

US EPA ARCHIVE DOCUMENT

MINE SITE VISIT:
ASARCO/TROY MINE

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U.S. Environmental Protection Agency
Office of Solid Waste
401 M Street SW
Washington, DC 20460

2.0 MINE SITE VISIT: ASARCO/TROY MINE

2.1 INTRODUCTION

2.1.1 Background

EPA has initiated several information gathering activities to characterize mining wastes and waste management practices. As part of these ongoing efforts, EPA is gathering data by conducting visits to mine sites to study waste generation and management practices. As one of several site visits, EPA visited ASARCO's Troy Mine near Troy, Montana, on July 23 and 24, 1991.

Sites to be visited were selected to represent both an array of mining industry sectors and different regional geographies. All site visits have been conducted pursuant to RCRA Sections 3001 and 3007 information collection authorities. When sites have been on Federal land, EPA has invited representatives of the land management agencies (Forest Service and/or Bureau of Land Management) to participate. State agency representatives and EPA regional personnel have also been invited to participate in each site visit.

For each site, EPA has collected waste generation and management information using a three-step approach: (1) contacting the facility by telephone to obtain initial information, (2) contacting State regulatory agencies by telephone to get further information, and (3) conducting the actual site visit. Information collected prior to the site visit is then reviewed and confirmed at the site.

The site visit reports describe mine processes, mine waste generation and management practices, and regulatory status on a site-specific basis and are based on information gathered from State and Federal agency files as well as on observations made during the site visit. The site visit report on ASARCO's Troy Mine was prepared from a variety of information sources including the ASARCO files from the Montana Department of State Lands (MDSL) and the Montana Department of Health and Environmental Sciences (MDHES), information collected during telephone conversations, the site visit, and other published information. The following individuals participated in the ASARCO/Troy Mine site visit on July 23 and 24, 1991:

ASARCO/Troy Mine

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Participants in the site visit were provided opportunity to comment on a draft of this report. Comments were submitted by ASARCO and EPA Region VIII. ASARCO's comments are presented in Appendix 2-A. EPA's responses to ASARCO's comments are presented in Appendix 2-B.

2.1.2 General Facility Description

ASARCO, Inc. (ASARCO) mines copper/silver ore from the underground Troy mine located in the Cabinet Mountains in the northwestern corner of Montana (see Figure 2-1

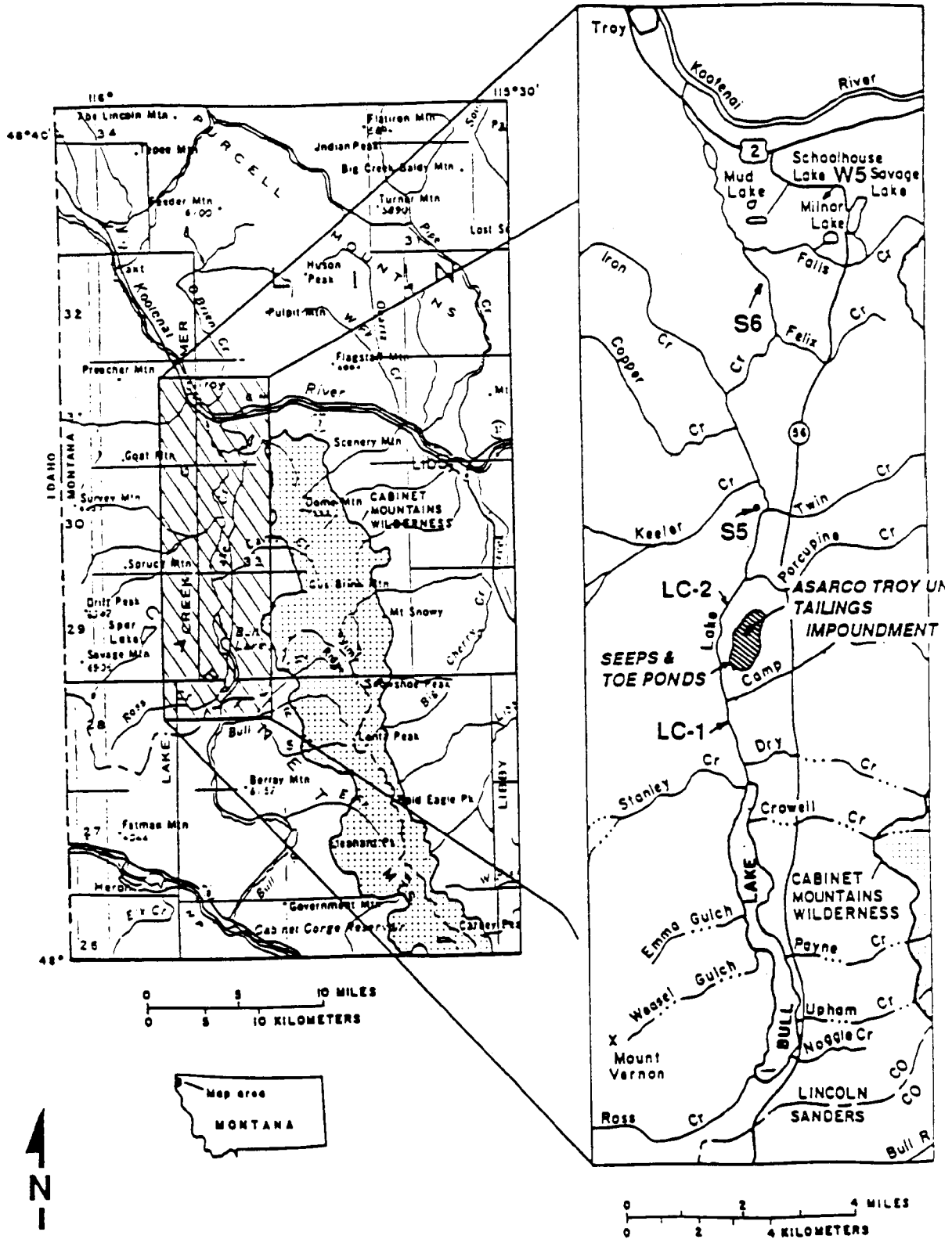


Figure 2-1. General Project Location Map

(Source: Levings et al., 1984)

). The mine is located in Lincoln County, approximately 15 miles south of Troy, Montana, the closest town with a variety of public services. Libby, Montana, is located approximately 20 miles northeast of the mine. The mine access and haulage road turnoff is located on the west side of Highway 56 approximately 12 miles south of Highway 2. The mine is seven miles from the mine access and haulage road turnoff.

The relatively flat lying stratabound ore body lies under Mt. Vernon at an elevation of approximately 4,400 ft. above sea level. Mine portals and facility buildings are perched on the steep northern slopes of Mt. Vernon (see Figure 2-2

