most mill operators disposed of mill tailings directly into the South Fork of the Coeur d'Alene River or its tributaries. After 1968, all mill tailings have been stored in tailings impoundments or returned to the mines for use as stope fill.

A preliminary accounting of the production and disposal of mill tailings shows that about 56 million metric tons of tailings containing 2,200 metric tons of silver, 800,000 metric tons of lead, and at least 650,000 metric tons of zinc were disposed of or otherwise lost into the Coeur d'Alene River or its tributaries. Another 13.2 million metric tons of tailings containing 400 metric tons silver, 200,000 metric tons lead, and at least 290,000 metric tons zinc were stockpiled along the floodplain of the Coeur d'Alene River, principally west of the town of Kellogg. The remaining production of mill tailings was either placed in one of several tailings impoundments, starting with that of the Bunker Hill & Sullivan Mining & Concentrating Co., west of Kellogg in 1928, or used as stope fill, beginning in 1949 at the Dayrock mine. These impoundments were typically built from, and built upon, older stockpiles of mill tailings.

Mitigation of fugitive mill tailings has been a major management issue in the region since the turn of the century. In 1904, two impoundments were built on the South Fork of the Coeur d'Alene River to contain mill tailings, one near the town of Osburn, the other near the confluence of Pine Creek and the South Fork, and a third impoundment built on Canyon Creek just above its confluence with South Fork. The Osburn and Canyon Creek dams were partly breached by flooding in 1917; the Pine Creek dam was breached in 1933. Meanwhile, mine and mill operators purchased pollution easements from property owners along the Coeur d'Alene River. By 1900, mill tailings had reached Lake Coeur d'Alene and had impacted as much as 25,000 acres of floodplain along the river. From 1932 to 1946, mine and mill operators dredged more than 15 million metric tons of tailings-contaminated sediments from the river at Cataldo Mission Flats, stockpiling recovered material on the floodplain. Many millions tons more of tailings were dredged from 1946 to the 1960s. Some of these tailings-contaminated sediments, along with tailings removed from the Central Impoundment Area at the Bunker Hill mine, were used to construct the road bed of Interstate 90, which follows the river valley.

Since 1900, some 6 million metric tons of tailings have been reclaimed from creeks and dumps for reprocessing. These operations recovered 149 metric tons of silver, 51,000 metric tons of lead, and 56,000 metric tons of zinc. Unknown quantities of tailings and tailings-contaminated sediments have been removed for such uses as railroad ballast, brick-manufacture, and fill. The amount of tailings and tailings-contaminated sediments remaining in the Coeur d'Alene River system cannot yet be determined.

INTRODUCTION

The Coeur d'Alene mining region in northern Idaho is one of the nation's most significant mineral producers, having yielded almost twenty percent of the silver and lead, and six percent of the zinc produced in the United States (Long and others, 1998). The total amount of metals produced from 1883 to 1997 include 34,300 metric tons of silver, 7,288,300 metric tons of lead, and 2,870,000 metric tons of zinc[1]. The total value of this metal production exceeds 26 billion in 1997 dollars. The Coeur d'Alene mining region is the largest silver-producing mining district in the world, including that of the Cerro Rico de Potosí district in Bolivia (Lockard and others, 1980).

Due to the relatively low-grade of many of the lead-zinc-silver ores mined, methods of concentration were introduced at the beginning of commercial mining operations in 1886. These milling operations produced large tonnages of mill tailings, the material remaining after crushing, grinding of the ore and separation of a significant portion of the economic minerals, as a waste product. During the first eighty-two years of mining and milling in the region, from 1886 to 1968, mill tailings were mostly disposed by dumping into the South Fork of the Coeur d'Alene River and its tributaries.

Mitigation of heavy metals-bearing, tailings-contaminated river sediments has been a management issue in the region since these sediments first reached farms and communities down river from the mines around 1900. Current management efforts seek permanent remediation of areas impacted by deposition of these tailings. The amount of tailings released, and the amount of metals contained in these fugitive tailings, has not been adequately determined. This study provides a preliminary estimate, based on the most comprehensive data on mineral production in the district collected to date. Results of this study are preliminary because additional data on mine and mill production prior to 1900 may be forthcoming which might alter estimates of production during the early period of mining in the region.

LOCATION

The Coeur d'Alene mining region covers the watershed of the South Fork of the Coeur d'Alene River and parts of the North Fork watershed, including Prichard, Eagle, and Beaver Creeks, in Shoshone County, northern Idaho (Figs. 1 and 2). The region comprises the officially-designated and contiguous Beaver, Coeur d'Alene, Eagle, Evolution, Hunter, Placer Creek, Summit, and Yreka mining districts. These mining districts are often collectively referred to as the Coeur d'Alene mining *district*, but to avoid confusion with the officially-defined district of that name, which is one of the smaller and least-significant in terms of production in the region, these districts will be collectively referred to as the Coeur d'Alene mining *region*.

The area impacted by tailings discharged into the South Fork of the Coeur d'Alene river extends downstream from the mining region along the river to Lake Coeur d'Alene. Most of this section of the Coeur d'Alene River system lies within Kootenai County, Idaho. Evidence has been found that tailings have moved beyond Lake Coeur d'Alene into the Spokane River along a reach that extends beyond the city of Spokane (Matuszak and others, 1996).

PREVIOUS ESTIMATES OF TAILINGS PRODUCTION

The earliest estimate of tailings released into the river was provided by the U.S. Bureau of Mines (1932) in a study on behalf of local governments. The study authors estimated that

[1] Metal production compiled by author from U.S. Bureau of Mines Minerals Yearbooks.

1.5 million short tons (1.4 million metric tons) of tailings had been disposed of into the Coeur d'Alene River up to 1930. A Bureau of Land Management study (Weston, 1989) gives a figure of 72 million short tons (65 million metric tons) of tailings, larger than the 56 million metric ton estimate of this study.

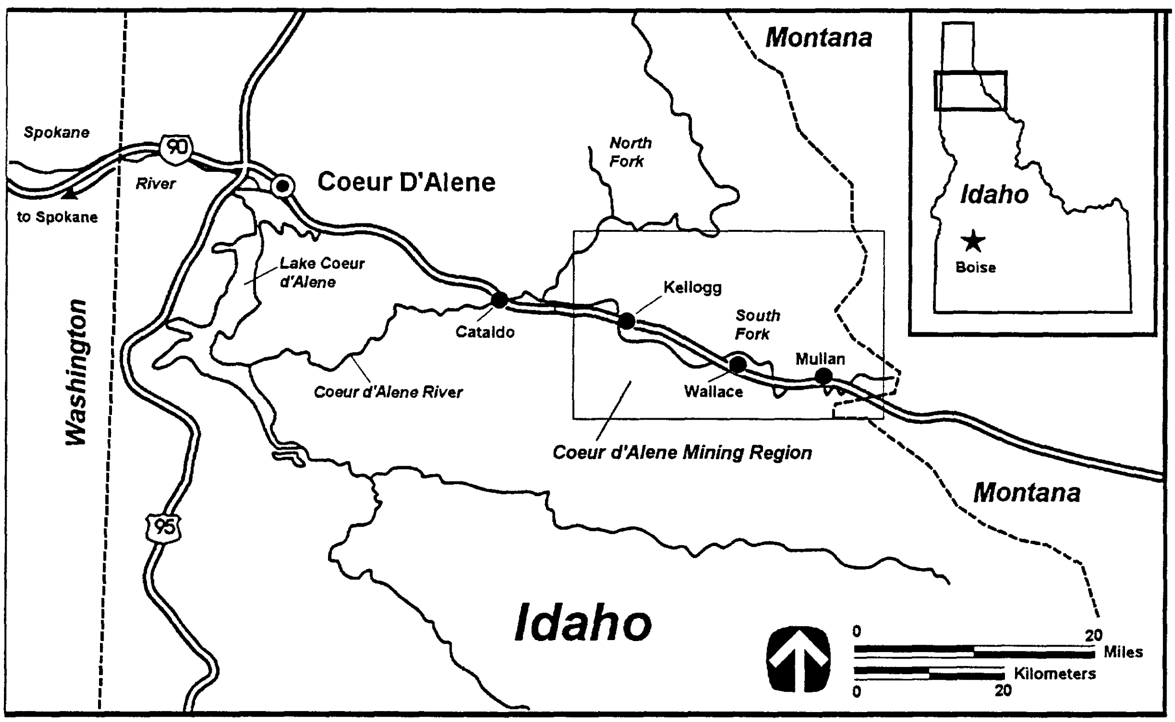

Figure 1. Map showing the location of the Coeur d'Alene mining region in relation to the Coeur d'Alene River and Lake Coeur d'Alene, northern Idaho.