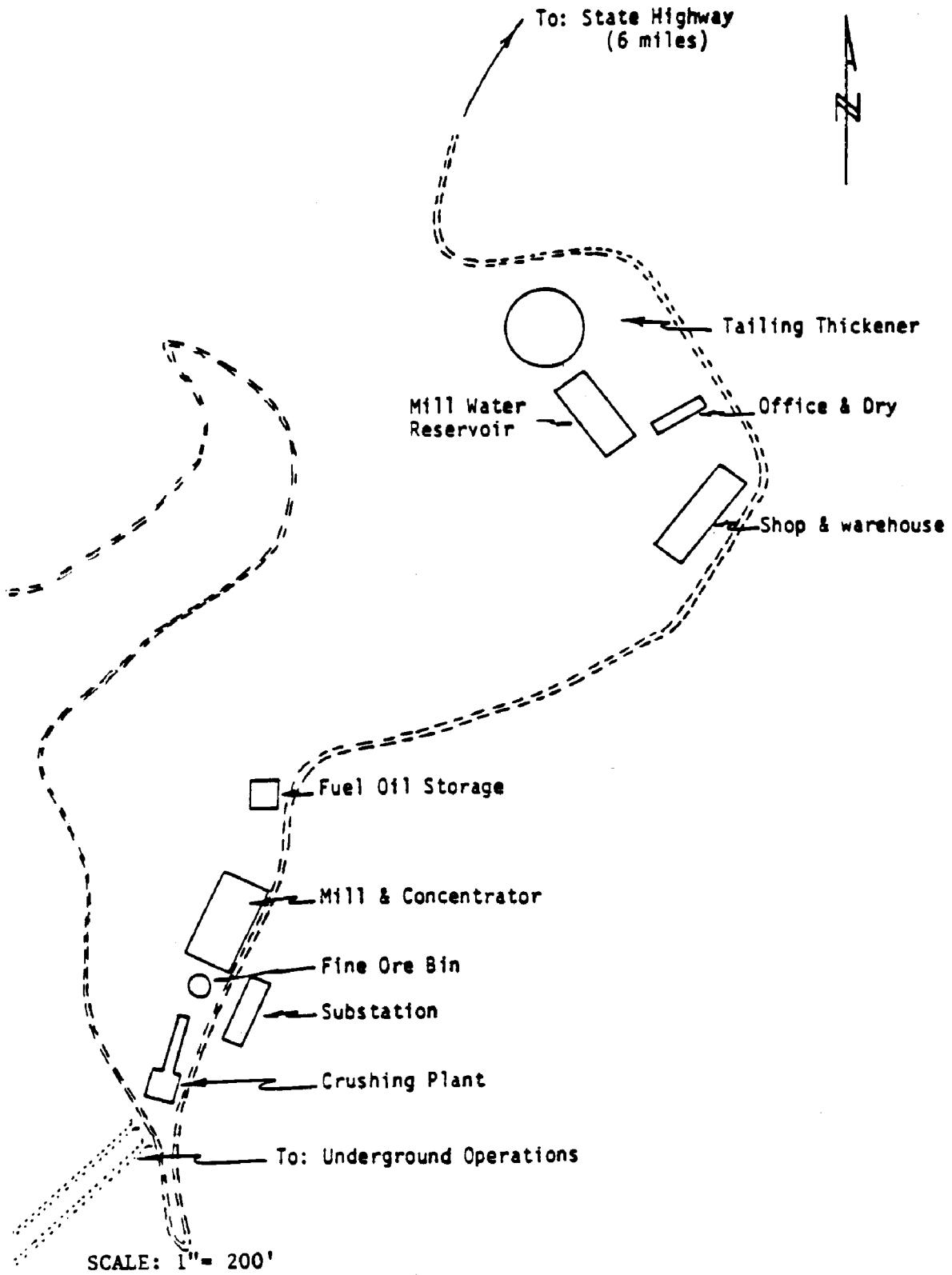


Figure 2-2. Facility Location Map, ASARCO Troy Mine

(Source: From 1979 MDHES Air Quality Bureau Construction Permit Application)

according to ASARCO, the fuel storage tank is actually located south of the shop rather than as shown in Figure 2-2). Vehicle access to the underground room and pillar workings is through two main adits. Extracted ore is crushed underground and conveyed to the surface mill for secondary crushing, grinding, and concentration of the silver-bearing and non-silver bearing copper minerals. Tailings generated through beneficiation of the ore are disposed of in a

tailings impoundment located approximately six miles north of the mill in Lake Creek Valley. Waste rock generated during the active phase of mining is returned to the mine or used as road or base for facility construction. The copper/silver concentrate is shipped out of State for processing.

The active facility is located on approximately 350 acres of United States Forest Service (USFS) and privately owned lands. The USFS lands are part of the Kootenai National Forest. According to the mine manager, the mine is located on patented claims, the mill is located on unpatented claims, and the tailings impoundment is located on land owned by Kennecott Minerals and leased to ASARCO. The mine holds unpatented and patented claims on an additional 2,400 acres of Forest Service land that are currently inactive or reserved for potential future uses. (MDSL and USFS, 1978)

2.1.3 Environmental Setting

Being located in northwestern Montana, the mine is usually under the influence of the Pacific maritime air mass providing a moist, temperate climate. However, cold arctic air masses occasionally spill over the Continental Divide, contributing to the extreme variation in temperatures on a seasonal basis. Temperature at Troy ranges from -25

vary greatly depending upon the elevation. The Draft Environmental Impact Statement (DEIS) for the Troy Project states that the annual precipitation on Mt. Vernon is over 100 inches, while the area surrounding the tailings impoundment receives approximately 35 inches of precipitation per year. Sixty-five percent of the precipitation occurs in the form of snow between November and March. In 1978, gross evaporation from planned reservoirs and evaporation ponds at the site was estimated at 28-30 inches of water per year. The primary wind direction is westerly; however, during the winter an occasional cold arctic air mass results in strong northeasterly and easterly winds. In the fall and winter, Lake Creek Valley frequently experiences low level inversions during periods of high pressure that tend to trap air pollutants in the valley until a front moves through the area. (MDSL and USFS, 1978)

2.1.3.1 Surface Water

The mine complex lies in portions of both the Stanley Creek and Lake Creek drainages. Stanley Creek drains the northern slope of Mt. Vernon, captures the flow of Fairway Creek downstream of the mill, and empties into the northern end of Bull Lake. Lake Creek drains from the northern end of Bull Lake, acquiring flow from several tributary streams before flowing into the Kootenai River 18 miles north of Bull Lake (see Figure 2-1). The Draft Environmental Impact Statement describes a marshy area along the southeastern border of the proposed tailings impoundment; however, a separate section of the document states that no wetlands exist in the mine study area. (MDSL and USFS, 1978)

2.1.3.2 Geology

Faulting, glaciation and the erosive force of water have influenced the topography and geology of the area around the Troy mine. The Lake Creek-Bull River Valley is a down-dropped block bordered by two major north-south trending faults. The deep valley was in-filled primarily with fine-grained glacio-lacustrine and glacio-fluvial sediments during Pleistocene glaciation. (MDSL and USFS, 1978)

The Cabinet Mountains are composed of partially metamorphosed, folded, and faulted argillites, quartzites, and carbonates of the Precambrian Belt Series, intruded by Jurassic and Cretaceous age granitic plutons. These well indurated sedimentary rocks have very low primary porosity and permeability although fractures and faults within these units can allow the movement of water. The reviewed documents (see References) briefly discuss several faults in and around the mine area; however, extensive information on fracture patterns and faulting for the site was not available. (MDSL and USFS, 1978)

Mining is occurring beneath Mount Vernon in the upper section of the Precambrian Revett quartzite in disseminated mineralization consisting of the copper minerals chalcocite, bornite, and chalcopyrite and small amounts of copper oxides and native silver. The ore body is approximately 7,400 feet long, 1,800 feet wide, and 60 feet thick. It trends north 5 degrees west and dips 0 to 15 degrees to the southwest. The eastern boundary of the ore zone is cut by a fault striking north-northwest. The ore body is cut by an east-west reverse fault dipping 70 degrees and the upper south block. (MDSL and USFS, 1978)

Geophysical investigations and borings indicate that the thick Lake Valley deposits overlying bedrock include coarse materials (sands, gravels, and cobbles) interlayered with the thick layers of silts and fine sandy silts deposited by glaciation. In addition, Lake Creek has deposited clays and silty alluvial materials in its floodplain. The sediments of Lake Creek Valley have been estimated to be over 400 feet thick. (MDSL and USFS, 1978)

The DEIS states that the mine is located in Zone 2 of seismic risk on the seismic risk map of the United States. Zone 2 indicates areas where moderate seismic damage should be expected as determined through historic records. (MDSL and USFS, 1978)

2.1.3.3 Hydrogeology

The reviewed literature does not define specific aquifers, but discusses ground water in relation to the lithology in which it is found. Ground water occurs in joints, fractures, and faults of the Belt Series bedrock. These features control the movement of ground water and yields to wells completed in bedrock. Alluvial deposits of Recent age are present in the Lake Creek floodplain. These deposits may yield small to moderate quantities of water. In addition to rainfall and snowmelt infiltration, the alluvial aquifer may be recharged by Lake Creek. In the summer, ground water provides baseflow to Lake Creek. (MDSL and USFS, 1978)

No detailed hydrological work was conducted in the mine area prior to mine construction and development. Small quantities of ground water were encountered in colluvium and landslide debris during drilling at one of the proposed adits. Rapid infiltration of surface water into the Stanley Creek channel sediments suggests significant ground-water supplies in the Stanley Creek alluvium. The facility maintains two mill supply water wells in lower Stanley Creek between the mine administration building and the tailings impoundment. Each well is approximately 300 to 400 feet deep. Facility representatives were unable to provide information about the yields of the wells or the volume of water provided to the mill by these wells. Three domestic water wells are also present in lower Stanley Creek. Another well, located 400 yards from the site, supplies potable water to the facility. According to ASARCO, the domestic wells are completed in bedrock, but the lithology within which the other wells are completed remains unidentified. Hydrogeological investigations in the area of the tailings impoundment have been largely unsuccessful in determining the hydrogeology of that area. (MDSL and USFS, 1978)

Most of the reports conclude that the hydrogeology of the tailings area is "complex" and that additional detailed hydrogeological investigations would produce a better understanding of the site hydrogeology. Prior to construction, ASARCO's contractors conducted an investigation of the tailings disposal area to provide information for use in the design of the unit. Two deep test wells and 12 test holes were drilled with a total of 25 permeability tests conducted in 11 of the holes (the type of permeability tests were not clear). The DEIS stated that no hydraulic testing of the aquifer was performed due to the presence of fine-grained materials. The two deep test wells were completed on the east side of the proposed impoundment. Test well 1 was completed at 283 feet below ground surface in a coarse-grained zone. The upper 167 feet of the well encountered fine-grained material. When the screened interval was placed in the fine-grained zone, the well collapsed and filled with sediment to the 190 feet level. The DEIS reported water levels in this well of 75.3 and 62.9 feet below the casing top. The 62.9 feet level was interpreted as below the level of Lake Creek at the time of measurement. The other test well was drilled through silts and sands before encountering coarse-grained materials at 165 feet. Test holes completed along the proposed tailings dam axis found medium dense silts, sandy silts, and silty sands down to 65 feet deep. In the southern part of the tailings impoundment site, medium dense to dense gravelly sand, sandy gravel, and cobbly gravel was encountered. Water levels in these test holes ranged from 9 to 65 feet below ground surface four days after drilling. The permeabilities calculated by the contractor for the materials below the proposed tailings impoundment range from 8 to 8100 ft. per year. The DEIS cautioned that the calculated figures could vary as much as two orders of magnitude from actual conditions. (MDSL and USFS, 1978; and ASARCO, 1990)

In addition, according to ASARCO, four ground water test wells are located on the west side of the impoundment. No information was available concerning the completion, date of installation, or monitoring of these wells.