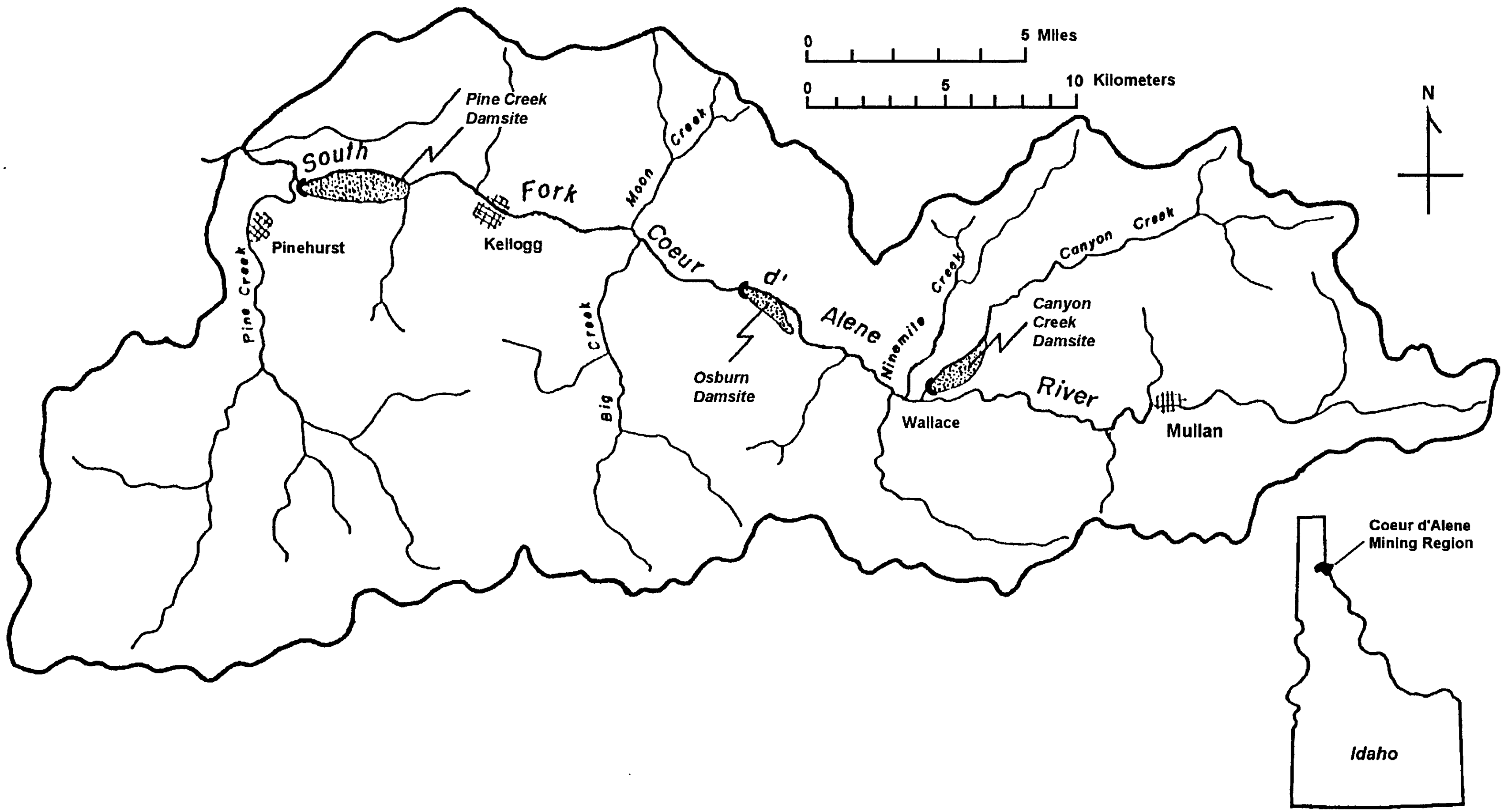

Figure 2. Map of the Coeur d'Alene mining region showing the location of tailings dams and impoundments (stippled) built in 1904.

SOURCES OF DATA

The estimates of tailings production and disposal reported here are based on an exhaustive compilation of production data for every mine and mill in the Coeur d'Alene mining region from all sources available to the U.S. Geological Survey. The primary source of data are production records maintained by mine and mill operators. These records take many forms, but generally follow standard industry practice of keeping a daily record of amount of ore treated, metal assays of ore treated, amount of concentrate produced with assays, and amount of tailings produced, with assays. Records were usually kept in large ledger books known as bullion books. Quality of record keeping varied widely. Larger mines operated by larger companies kept detailed, professional records based on reasonably accurate weighing of material treated, automatic mechanical sampling and reliable assaying of material sampled, with proper attention to accurate assaying of tailings produced. With such record-keeping, operators could effectively monitor mill performance and seek ways to improve metal recovery in concentrates. Many smaller operators lacked equipment for weighing and automatically sampling material delivered to mills, and assayed tailings infrequently. From such records, accurate calculation of the amount and metal content of tailings is not possible, although reasonable estimates may be made.

At the present time, the only operator's records available to the U.S. Geological Survey are those of Day Mines, Inc. and the Bunker Hill & Sullivan Mining & Concentrating Co. held by the University of Idaho Library, and those of the Anaconda Copper Co. held by the International Archive of Economic Geology at the University of Wyoming. The principal source of production data for other operators are records of production reported by operators to the U.S. Geological Survey from 1901 to 1931, and then to the U.S. Bureau of Mines from 1932 to 1997, as part of an annual voluntary survey of domestic mine production. Individual mine operator's production, reported under this survey, are held in the strictest confidence. However, in the case of mines in the Coeur d'Alene mining region, these data have been previously released with operators consent (Mitchell and Bennett, 1983). For this study we have used records from 1901 to 1977. Records of production after 1977 were obtained from annual reports and Securities and Exchange Commission Form 10Ks of the companies operating mines in the Coeur d'Alene mining region.

Another valuable, secondary source of data are annual reports to stockholders, prospectuses, annual filings with the Securities and Exchange Commission, and other reports published or released by publicly-owned companies operating in the region. Production data have also been found in the published mining engineering literature, including reports of the U.S. Bureau of Mines and articles in various mining trade journals. Of some use are records of the Shoshone County Assessor's Office which collects a net proceeds tax on ores and concentrates produced in the region. Other data have been found in contemporary press reports, mainly in mining trade journals and local newspapers.

From these various sources, a complete record of production for each mill was compiled for the years 1901 to 1997. Determining the amount of tailings produced and their metal content in this period is largely a computational exercise. The only estimation required was that of head grades for smaller mines in the years prior to 1940. Only an incomplete record could be compiled for the years 1886 to 1900. Much of what we know about individual mill production in that period had to be reconstructed from contemporary press reports. Estimates of mill production in this period have large uncertainties, partly compensated by the relatively small scale of production at the time. However, recovery of lead and silver in concentrates was as low as forty percent at the time, and no attempt was made to recover zinc. Hence, these early-day tailings were a major source of metal contamination. The quality of these estimates are a major concern to this study, and efforts are underway to acquire more data to improve these estimates.

Tailings disposal methods for each mill was determined through research into the history of mining and milling in the region. Larger mills are generally well described in the mining engineering literature. Such descriptions generally comment on tailings disposal methods. Other information was found in court records in litigation over harm caused by disposal of tailings into local rivers, contemporary press reports, historical studies of the district, unpublished engineers and geologists reports, and other sources. The history of the district is, in general, well documented. A running chronicle of events, mine-by-mine, may be found in the series Mineral Resources of the United States from 1902 to 1931, renamed Minerals Yearbook from 1932 to the present (U.S. Geological Survey, 1902-1923; U.S. Bureau of Mines, 1924-1997), and in annual reports of the Idaho State Mine Inspector from 1898 to 1974 (Idaho State Mine Inspector, 1898-1974).

HISTORY OF TAILINGS MANAGEMENT

Tailings disposal is a basic issue in mine design, in particular for determining the location of a mill (Wiard, 1915). By the late 19th century, mill engineers had recognized that improvements in mineral processing technology would make it possible to profitably reprocess old mill tailings. Storage of tailings for future retreatment was considered good engineering practice (Richards and others, 1940). Unfortunately, topography in the Coeur d'Alene mining region made it impossible for many mill operators to even consider stockpiling mill tailings. Suitable locations for the construction of tailings impoundments were few, and only a few companies, such as the Bunker Hill, were able to secure title to those locations.

The decision on where to locate a mill for the Black Bear mine around 1890 is a good example of the limited choices available to early day mill operators. An engineer's report (Bennett, no date) reveals that company officers and engineers desired a site with sufficient space to store mill tailings. The site would also have to have an adequate supply of water and be conveniently located for the transport of ore from the mine. Apparently, no site could be found that met all these criteria and the company built its mill adjacent to the mine on Canyon Creek where tailings were disposed of (Magnuson, 1968). In the same report, it was noted that the Hercules mill had limited space for storing tailings, the operators having chosen to only stockpile sand-size jig tailings and dispose of slimes into the Coeur d'Alene River.

River disposal of tailings had immediate consequences that mill operators could not ignore. Diminished flow of water in some creeks during dry season forced some mills to shut down until the next storm flushed accumulated tailings out of the channel immediately adjacent to the mill or until surface rights for storage of tailings could be obtained (Tamarack & Custer Consolidated Mining Co., 1913). Mills downstream from other mills sometimes had to remove slimes and sewage from their intake water before it could be used to process ore. The large quantities of tailings accumulating in stream channels presented opportunities, however. Tailings were used to pave the streets of Wallace and a company was formed in 1904 to make bricks from tailings (Engineering and Mining Journal, 1904). The two railroads in the district apparently used tailings as ballast (Handy, 1919).

Early day mills used jigs and vibrating tables to separate galena from other minerals in the ore and produce a saleable lead concentrate. Tailings from these mills were of two types: (1) jig tailings, which were sand-size particles that would accumulate in large piles along the creeks in which they were disposed; and (2) slimes, which were very fine-grained, sub-silt sized tailings that would travel much further downstream than jig tailings. Many mills retreated these slimes using buddles or vanners prior to slimes disposal. Metallurgical efficiencies for these early mills could be quite poor by modern standards. Lead recoveries were as low as forty percent and no attempt was made to recover zinc. Early day tailings consequently were quite high in lead and zinc content, sometimes approaching ten percent for each metal.