The DEIS stated that a coherent picture of the piezometric surface was not provided by the data collected at that time. Low permeability, fine-grained materials were considered to be the reason for the inconclusive testing. The DEIS assumed, for the purposes of that document, that ground water flows toward Lake Creek

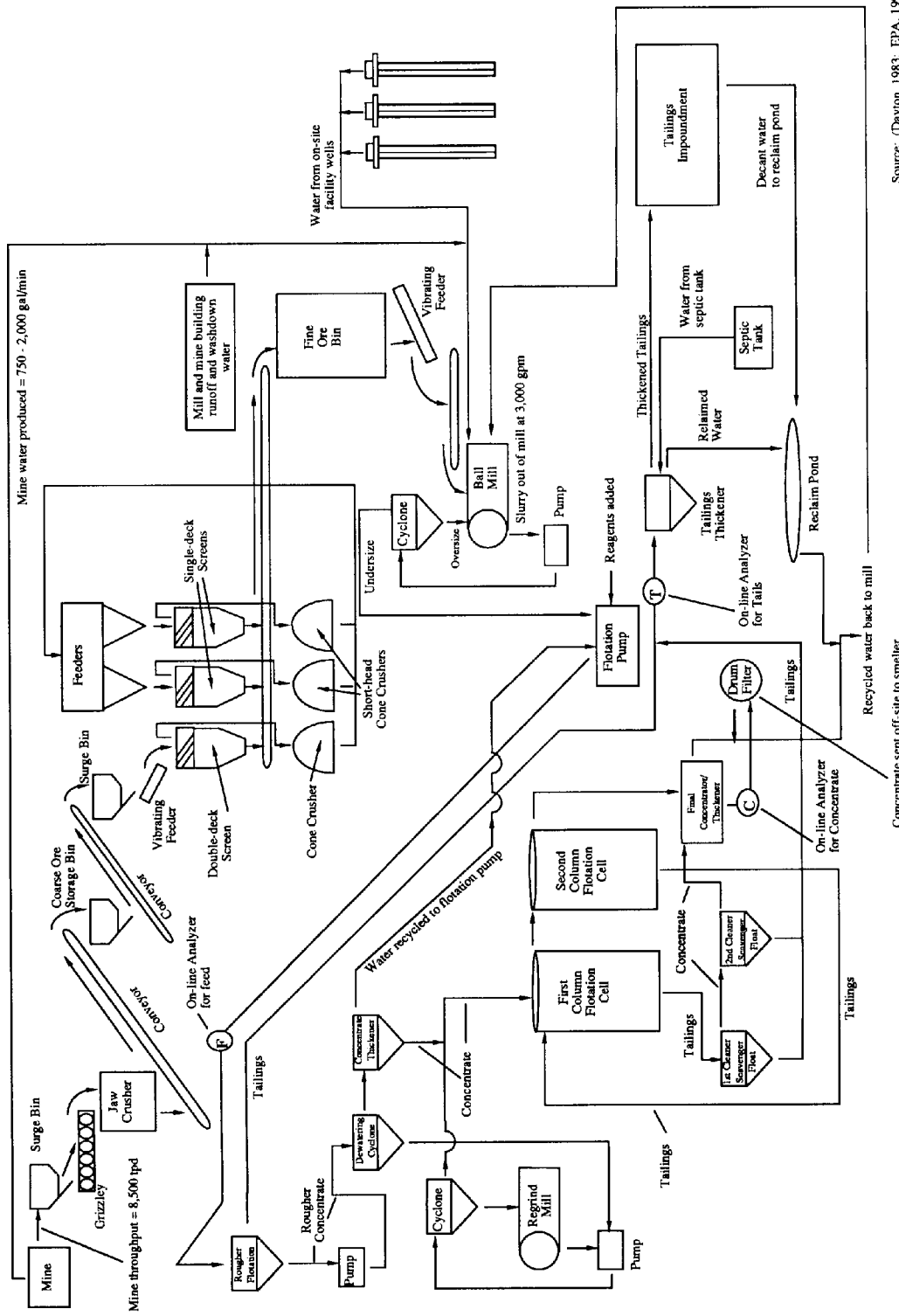
as suggested by the geophysical survey, water-level data, and the general hydrogeologic setting of the pond. The original hydrogeological investigation was not available for review and inclusion in this report and the available documents did not provide information concerning aquifer properties such as hydraulic conductivity, gradient, transmissivity, and storativity. (MDSL and USFS, 1978)

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2.2 FACILITY OPERATIONS

The Troy copper/silver ore body was delineated in 1964 as a result of an exploratory drilling program. Development and construction of the mine began in 1979, with full production following in 1982. At the Troy mine, room and pillar methods are used to mine ore from the underground workings. Ore is hauled by trucks to the underground crusher and then conveyed to the mill. Milling unit operations include crushing, grinding, concentration by flotation, regrinding coarse concentrate fractions, and dewatering concentrate.

The flotation operation used at the mill is a physical separation and concentration operation that allows the valuable minerals to float to the top and over the edge of the flotation cell in a froth. Chemicals are added to the slurry entering the flotation cells to facilitate the separation process. The product of the flotation cell, the froth, is dewatered in a concentrate thickener and further dewatered on a drum filter. The waste product of flotation, gangue minerals known as tailings, flow from the bottom of the flotation cell to a tailings thickener for dewatering. Water from the concentrate thickener, filter drum, and tailings thickener are recycled back to the ball mill. A control room in the grinding and concentrating mill building monitors and controls the operations. The final product of flotation and filtration is a concentrate of silver and copper minerals. Figure 2-3



Source: (Dayton, 1983; EPA, 1991)

illustrates the mining and milling operations, from the input of raw materials to the output of products and wastes.

Approximately 350 acres are disturbed by facility buildings, roads, and operations. The mine employs approximately 320 people and operates 24 hours a day seven days a week. Mine and mill employees work 12-hour shifts. Ore is extracted from the mine at a rate of 8,500 tons per day, with yearly production at approximately 3 million tons per year. Seventy-five percent of the 64 million ton ore reserve is recoverable and 25 percent will remain in the supporting pillars. The ore averages 0.76 percent copper and 1.58 ounces of silver per ton. Approximately 80 tons of ore are required to extract one ton of concentrate. The final concentrate, averaging approximately 100 ounces of silver per ton (0.3 percent) and 45 percent copper, is trucked to Troy where it is loaded into railcars for shipment to a smelter. The mine life is estimated to be 15 years from the start of full production in 1982. According to the mine manager, the current reserves should last another 6 to 7 years at the current rate of production. Exploration to extend the reserves is ongoing. (Dayton, 1983; and EPA, 1991.) A detailed explanation of the mining and milling operations, including the products and wastes generated by each state of the operation, is discussed below.

2.2.1 Mining Operations

The underground mining operations are accessed by vehicles through two main adits, the service adit and the main haulage adit. These two adits and the south and conveyor adits function as air intake adits. The EPA team entered and exited the mine via the service adit. Two additional adits (the east and west adits) function as air exhaust adits. Rock removed during adit excavation was used as fill to construct patios for the surface buildings. (Dayton, 1983; and EPA, 1991)

Figure 2-3. ASARCO Troy Flow Diagram

(Source: Dayton, 1983 and EPA, 1991)

The competent stratabound deposit is mined using headings and benching in a room-and-pillar pattern. Top slice headings are driven 20 feet high by 45 feet wide using mobile electro-hydraulic rigs to drill horizontal rounds. The lower 40 foot benches are drilled vertically using electro-hydraulic rigs. The 45 feet deep holes are loaded with an emulsified slurry (ANFO). After blasting, Caterpillar 988 and 980 loaders muck the newly blasted faces and load the ore into diesel-powered, articulated haulers. The ore is transported to a surge bin at the underground primary crusher. (Dayton, 1983)

Mine water collected from areas throughout the mine flows to two sumps in the mine. Water is pumped from the sumps through a secondary pumping station to the surface mill for use in the grinding and flotation circuits. Flow rate into the sumps ranges from 750 to 2000 gallons per minute (gpm) depending upon the season. In the event of excess water, the surplus is pumped directly to the tailings thickener. Although the DEIS suggested that an oil/water separator or skimmer was to be used at the sumps, according to the mine manager, none existed at the time of the site visit. (MDSL and USFS, 1978)

Ore is fed from the underground ore bin along a vibratory feeder to the Allis-Chalmers 48 x 60 inch, 250 HP jaw crusher. The ore is crushed to minus 6 inches before it drops into the coarse ore storage bin below the primary crusher. A conveyor transports ore from the coarse ore storage bin through the 4,400 foot long adit decline to the surface mill. The EPA team viewed the primary ore crusher on Wednesday July 24, 1991, when it was shut down for weekly maintenance. At the time of EPA's visit, water was in use for cleaning the primary crusher. Particulate emissions from the jaw crusher are controlled by a baghouse.