The first reports of tailings damaging farmland west of the Coeur d'Alene mining region appear about 1900. Casner, 1991, gives a detailed history, a few salient points being repeated here. In 1903, a series of lawsuits by farmers against the mining companies resulted in the Mine Owners Association purchasing pollution easements to 11,000 acres of land and building three tailings impoundments (Fig. 2), behind the Osburn, Canyon Creek, and Pine Creek[2] wooden-plank dams. These dams were used to impound tailings from 1904 until the flood of 1917, which caused a partial failure of the Canyon Creek and Osburn dams. The Pine Creek dam was destroyed by flood in May, 1933 (Ioannu, 1979). As these impoundments had already been filled, no attempt was made to repair the dams (Zeigler, 1947).

About 1905, the Bunker Hill & Sullivan Mining & Concentrating Co. began experimenting with reprocessing tailings from the dump north of its West mill. These tests led to the construction of the North mill in 1907 to process parts of the dump composed of sulfides in siderite gangue (Wiard, 1910a). Other parts of the dump composed of vein quartz or quartzite with finely disseminated sulfides required too fine a grind to liberate the ore minerals or was too low in grade to be economically treated at the time. With the introduction of flotation methods in the 1920s, treatment of the remaining tailings became possible (Zeigler, 1947).

An example of how tailings management issues were dealt with is offered by the Big Creek Mining Co. which began milling ore from what is now the Crescent mine on April 9, 1920 (Engineering and Mining Journal, 1920a). The company discharged slimes and tails directly into Big Creek, a tributary of South Fork, about a mile upstream from where the city of Kellogg obtained its water supply. The company was promptly sued by the city and local water company and enjoined by a district court from discharging tailings a few months later. (Engineering and Mining Journal, 1920b, 1920c). The company built a flume to convey tailings away from the creek and resumed mill operations (Engineering and Mining Journal, 1920d, 1920e).

By the 1920s, nearly every mill in the Coeur d'Alene mining region introduced flotation for the treatment of slimes, replacing vanners, and the recovery of zinc, based on experiments which began as early as 1910 (Rice, 1918). Eventually, it was found more economical to grind the ore very fine initially, and recover lead and zinc concentrated solely by flotation, eliminating the use of jigs and tables (Fahrenwald, 1927). A result of these changes in milling technology was the increased production of slimes and the loss to tailings of organic chemicals, such as pine oil, used as flotation reagents. The increased volume of slimes produced were carried much farther downstream, crossing Lake Coeur d'Alene and possibly reaching the Spokane River (Casner, 1991).

In 1928, the Bunker Hill & Sullivan Mining & Concentrating built the first tailings impoundment in the Coeur d'Alene mining region between its mills and the South Fork of the Coeur d'Alene River (Norman, 1977). This impoundment, built from old jig tails, was filled to capacity in 1956 and deactivated. A new impoundment was built just west of the old impoundment and used until 1965. The Idaho Department of Transportation dredged tailings from the old impoundment from 1962 to 1963 for use in building Interstate 90 through the Kellogg area. The area dredged was refilled with slimes through 1968. A

[2] Although called the Pine Creek dam, the dam was not located on Pine Creek but on the South Fork of the Coeur d'Alene river just above the confluence of Pine Creek and South Fork.

third impoundment was built from old jig tails to the east of the old impoundment from 1966 to 1967. In 1974, Bunker Hill began treating effluent from the impoundments that had previously been dumped directly into South Fork.

In 1930, the Jack Waite Consolidated Mining Co. built the second major tailings impoundment in the Coeur d'Alene mining region on Eagle Creek, a tributary to the North Fork of the Coeur d'Alene River. This impoundment was built in response to an injunction issued that year against disposal of tailings into Tributary Creek, a tributary of Eagle Creek (Engineering and Mining Journal, 1930a, b). The company purchased land at the confluence of Tributary and Eagle Creeks, building a new mill and a tailings dam. This tailings impoundment was reclaimed in 1981 by the U.S. Forest Service and the Idaho National Guard (Lockard and others, 1981).

The Federal Mining & Smelting Co. built embankments to impound tailings from the Page mine in 1939 in a swampy area on the west side of Smelterville Flats where tailings had been dumped since 1923 (Ioannou, 1979). This impoundment has since been used by the Environmental Protection Area to store wastes recovered during cleanup at the Bunker Hill Smelter Superfund site, and is presently the site of the sewage treatment plant for the city of Kellogg.

In response to public concern and official investigations, the Mine Owners Association installed a suction dredge at Cataldo Mission Flats to remove tailings from the river and dispose of it on the floodplain (Casner, 1991). The dredge began operations in July, 1932 and continued until mandatory tailings impoundment began in 1968. More than 15 million metric tons of tailings were dredged up to 1946 (Engineering and Mining Journal, 1946). During the 1960s, much of these tailings were used to build the road bed for Interstate 90 through Mission Flats (Casner, 1991).

During World War II, several projects were undertaken to reprocess tailings at several places in the Coeur d'Alene mining region. From 1940 to 1946, about 5,600,000 short tons of material was processed with an average recovery of about 65 percent of the silver, 50 percent of the lead, and 75 percent of the zinc contained in the tailings reprocessed (Zeigler, 1947). Tailings from the reprocessing operations were either returned to the same tailings dumps being retreated or dumped into the South Fork of the Coeur d'Alene River. Since 1900, a total of 6 million metric tons of tailings have been reclaimed from creeks and dumps for reprocessing. These operations recovered 149 metric tons of silver, 51,000 metric tons of lead, and 56,000 metric tons of zinc (Mitchell and Bennett, 1983).

In 1949, Day Mines, Inc. mine introduced a new method of tailings disposal to the Coeur d'Alene mining region at the Dayrock mine, using the sand-size fraction of tailings to backfill stopes within the mine (Farmin and Sparks, 1951). Similar systems were installed at the Galena mine in 1954 (Visnes, 1957), the Star mine in 1959, the Lucky Friday and Sunshine mines in 1960 (Featherstone, 1963; Mining World, 1963), and the Bunker Hill mine in 1961 (Park, 1962). These systems typically recovered about 50 to 55 percent of the tailings for use as stope fill. The remainder of the tailings, consisting mostly of slimes, was disposed of in the usual fashion.

In 1968, mill operators were required to impound all tailings (Williams, 1973). Tailings impoundments were built at all the surviving mills and some are in use up to this day. Some mining wastes are still being discharged into the Coeur d'Alene River under an Environmental Protection Agency Permit that allow the release of up to 5 metric tons of lead a year (Horowitz and others, 1993).

ESTIMATION OF TAILINGS PRODUCTION

With sufficient information, the production of tailings and their metal content may be directly calculated from data on the tonnage and grade of ore milled and the tonnage and grade of concentrates recovered. The formulas for these calculations are:

Tailings (tons) = Ore Milled (tons) – Concentrates Recovered (tons)

Metal in Tailings (tons) = Metal in Ore (tons) – Metal in Concentrates (tons)

The accuracy of these calculations depends entirely on the accuracy of the weighing and sampling methods employed when these ores were milled. In the early days of the district these methods had serious shortcomings. Wiard (1910a), in a thorough review of milling practice in the Coeur d'Alene mining region, commented: "I am not sure that the samples taken in the mills and at the mines even allow of a shrewd guess being made as to the metallic content of ores passing through the mills" and "It may be asked what average figure would represent the saving in the Coeur d'Alene mills. I might guess, but I do not know. If there are any reliable figures from any of the properties, I am not cognizant of them."

The author has examined the original daily mill records of the Success Mining Co. (Success Mining Company, 1915-1925) which processed zinc-rich ores from the Granite mine from 1905 to 1931. Apparently, the company did not use a scale to weigh ore fed to the mill. The records tabulate the number of cars of ore delivered to the mill and multiply that number by an assumed weight of ore per car. A grab sample was taken from each car of ore, from each shipment of concentrates, and, at times, from the tailings flume. No automatic samplers were used. Assays, which were not duplicated or otherwise checked, were by fire assay methods. If these sampling, weighing, and bookkeeping methods are typical of early day practice in the district, then Wiard's (1910b) comments are substantially correct.

The principal source of data from 1901 to 1977 are production of ores, concentrates, and metals reported by individual mine operators to the U.S. Geological Survey from 1901 to 1923 and the U.S. Bureau of Mines from 1924 to 1977. These data were supplemented by original mine and mill records for several operators, published annual reports of mining companies operating in the region, and other published sources. Data after 1977 are entirely from company annual reports and filings with the Securities and Exchange Commission. Data on production prior to 1900 were pieced together from contemporary accounts in mining industry journals and local newspapers, company records and annual reports, and other published literature. A detailed listing of all sources of data is beyond the scope of this report.

Tables of annual production of ores milled, concentrates produced, and metals contained in each were prepared for each mine using electronic spreadsheet software. The amount of tailings produced and their metal content were calculated using the formulae given above. Data were aggregated across time and across mines for the entire mining region. Disaggregated, annual data can not be reported here as those data are often confidential. Methods of tailings disposal were determined by historical research, principally using mining industry journals and related publications, including some previous studies on tailings disposal in the district listed under the section on references cited.

PRELIMINARY ESTIMATE OF TAILINGS PRODUCTION AND DISPOSAL

A preliminary accounting of the production and disposal of mill tailings (Table 1) shows that about 56 million metric tons of tailings containing 2,200 metric tons silver, 800,000 metric tons of lead, and at least 650,000 metric tons zinc were disposed of or otherwise lost into the Coeur d'Alene River or its tributaries. Another 53 million metric tons of tailings containing 900 metric tons silver, 350,000 metric tons lead, and at least 472,000 metric tons zinc were stockpiled along the floodplain of the Coeur d'Alene River, placed in one of several tailings impoundments, or used as stope fill.