There are several maintenance and chemical storage (oil, gas, lubricates, etc.) facilities located underground. The EPA team visited an equipment maintenance area. Tools, welding tanks, and spare parts were observed in this area. A 10,000 gallon diesel fuel tank is stored in a topslice heading down grade from the underground maintenance facility. Used oils generated underground are stored in surface tanks. Drums were observed as the EPA team toured the mine.

2.2.2 Milling Operations

Primary crushed ore is transported on a conveyor to the surface secondary crusher building. One Symons standard cone crusher and two Symons short head crushers perform secondary crushing. According to the mill superintendent, throughput of ore is 600 tons/hour. Ore is initially fed to the Symons standard cone crusher along vibrating feeders to a vibrating double deck screen. Fines falling through the double deck screen (minus 1/2 inch) are transported by belt conveyor to the fine ore bin. Oversized material is fed to the cone crusher for size reduction. The product of the cone crusher is transferred to single deck screens (with slots minus 1/2 or 5/8 inch by 3 inches) for sizing. Material falling through the single deck screen is conveyed to a fine ore surge bin. Coarse materials remaining on the screen are fed into the short head cone crushers. As crushed ore exits the short head crushers it is conveyed back to the single-deck screens for a repeat of the sizing and crushing operations. The moisture content of coarse ore entering the secondary crushing stage is 1.8 percent. No water is added to the ore during the secondary crushing stage. (Dayton,

1983) The secondary crushers were down for maintenance during EPA's Tuesday, July 23, 1991, visit to the mill area.

The secondary crushing building is equipped with a wet scrubber to treat emissions resulting from the transfer points in the crushing circuit. A hooded vacuum system pulls the dust up into the scrubber. Slurry produced in the scrubber is pumped to the ball mill discharge sump and joins the ball mill discharge for additional comminution circuit processing. (EPA, 1991)

Fine ore is conveyed from the fine ore surge bins to a transfer tower to facilitate transport to the fine ore bin. The transfer tower is equipped with a baghouse to control emissions. The collected dust is returned to the belt and transported to the fine ore bin. The mill superintendent stated that the bags are disposed of "at the end of their life."

The fine ore bin receives materials crushed and sized to minus 3/4 inch. Six vibrating feeders transport fine ore from the bin to a conveyor system that feeds two KVS ball mills. Forty percent of the ball mill volume is filled with steel balls of a 3 1/2 inch top size. The balls are added continuously during operation of the mills due to steel abrasion of approximately 2 pounds of steel balls per ton of ore. Ball mill makeup water is supplied by a variety of sources depending on seasonal availability. These sources include mine water, tailings decant water, tailings thickener overflow, secondary crushing wet scrubber slurry, mill patio area runoff, and well water. The mill superintendent could not provide an estimate of the water flow rate entering each ball mill. ASARCO's 1978 plan of operations estimated that 4,313 GPM of process water would be required in the milling circuit (the amount added in the ball mills is not specified). The mill manager stated that approximately 3,000 gpm of ground ore slurry leaves the ball mills and is pumped to a cyclone for sizing. The 35-40 percent pulp density overflow from the cyclone reports to the three rougher flotation cells and the underflow is recycled back to the ball mills for further grinding.

The mill control room is located between the grinding circuit and the flotation circuit. An on-stream analyzer provides continuous metals content analysis of the grinding circuit feed, concentrate and tailings streams. During the mill tour, drums of reagents were observed in storage beneath the concentration circuit.

Potassium amyl xanthate, a collector, and an 80/20 mixture of pine oil and Dowfroth 250 (a frothing agent) are added to the cyclone overflow before it enters the flotation circuit. Collectors coat the target minerals and make them hydrophobic. Frothers stabilize air bubbles in the flotation unit, allowing the target minerals to cling to the bubbles and rise to the top of the flotation unit. The 80/20 frother mixture is added to the slurry at a rate of 0.02 pound per ton of feed and the xanthate at 0.03 pound per ton of feed.

The chemically fortified ore slurry is pumped to one of three banks of seven 500 Wemco 144 flotation cells. Air is injected from the bottom of the cell into the slurry. The ore mineral particles attach to the air bubbles and rise to the surface. A bubbling froth is created at the surface of the cell as the minerals float to the top of the cell. This surface froth of air bubbles, water and ore minerals overflows the cell into a collection launder.

The froth from the first three cells of each bank is collected and pumped to the first column cell. The froth from the remaining four cells of each bank is collected and pumped to cyclones for size classification.

Ore froth overflow (fine material) from the cyclone flows to a middlings thickener. The cyclone underflow (coarse material) flows to the regrind ball mill. The valueless gangue minerals (e.g., quartz) settle and flow out the bottom of the flotation cells to the tailings thickener.

The first column flotation cell is used to "clean" (remove unvaluable minerals) the froth from the first three Wemco cells. The froth from the first column cell reports to the final concentrate thickener. The tailing or underflow of the first column cell is pumped to a cyclone for size classification.

The thickened middlings concentrate is sent to two banks of first cleaner flotation cells. Concentrate overflow from the first cleaner cells is sent directly to the second column cell. The tailings are sent to the cleaner scavenger cells. Second column cell concentrate overflow goes directly to the concentrate thickener and the tailings report back to the first cleaner flotation.

The cleaner scavenger froth concentrate is pumped to a cyclone for size classification. The cleaner scavenger tailing flows to the tailings thickener.

A 75-foot diameter final concentrate thickener dewateres the concentrate with the aid of an anionic flocculent added at the rate of 0.015 lbs./ton of feed. The thickened concentrate is further dewatered on a drum filter and then stored in a bin; the water is recycled to the ball mills. The final moisture content of the concentrate averages 12%. The final concentrate averages 45% copper and 100 ounces of silver per ton. Approximately 80 tons of ore are needed to produce one ton of concentrate.

There is an equipment and vehicle maintenance and reconditioning building located north and downhill of the mill buildings. The EPA team did not visit this area. There is also an onsite laboratory that the EPA team did not visit.

2.3 WASTE MANAGEMENT

2.3.1 Types of Waste

Wastes produced at the ASARCO/Troy mine are generated as a direct result of mining and milling of ore. Wastes generated at the Troy mine include mill tailings, tailings pipeline pigging waste, and waste rock. Ground water seeping into the Troy underground mine workings becomes mine drainage; however, according to the mine manager, it is currently used in the mill process or bypasses the mill process and flows with the mill tailings to the tailings thickener. Mine water has never been discharged to surface water or ground water.

Mill tailings are the largest volume solid waste generated at the Troy mill and disposed of in the tailings impoundment. Tailings pipeline pigging waste is produced infrequently. Exact volumes of pigging waste were not provided by the facility. Waste rock (non-ore bearing rock removed to access the ore) is currently removed and disposed of in the underground workings. During development and construction of the mine complex, the removed waste rock was used as fill to create a surface area large enough to accommodate the mill and associated buildings.

Several wastes are generated at the mine that are not uniquely associated with mining and milling operations. According to the mine manager, waste halogenated solvents, used in the cleaning of parts and equipment, are the primary hazardous wastes produced at the facility. A few PCB-containing transformers or capacitors are still in use in the mine. Wet chemistry lab wastes are produced on site from the analysis of mine and mill products (ore, concentrate and tailings) and are placed in the flotation circuit for concentration. Waste hydraulic and motor oil, considered nonhazardous by Montana State law, are produced from their use in mine vehicles and equipment. The waste oils are collected by a waste oil recycler and transported offsite. The mine also generates garbage and sewage/sanitary wastewaters. Garbage is transported to a local landfill and sanitary waste water is disposed of in the tailings impoundment via the tailings thickener.

2.3.2 Solid Waste Management Units

2.3.2.1 Tailings Thickener

Tailings leaving the flotation circuit flow to a 250-foot diameter tailings thickener, located downhill and north of the mill buildings (see Figure 2-2). According to the mine manager, the tailings thickener also receives wastewater from the septic system and any excess drainage from the mine water supply system that is not required for milling operations. The thickener settles tailings to a specific density using a cationic-anionic flocculent at a rate of 0.01 pounds per ton of feed. Overflow water drains to the partially fenced, lined (1/16-inch Hypalon), tailings thickener reclaim pond. The reclaim water is used as needed in the mill circuit. According to ASARCO, in the event of a reclaim pond surplus, an overflow box located on the east side of the reclaim pond would convey the excess water to the tailings impoundment via the tailings pipeline. North and downhill of the tailings thickener and thickener reclaim pond is an unlined basin used as the emergency overflow pond. According to the mill superintendent there are pumps available to remove water from the emergency overflow basin. None were noted by the EPA team. The mine manager stated that the pond is

used infrequently; however, the last use of the emergency dump pond was within the two weeks prior to EPA's visit. All three units are located on the cut and fill slope constructed during mine development.

The mine manager stated that the quality of the thickener reclaim water is not monitored and there are no ground-water monitoring wells in the area. The surface-water-quality and benthic macroinvertebrate populations of Stanley Creek, located below the thickener and the two ponds, are monitored downstream of the plant site. No releases from these units have been documented in the State files reviewed by EPA or in conversations with facility personnel.

2.3.2.2 Tailings Pipeline

Two eight-inch schedule 40 steel pipes convey, by gravity flow, thickened tailings seven miles to the tailings impoundment. According to the mine manager, the pipe interiors are coated with urethane. Gravity flow of tailings through the pipeline ranges from 7 to 12 feet/second, depending upon tonnage. No drop boxes are used on the pipeline.