Several assumptions were made which may significantly affect these preliminary estimates if additional data are obtained. It has been assumed, based on actual results reported by mine operators (Farmin and Sparks, 1951), that the actual amount of tailings used as sand fill is approximately half of all tailings generated. It has also been assumed that half of the original tailings dump at the Sweeny mill site west of Kellogg has been eroded into the South Fork of the Coeur d'Alene river (Handy, 1919). An unknown amount of tailings, particularly slimes, was also been eroded or otherwise lost from the Bunker Hill tailings dump prior to construction of a tailings impoundment in 1928. Uncontrolled tailings dumps along the various tributaries to South Fork have been treated as tailings disposed of into creeks because much of these tailings have already been eroded into streams.

Method of Disposal	**Dates**	**Amount of Tailings** *metric tons*	**Metals Contained in Tailings** *metric tons*		
			Silver	**Lead**	**Zinc**
To creeks	1884-1967	56,100,000	2,200	800,000	>650,000
To dumps	1901-1942	13,200,000	400	200,000	>290,000
As mine fill	1949-1997	16,300,000	200	35,000	20,000
To impoundments	1928-1997	23,800,000	300	99,000	160,000
Total	1884-1997	109,400,000	3,100	1,134,000	>1,120,000

Table 1. Preliminary estimates of mill tailings produced in the Coeur d'Alene mining region from 1884 to 1997 classified according to method of disposal. Dumps are defined as stockpiles of tailings unsecured by dams or other structures to form an impoundment to protect against loss of tailings by erosion. Many impoundments were built on top of and from older tailings dumps.

REFERENCES CITED

Casner, Nicholas A., 1991, Toxic river; politics and Coeur d'Alene mining pollution in the 1930's: Idaho Yesterdays, v. 35, n. 2, p. 2-19.

Bennett, George N., no date, Report on the Black Bear Consolidated Mining Co. property: Butte, Montana, Butte & Superior Mining Co., unpublished report, 7 p. (Anaconda Geological Documents Collection, File No. 21704.01, International Archive of Economic Geology, American Heritage Center, University of Wyoming)

Engineering and Mining Journal, 1904, Special correspondence, Spokane, April 27: Engineering and Mining Journal, v. 77, n. 18, p. 735.

Engineering and Mining Journal, 1920a, News from the mines, Idaho, Shoshone County: Engineering and Mining Journal, v. 109, n. 17, p. 994.

Engineering and Mining Journal, 1920b, News from the mines, Idaho, Shoshone County: Engineering and Mining Journal, v. 109, n. 26, p. 1432.

Engineering and Mining Journal, 1920c, News from the mines, Idaho, Shoshone County: Engineering and Mining Journal, v. 110, n. 6, p. 281.

Engineering and Mining Journal, 1920d, News from the mines, Idaho, Shoshone County: Engineering and Mining Journal, v. 110, n. 12, p. 592-593.

Engineering and Mining Journal, 1920e, News from the mines, Idaho, Shoshone County: Engineering and Mining Journal, v. 110, n. 18, p. 885.

Engineering and Mining Journal, 1930a, Jack Waite reorganizes; under new management: Engineering and Mining Journal, v. 130, n. 4, p. 197.

Engineering and Mining Journal, 1930b, Start work on construction of new Jack Waite mill: Engineering and Mining Journal, v. 130, n. 6, p. 307.

Engineering and Mining Journal, 1946: News from the mines, Idaho: Engineering and Mining Journal, v. 147, n. 1, p. 121-122.

Fahrenwald, A.W., 1927, Flotation practice in the Coeur d'Alene district, Idaho: Mining Congress Journal, v. 13, p. 699-704.

Farmin, R., and Sparks, C.E., 1951, Sand-fill methods at Dayrock: Engineering and Mining Journal, v. 152, n. 9, p. 92-97.

Featherstone, Wray, 1963, History of Lucky Friday, in The Coeur d'Alene mining district *in* 1963: Idaho Bureau of Mines and Geology Pamphlet 133, p. 23-25.

Handy, R.S., 1919, Treatment of tailings and ore in the Sweeny mill: Mining and Scientific Press, v. 119, n. 13, p. 289-294.

Horowitz, A.J., Elrick, K.A., and Cook, R.B., 1993, Effect of mining and related activities on the sediment trace element geochemistry of Lake Coeur d'Alene, Idaho, USA; Part 1, Surface sediments: Hydrological Processes, v. 7, p. 403-423.

Idaho State Mine Inspector, 1898-1974, Annual report on the mining industry of the state of Idaho: Boise, Idaho, State Mine Inspector, annual publication.

Ioannou, Christos, 1979, Distribution, transport and reclamation of abandoned mine tailings along the channel of the South Fork of the Coeur d'Alene River and tributaries, Idaho: Moscow, Idaho, University of Idaho, M.S. thesis, 146 p.