Tailings pipeline inspections are no longer conducted on a formal basis by the mine staff. However, according to the mine manager the pipeline's primarily above ground location along the mine access road allows for daily observation by the mine maintenance staff. According to the mine manager, a break in the pipe would be detected immediately in the mill control system due to the loss of pipeline pressure. It is unclear if the facility has a pressure loss detection system at the end of the pipe which would be necessary to signal a leak in a pipeline under gravity flow. The pipeline required pigging after six years of operation and then once a year for the past two or three years. Pigging wastes were disposed of in the tailings impoundment.

MDSL and MDHES documents indicate that the pipeline has released tailings into the environment in two separate events. In July 1981, tailings from a break in the tailings pipeline indirectly entered Stanley Creek when they leaked from the emergency storage impoundment, where they had been diverted. In June 1984, a tailings pipeline break released tailings into Lake Creek.

2.3.2.3 Tailings Impoundment

The 320 acre tailings impoundment is used for the management of the estimated 2,930,000 tons of mill tailings produced each year. It is located in the Lake Creek Valley, on a terrace east of Lake Creek and is dammed on three sides; north, west, and south. The eastern boundary of the tailings impoundment is located just west of a bedrock hill, which will eventually mark the eastern boundary of the tailings impoundment. Four toe ponds (two north toe ponds, toe pond number two, and south toe pond) are located along the toe of the west dam, as shown in Figures 2-4 and 2-5 (locations NTP, TP2, STP on Figure 2-4 and as labeled on Figure 2-5—it should be noted that Figure 2-5 is not drawn to scale; the toe ponds are shown greatly enlarged for illustrative purposes).

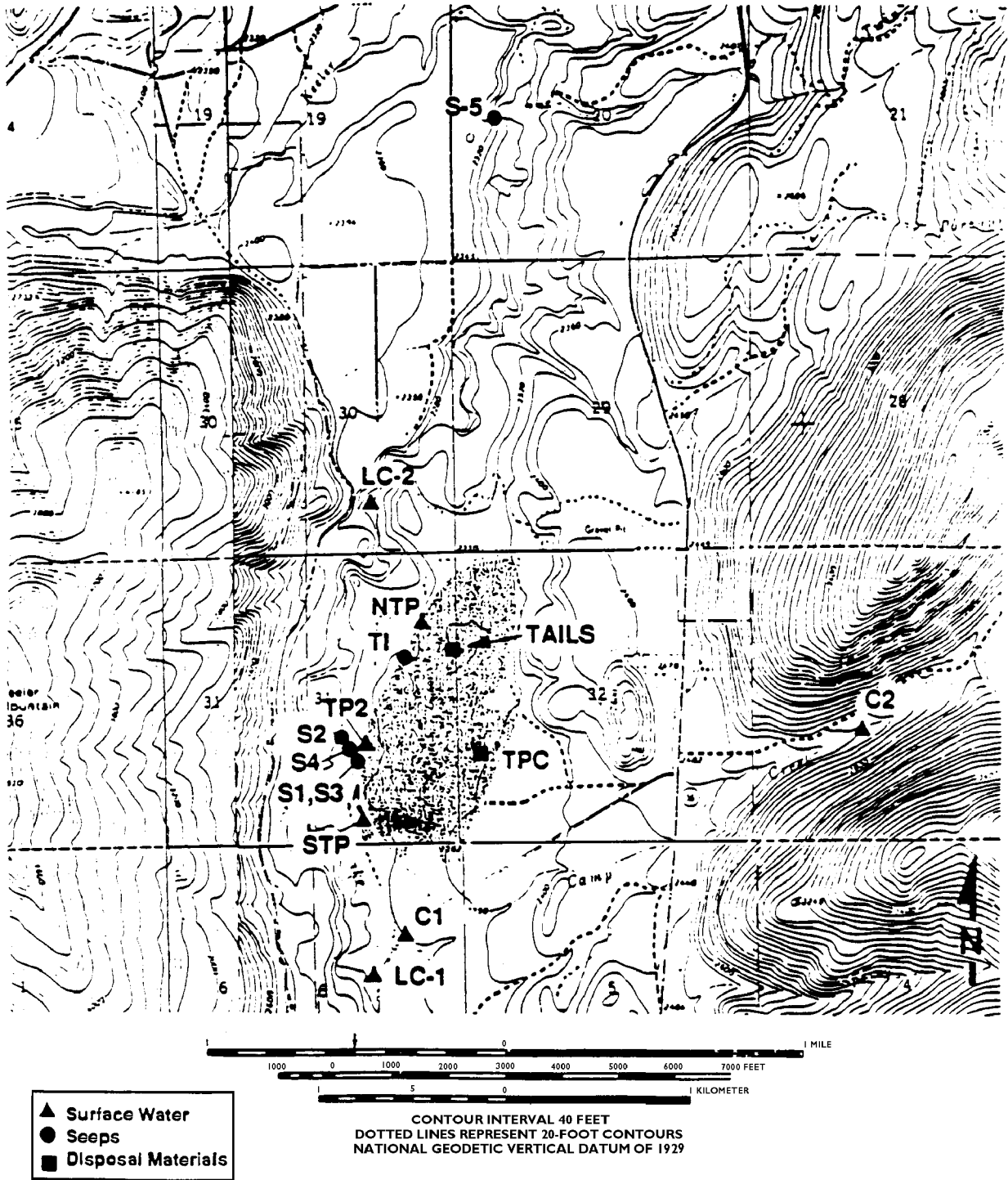


Figure 2-4. Location Map: Sampling Stations
Base: USGS 7.5' Quadrangles: Crowell Mountain and Spar Lake 1963 (PR 1923)

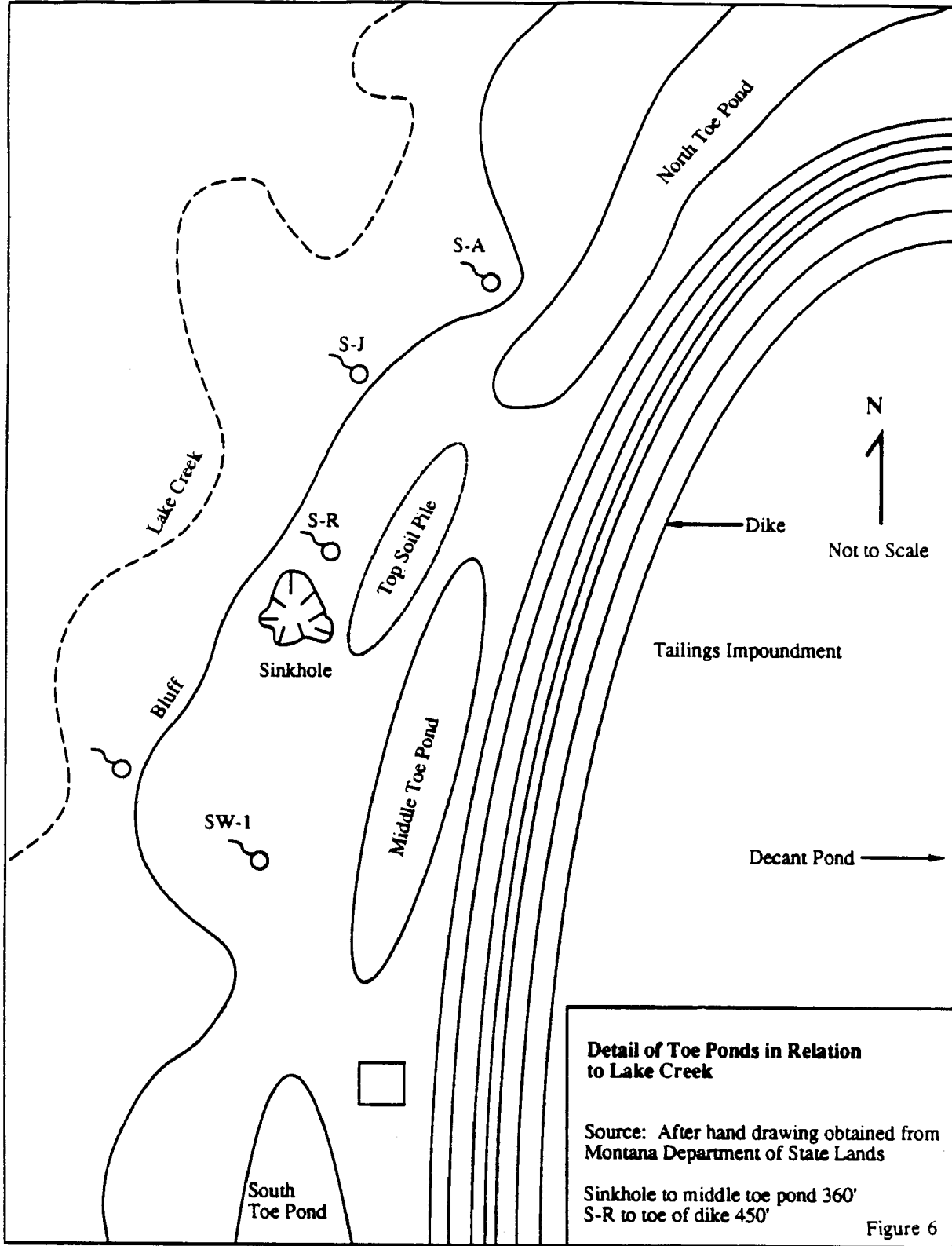


Figure 2-5. Detail of Toe Ponds in Relation to Lake Creek

According to the mine manager, tailings impoundment construction included compacting native materials on the bottom of the tailings impoundment and the placement of slimes along the perimeter dike before tailings were deposited in the pond. The tailings impoundment is composed of three quadrants (term used by mine manager) separated by east-west dividing dikes. Quadrant 1 is the south section of the pond, quadrant 2 is the middle section, and quadrant three is the northern most section. The mine alternates tailings disposal among the three quadrants. At the time of the site visit, the mine was spigoting tailings along the perimeter of quadrant 3. Perimeter dams and interior quadrant dividing dikes are heightened during a quadrant's period of inactivity when tailings are deposited in a different quadrant. Materials for these dam heightening operations are obtained from the borrow pits dug east of the pond's current eastern perimeter. The maximum current height of the tailings dam is 70 feet.