Lockard, D.W., Bennett, E.H., and Miller, M.M., 1981, The mineral industry of Idaho, in Minerals Yearbook: Washington, D.C., U.S. Bureau of Mines, v. 2, p. 157-169.

Lockard, D.W., Miller, M.M., and Bennett, E.H., 1980, The mineral industry of Idaho, in Minerals Yearbook: Washington, D.C., U.S. Bureau of Mines, v. 2, p. 157-169.

Long, K.R., DeYoung, J.H., Jr., and Ludington, S.D., 1998, Database of significant deposits of gold, silver, copper, lead, and zinc in the United States; Part A, Database description and analysis: U.S. Geological Survey Open-File Report 98-206A, 33 p.

Magnuson, Richard G., 1968, Coeur d'Alene diary; the first ten years of hardrock mining in north Idaho: Portland, Oregon, Metropolitan Press, 319 p.

Mining World, 1963, Improved methods at Sunshine mine sends higher grade silver ore to mill: Mining World, v. 25, no. 2, p. 14-17.

Mitchell, V.E., and Bennett, E.H., 1983, Production statistics for the Coeur d'Alene mining district, Shoshone County, Idaho; 1884-1980: Idaho Geological Survey Technical Report 83-3, 33 p.

Matuszak, David C., Downs, Fred T., Schuler, Mark V., and Ikramuddin, Mohammed, 1996, Impact of mining activities on the trace element geochemistry of the Spokane River, Idaho and Washington: Geological Society of America Abstracts with Programs, v. 28, n. 7, p.97.

Norman, Lonnie Dale, 1977, The grain size distribution of tailings and other solids in the Bunker Hill Central Impoundment Area and its relationship to the occurrence and control of leakage and seepage: Moscow, Idaho, University of Idaho, M.S. Thesis, 74 p.

Park, M.A., 1962, Automated sand fill system; some 100,000 tons of back fill have been placed in the Bunker Hill mine over the past year, with costs as low as 43 cents per ton of replaced ore: Mining Congress Journal, v. 48, n. 10, p. 24-26.

Rice, Claude T., 1918, Flotation in the Coeur d'Alenes: Engineering and Mining Journal, v. 105, n. 16, p. 707-716.

Richards, R.H., Locke, C.E., and Schuhmann, R., 1940, Textbook of ore dressing: 1940, McGraw-Hill, 608 p.

Success Mining Co., 1915-1925, Daily record of ore production: Moscow, Idaho, University of Idaho Library, Special Collections, Manuscript Group 291, Records of the Success Mining Co., File 175.

Tamarack & Custer Consolidated Mining Co., 1913, Annual report to management by the mill superintendent: Wallace, Idaho, Tamarack & Custer Consolidated Mining Co., unpaginated.

U.S. Bureau of Mines, 1924-1931, Mineral resources of the United States: Washington, D.C., Government Printing Office, annual publication.

U.S. Bureau of Mines, 1932-1997, Minerals yearbook: Washington, D.C., Government Printing Office, annual publication.

U.S. Bureau of Mines, 1932, Pollution of the Coeur d'Alene River and Lake by mill tailings: Report to the Coeur d'Alene River and Lake Commission, unpublished manuscript, Records of the Bureau of Mines, Record Group 70, National Archives, Washington, D.C., 14 p. (Cited in Casner, 1991)

U.S. Geological Survey, 1902-1923, Mineral resources of the United States: Washington, D.C., Government Printing Office, annual publication.

Visnes, Norman, 1957, Sand filling at the Galena mine: Mining Engineering, v. 9, n. 1, p. 49-52.

Weston, Roy F., 1989, Site inspection, Lower Coeur d'Alene River: Final report, Bureau of Land Management. (Cited in Casner, 1991)

Wiard, Edward S., 1910a, Ore dressing in the Coeur d'Alene district; X; Concentrates handled in wheelbarrows and carts. Installation of tailings plants. Overloaded machinery. Resume of general practice: Engineering and Mining Journal, v. 89, n. 19, p. 967-969.

Wiard, Edward S., 1910b, Ore dressing in the Coeur d'Alene district; IX, Crude sampling method usually employed; Hualtain sampler used for wet sands. Assaying methods. All ore sold on fire assay: Engineering and Mining Journal, v. 89, n. 17, p. 875-877.

Wiard, Edward S., 1915, The theory and practice of ore dressing: New York, McGraw-Hill, 426 p.

Williams, Roy E., 1973, Modernization of Coeur d'Alene tailings disposal practices, *in* Aplin, C.L., and Argall, G.O., Jr., Tailing disposal today: San Francisco, Miller Freeman, p. 634-673.

Zeigler, W.L., 1947, Tailings and mine-dump reclamation in the Coeur d'Alenes during World War II: Mining Technology, v. 11, n. 2, (AIME Technical Publication 2145) 10 p.