Tailings impoundment design allows for the addition of approximately 40 feet in height before design capacity is reached. ASARCO estimates that the remaining reserves will require 20 feet in additional height over the next 7 to 10 years.

Quadrants 1 and 2 were seeded with barley in the spring to prevent wind erosion of the tailings. A sprinkler system uses tailings water to irrigate the barley and prevent wind erosion. Large areas of quadrants 1 and 2 were barren. The mine manager stated that several of the large barren areas were not seeded due to saturated conditions at the time of planting. The southeastern section of the pond was developed over forested land, evidenced by the tops of trees extending through the tailings.

A tailings water decant pond is located along the eastern pond boundary, adjacent to quadrant 2. The decant pond was slimed on the bottom and sides, but the bottom was not compacted. It stores water reclaimed from the tailings impoundment for reuse in the mill process or for irrigation and dust control on the tailings impoundment. A pump barge is used to pump the reclaimed tailings water to the lined reclaim pond or to a sprinkler system. EPA observed the decant pond barge pumping tailings water to the sprinkler system. The reclaim pond is located approximately 100 yards southwest of the tailings impoundment. At the time of EPA's site visit, the lined reclaim pond contained aquatic plants and tadpoles.

Two borrow pits, excavated in what appeared to be medium to coarse grained material, lie between the bedrock hill and the current eastern boundary of the tailings impoundment. EPA observed one of the borrow pits filled with water to approximately the same level as the adjacent decant pond.

According to the mine manager, the water is collected surface-water drainage and, due to the placement of slimes along the pond perimeter during the construction of the decant pond, is not presumed by the company to be the result of tailings water movement through subsurface materials.

In 1982, not long after the tailings impoundment began to receive tailings, water emerged west of the tailings dam, apparently as a result of seepage through the west tailings impoundment dam. An earthen dike was constructed in 1983 to contain the seepage in three toe ponds. According to a February 10, 1983, letter from Dames and Moore, ASARCO's contractor, the dike would allow for the collection and pumpback of the water to the tailings impoundment. The contractor cautioned that although the ponded water would not significantly affect the overall stability of the tailings impoundment starter dam, it could result in localized sloughing of the terrace slopes adjacent to Lake Creek downgradient of the starter dam. According to the mine manager, the water in the toe ponds is tested quarterly and the water is pumped back to the tailings impoundment for use in the sprinkler system. (MDSL, 1983)

In January 1991, MDSL conducted an inspection at the ASARCO tailings facility to investigate a report that a sinkhole had formed downgradient of the west tailings dam and toe ponds, near the edge of the terrace adjacent to Lake Creek. At the time of the State inspection, the hole was estimated to be 15 feet by 12 feet and 10 feet deep and water was heard draining through the hole. The origin of the sinkhole was attributed to water "piping" below ground surface. MDHES stated that water-quality data from a seep in the terrace slope, assumed to be directly associated with the sinkhole, indicates a component of tailings water. (ASARCO states that the original design engineer did not believe the sinkhole was the result of piping from the tailings impoundment and that springs and seeps existed in the area prior to construction.) MDHES suggested that the only immediate danger to the environment is from increased sedimentation to Lake Creek. Worst case scenarios would be mass failure of the terrace bank and head cutting into the sinkhole area. During EPA's visit to the sinkhole, the fine-grained materials along the walls of the hole appeared to be saturated, but no water flowed in the hole. (MDHES, 1991)

Downhill (downgradient) from the toe ponds is a topsoil stockpile. Below and both north and south of the topsoil pile are several springs located at approximately the slope break. Approximately six feet downhill from one of the seeps is a sump which collects water to be pumped to the tailings impoundment. The pump was operating at the time of EPA's visit. The EPA team observed iron staining along the surface flow path of the seep water. According to the mine manager, the seeps have been sampled numerous times and a report on the water quality of the seep indicated that the seeps were not tailings water. The MDSL sampled the seeps on two separate occasions and concluded that the water was of good quality, but that there appeared to be a correlation between several of the seeps and the north toe pond water. According to the mine manager similar seeps are found on the other side of Lake Creek, both upstream and downstream of the tailings impoundment. (MDSL, 1991; and ASARCO, 1990)

2.3.2.4 Waste Rock

During adit excavation and mine development, development waste rock was used as fill for the construction of the patio for the mill buildings, maintenance buildings, and general mine office buildings. Although the patio area is not considered a waste unit by the facility, impacted surface water has been associated with the fill materials. Therefore, for the purposes of this report, it will be discussed in this section. Waste rock is currently excavated (exact amounts unknown) and is backfilled into the mine.

A Stanley Creek monitoring point is located at least two miles downstream of the patio area. From 1985 to 1987, extensive sampling was conducted of Stanley Creek surface water and sediment below the patio fill in response to elevated copper concentrations detected in Stanley Creek surface water. The cause of these elevated copper concentrations was determined to be due to erosion of the waste rock used as fill in the patio upon which the mill was constructed. The scope of the entire corrective action was not documented in the reviewed documents, but ASARCO apparently took some type of erosion control measures. (MDHES, 1990)

2.3.2.5 Waste Oil Storage Tanks

Waste oils are stored onsite in aboveground storage tanks. The volume of these tanks was not stated in the available references. Moore Oil in Libby, Montana picks up the oil approximately once a month. EPA viewed used oil shipping records during the visit to the mine. Used oil shipments are not manifested in Montana because State laws do not consider waste oil to be a hazardous waste.

2.3.2.6 Burn Pit

Mine personnel stated that plant domestic garbage is disposed of at a landfill in Libby. Reference was made to a burn pit used for general waste in a 1987 Montana Department of Health and Environmental Sciences - Air Quality Bureau inspection report. However, according to ASARCO, wood products are no longer burned. (MDHES, 1987)

2.3.3 Waste Water Management Units

2.3.3.1 Mine Water

According to facility representatives, the mine has no current discharges to surface water. Mine adit water is used in the milling operation. According to the mine manager, if mine water discharge volumes exceed the needs of the mill circuit, the water is sent directly to the tailings thickener. As noted previously, the mine manager stated that the tailings are discharged from the thickener to the pipeline at a specific density in order to maintain proper performance of the pipeline. Consequently, it is unclear how large volumes of excess mine water may affect the performance of the tailings thickener and the density of the discharged tailings slurry. The facility does not monitor the quality of the mine water.

2.3.3.2 Sanitary Sewage

The facility maintains a septic tank system to treat sewage and sanitary waste. Treated septic tank effluent flows to the tailings thickener for reuse in the mill circuit or disposal in the tailings impoundment. The septic tank sludge has been removed once by a contractor. There is no specific monitoring of the septic system.

2.3.3.3 Assay Laboratory Wastes

According to ASARCO, dilute acids and other wastes from the wet chemistry laboratory are disposed of in lab sinks that drain to the flotation cells.

2.3.4 Hazardous Waste Management Unit

2.3.4.1 Waste Solvent Tanks

Waste halogenated solvents are stored on site and picked up every two weeks by Safety Kleen. These tanks were not visited by the EPA team. The location of the waste solvent storage tank(s) is not available in the reviewed information.

2.4 MONITORING

During the period prior to mine development and up to the time of the site visit, ASARCO has sampled surface water, ground water and air in the areas likely to be impacted by the Troy mining activities. As presented in ASARCO/Troy's mining operating permit, MDSL requires the mine to sample and analyze surface-water-quality. Since the permit was issued, MDSL has modified the monitoring requirements as needed. Ground-water monitoring was required at one time and tailings water monitoring has become a requirement. In addition, monitoring requirements for surface water have changed as monitoring results over time indicated a need for new analytical procedures, new monitoring locations, biological monitoring, termination of monitoring due to inconclusive or spurious results, and other difficulties. ASARCO conducts air monitoring as required by the Air Quality Bureau - Montana Department of Health and Environmental Sciences. The MDSL and MDHES also sample and analyze environmental media to check analyses reported by ASARCO and in response to citizen complaints of alleged violations.

2.4.1 Surface Water

The earliest surface-water-quality monitoring results discussed in MDSL documents provided to EPA are from Lake Creek in 1974. This early baseline surface-water monitoring conducted by ASARCO was complemented with monitoring in the Stanley Creek drainage in 1977, both above and below the mill site. The United States Geological Survey (USGS) and the Montana Bureau of Mines and Geology (MBMG) have both sampled Lake Creek below the tailings dam; the USGS monitored from 1976 to 1978 and the MBMG monitored from 1979 to 1982. EPA did not have access to the raw data collected by ASARCO (prior to 1985), MBMG or the USGS.

Water-quality monitoring required by the MDSL since 1985 includes surface-water and aquatic benthic macroinvertebrate sampling of three streams that could potentially be impacted by releases from the mine: Stanley Creek, Fairway Creek and Lake Creek. Five locations are sampled during the spring, summer, and fall quarters each year (see Figure 2-6

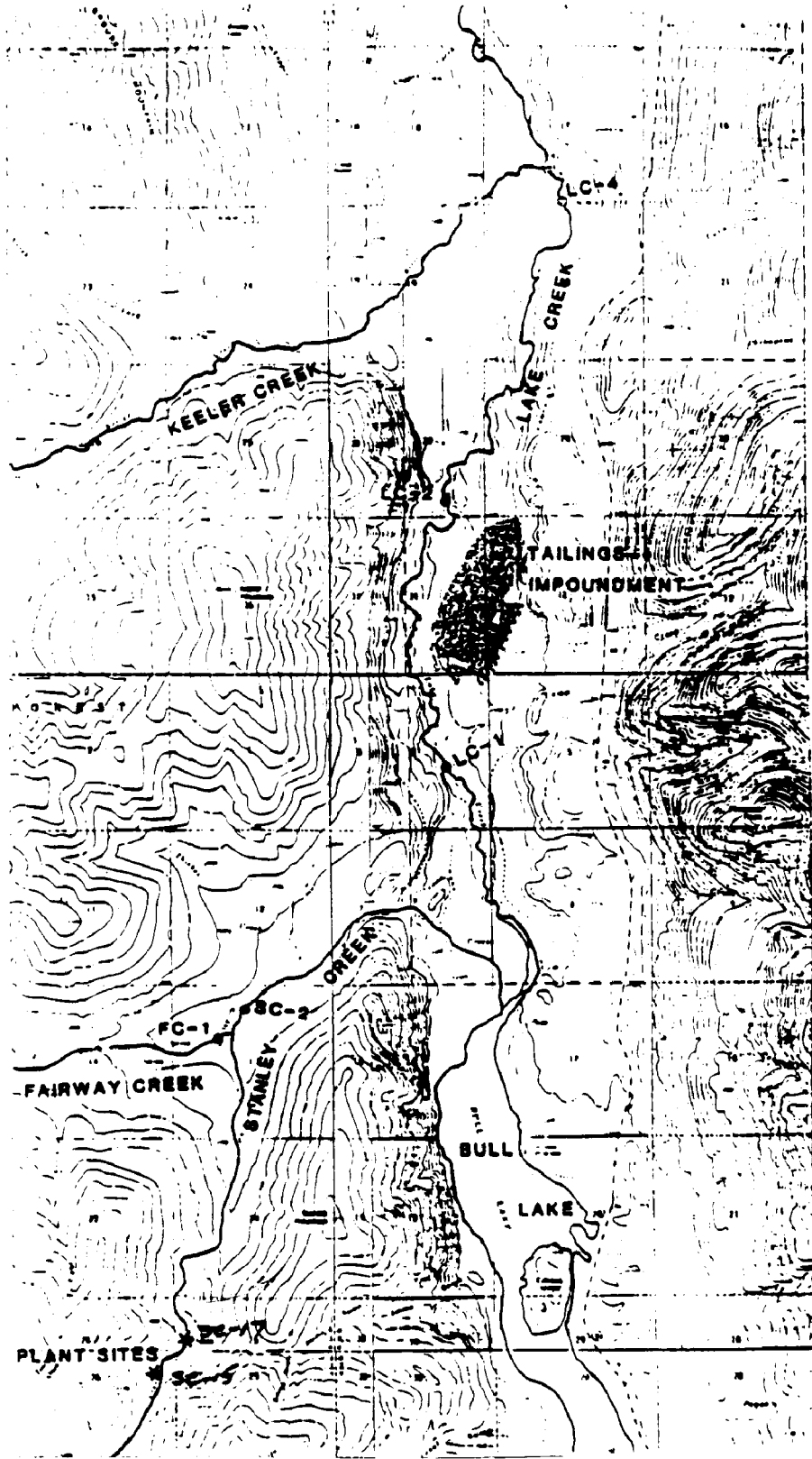


Figure 2-6. Sampling Locations (e.g., FC-1): ASARCO Troy Unit Macroinvertebrate Monitoring Program

). MDSL also requires the sampling and analysis of tailings water during each of the three quarters. Three sample locations are upstream of the tailings impoundment and two are downstream of the impoundment (see Figure 2-5). Two sample sites on Stanley Creek have been and continue to be sampled by the facility, the MDSL and the MDHES, but not as a monitoring requirement. (MDSL, MDHES, and ASARCO, 1987)

ASARCO is required to submit quarterly and yearly reports of the monitoring results. ASARCO also submits an interpretation of the results using statistical models, although this analysis is not required by the MDSL. The statistical models applied by ASARCO determine significant variations between study locations, seasons, and years. In addition, ASARCO determines statistical correlations between the macroinvertebrate and key water-quality data. (MDSL et al., 1987)

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The most recent MDSL report (1990 draft) performed basic statistics on all the ASARCO/Troy water-quality data available in the files of the MDSL and MDHES through 1988. The results of these analyses indicate that there is no statistical difference in the quality of the water at LC-1, LC-2, and LC-4 due to the operation of the mine and tailings impoundment. (MDSL, 1990)

2.4.2 Ground Water

According to a MDSL review of ASARCO Troy monitoring data, five ground-water wells were monitored from September 1983 to December 1984. The program was discontinued in 1984 due to several reasons. For example, the background well consistently produced water that exhibited toxicity to aquatic life (i.e., Daphnia). In addition, there were unresolved questions about the well completions, particularly the materials used. Finally, the MDSL determined that the ground-water hydrology under the tailings impoundment was too complex and the four ground-water wells surrounding the impoundment were not adequate to monitor a 400-acre area. The ground-water monitoring data for the period of September 1983 to December 1984 were not provided to EPA, and thus was not included in this report.

Although the facility is not currently required to conduct formal ground-water monitoring at the tailings impoundment, EPA noted several piezometers drilled into the west dam. According to the facility manager, these piezometers were installed for yearly stability analysis of the tailings dam and have not been used to monitor ground-water quality.

2.4.3 Air

The Air Quality Bureau of the MDHES requires ASARCO/Troy to maintain one-high volume six-day air sampler to measure total suspended particulates. Quarterly sampling reports are submitted to the State. According to the facility, the most recent monitoring report submitted to the State (at the time of the site visit) was for the winter quarter of 1990.

2.5 REGULATORY REQUIREMENTS AND COMPLIANCE

2.5.1 Operating Permit

The MDSL issues Mining Operating permits as required by the Montana Metal Mine Reclamation Act, and under the regulations promulgated in the Montana Hard Rock Mining Requirements. The operating permit is not issued until the Montana Environmental Policy Act/National Environmental Policy Act (MEPA/NEPA) process is complete [i.e., an Environmental Assessment (EA) or Environmental Impact Statement (EIS) has been completed] and the State makes a decision. When Federal lands are involved, the applicant must also obtain approval from the appropriate Federal agency (MDSL, 1990).

On February 18, 1974, ASARCO submitted application number 00128 to the MDSL for an operating permit. Numerous additional reports and data were submitted prior to the permit approval. The Montana Board of Land Commissioners approved ASARCO's \$2,752,000 Reclamation Bond on August 19, 1978 following MDSL's approval of ASARCO's operating plan. The MDSL issued Operating Permit Number 00093 on November 27, 1978. The permit required ASARCO to establish and/or continue a satisfactory water-quality monitoring program for Lake Creek (Montana Board of Land Commissioners, 1978; and MDSL, 1978).

The location of ASARCO/Troy on USFS lands necessitated the involvement of the Forest Service in the operating permit approval process. In 1978, The MDSL and the USFS jointly produced an EIS for the Troy mine. The USFS concurred with the operating plan (as included in the Draft EIS and slightly amended in the Final EIS) and issued a Forest Service Record of Decision (MDHES and USFS, undated).

The MDSL has approved three operating permit amendments for the mine and ASARCO/Troy has applied for a fourth amendment to date. USFS involvement in amendment approval was not found in the available file documents. Amendment No. 1, approved on July 19, 1979, incorporated the construction of the Stanley Creek tailings impoundment, the staging area, and the aggregate storage area. According to the mine manager, Amendment No. 2 was for the construction of the emergency pond below the tailings thickener. Amendment No. 2 was not available for review. Amendment No. 3, approved on July 14, 1983, incorporated the construction of a secondary dike below the tailings dam toe and installation of a permanent pumping station to maintain the water level of water ponding behind the secondary dike to at least 10 feet below the dike crest. According to the Mine Manager, the pending fourth amendment application requests approval for the excavation of an 18 x 18 foot ventilation adit to be driven from within the ore body to the southwest side of the mountain (MDSL, 1979, 1983).

2.5.2 Solid Waste

Mine waste is not regulated as a solid waste in Montana. The only solid waste managed on site is domestic garbage, used oil, and sewage sludge. The facility ships this waste offsite and is not subject to the State solid waste permitting requirements.

2.5.3 Surface Water

A Montana Pollutant Discharge Elimination System (MPDES) permit is required for all point source discharges to State surface waters, under authority of the Federal Clean Water Act. Montana operates a Federally delegated program. The MPDES permit is required regardless of whether an operating permit was issued by MSDL. The administrating office is the Water Quality Bureau (WQB) of the MDHES, which issues these permits and enforces the State surface-water discharge regulations. In addition, in accordance with the issuance of a full-scale mining operation permit, MDSL requires monitoring of surface-water and ground-water quality (MDSL, 1990).

The 1978 DEIS stated that discharges to surface water would be required to meet the State's water-quality nondegradation standard contained in the Montana Laws Regarding Water Pollution [Title 69, Chapter 48, 69-4801.2(1)(c)(iii)]. The nondegradation standard requires waters of higher quality than the State's water-quality standards to be maintained at the stream's higher quality. However, according to the MDSL, the Troy mine is exempt from this standard because it was permitted prior to 1984, and therefore, must only meet the State's water-quality standards (MDSL and USFS, 1978). In 1978, ASARCO/Troy Mine applied for a MPDES permit to discharge mine adit water from a settling sump.

2.5.4 Ground Water

Facilities which discharge directly to ground water, such as through the operation of a percolation pond, must obtain a Montana Groundwater Pollution Control System (MGWPCS) permit issued by the WQB of the MDHES. This permit is not required if MDSL issues a full-scale mining operating permit. This exemption exists because MDSL reviews and monitors the proposed operation at the same level as the WQB would review a MGWPCS permit application (MDSL, 1990). ASARCO is exempted from the ground-water permit requirement and the MDSL does not require ASARCO/Troy to conduct ground-water monitoring at any of the facility areas under the facility's operating permit.

2.5.5 Air

The MDHES, Air Quality Bureau (AQB) issues permits and regulates emissions from projects expected to exceed certain threshold values for various parameters. Generally an air permit is required if emissions of any pollutant, including fugitive dust, exceed 25 tons/year.

ASARCO/Troy applied for an Air Quality permit in December 1978 for the construction and operation of the secondary crushing plant. The application proposed the use of 5 baghouses to control particulate emissions from the secondary crushing plant, specifically, to address the ore transfer points in the plant (MDHES, 1978). The AQB issued permit No. 1316 to ASARCO/Troy on May 16, 1979 with a conditional approval (MDHES, 1979). One condition to be met by ASARCO was the installation and operation of at least one high-volume sampler in the vicinity of the mill site. The permit was modified in 1982 when the baghouse at

the secondary crusher building was replaced with a high efficiency wet scrubber (ASARCO, 1978; and MDHES, 1979).

2.5.6 Hazardous Waste

The Montana Department of Health and Environmental Sciences issues identification numbers to generators of hazardous wastes. The ASARCO/Troy Mine is assigned the hazardous waste generator identification number MT13096199989. The facility transports its hazardous wastes (e.g., safety-kleen solvents) offsite. There was no information in the files reviewed concerning releases of hazardous wastes. According to the mine manager there have been no releases of any waste type (small spills of reagents, fuels, solvents, etc. excepted).

2.6 REFERENCES

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APPENDIX 2-A

ASARCO COMMENTS ON DRAFT SITE VISIT REPORT

US EPA ARCHIVE DOCUMENT

[ASARCO comments on the draft site visit report were submitted in a letter dated January 14, 1992. This letter is not reproduced in this electronic version of this document. Copies of the comment document may be received from U.S. EPA, Office of Solid Waste, Special Waste Branch.]

APPENDIX 2-B

EPA RESPONSES TO ASARCO COMMENTS ON DRAFT SITE VISIT REPORT

A copy of the draft *Mine Site Visit: ASARCO/Troy Mine* was provided to ASARCO for their review. EPA addressed the comments submitted by ASARCO on January 14, 1992 (see Appendix 2-A) in the revised report as described below.

- Comment 1. The text on page 2 was changed to read: "...and concentration of the silver-bearing and non-silver bearing copper minerals." The text on page 6 now reads: "...the copper minerals chalcocite, bornite, and chalcopyrite and small amounts of copper oxides and native silver."
- Comment 2. The location of the fuel storage tanks on the sketch map (Figure 2-2 in the report) was not changed since the map was taken from the 1979 MDHES Air Quality Bureau Construction Permit Application. However, the text now includes a parenthetical note: "According to ASARCO, the fuel storage tank is actually located south of the shop rather than as shown in Figure 2-2."
- Comment 3. The sentence has been changed to read: "According to the mine manger, the mine is located on patented claims, the mill is located on unpatented claims, and the tailings impoundment is located on land owned by Kennecott Minerals and leased to ASARCO."
- Comment 4. EPA found that using the term "pond" for the tailings disposal area (rather than "impoundment" could lead to confusion with the various toe ponds on the site. Accordingly, the term "impoundment" was used when referring to the tailings disposal area and "pond" for the toe ponds. (Note that ASARCO used the term impoundment throughout its comments when referring to the tailings disposal area.)
- Comment 5. The text was changed to read: "The facility maintains two mill supply water wells in lower Stanley Creek between the mine administration building and the tailings impoundment. Each well is approximately 300 to 400 feet deep. The facility representatives were unable to provide information about the yields of the wells or the volume of water provided to the mill by these wells. Three domestic water wells or the volume of water provided to the mill by these wells. Three domestic water wells are also present in lower Stanley Creek. Another well, located 400 yards from the site, supplies potable water to the facility. Accordingly to ASARCO, the domestic wells are completed in bedrock, but the lithology within which the other wells are completed remains unidentified."
- Comment 6. The text was changed to read: "According to ASARCO, the domestic wells are competed in bedrock, but the lithology within which the other wells are completed remains unidentified."
- Comment 7. The text now reads: "...according to ASARCO, four ground water test wells are located on the west side of the impoundment. No information was available concerning the completion, date of installation, or monitoring of these wells."
- Comment 8. The reference to chemical separation has been deleted.
- Comment 9. The text now reads: "The underground mining operations are accessed by vehicles through two main adits, the service adit and the main haulage adit. These two adits and the south and conveyor adits function as air intake adits. The EPA team entered and exited the mine via the service adit. Two additional aids (the east and west adits) function as air exhaust adits. Rock removed during adit excavation was used as fill to construct patios for the surface buildings."

- Comment 10. ASARCO was subsequently offered the opportunity to review a more legible copy of this figure. Unfortunately, they were not able to provide comments prior to the time the report had to be revised.
- Comment 11. The text has been changed to read: "Fines falling through the double deck screen (minus 1/2 inch) are transported by belt conveyor to the fine ore bin. Oversized material is fed to the cone crusher for size reduction. The product of the cone crusher is transferred to single deck screens (with slots minus 1/2 or 5/8 inch by 3 inches) for sizing. Material falling through the single deck screen is conveyed to a fine ore surge bin. Coarse materials remaining on the screen are fed into the short head cone crushers."
- Comment 12. The reference to Wagner ST8 machines has been removed and the use of Caterpillar 980 loaders is noted.
- Comment 13. The reference to a grizzly has been deleted.
- Comment 14. The text has been changed to read: "A 10,000 gallon diesel fuel tank is stored in a topslice heading down grade from the underground maintenance facility."
- Comment 15. ASARCO commented that the drum storage rooms noted by EPA as having been observed during the mine tour are unknown to them. EPA did not tour the fuel storage areas or the room seen during the mine tour, so it is not known if the drums were of "antifreeze or grease," as ASARCO suggested in their comment, or whether they were stored in the fuel storage area, as also was suggested. The revised report continues to note that "drums were observed during the mine tour."
- Comment 16. The text now reads: "Material falling through the single deck screen is conveyed to a fine ore surge bin."
- Comment 17. The text has been changed to read: "The collected dust is returned to the belt and transported to the fine ore bin. The mill superintendent stated that the bags are disposed of "at the end of their life."
- Comment 18. The text in these paragraphs now reads:
- "Potassium amyl xanthate, a collector, and an 80/20 mixture of pine oil and Dowfroth 250 (a frothing agent) are added to the cyclone overflow before it enters the flotation circuit. Collectors coat the target minerals and make them hydrophobic. Frothers stabilize air bubbles in the flotation unit, allowing the target minerals to cling to the bubbles and rise to the top of the flotation unit. The 80/20 frother mixture is added to the slurry at a rate of 0.02 pound per ton of feed and the xanthate at 0.03 pound per ton of feed.
- "The chemically fortified ore slurry is pumped to one of three banks of seven 500 Wemco 144 flotation cells. Air is injected from the bottom of the cell into the slurry. The ore mineral particles attach to the air bubbles and rise to the surface. A bubbling froth is created at the surface of the cell as the minerals float to the top of the cell. This surface froth of air bubbles, water and ore minerals overflows the cell into a collection launder. The froth from the first three cells of each bank is collected and pumped to the first column cell. The froth from the remaining four cells of each bank is collected and pumped to cyclones for size classification.

"Ore froth overflow (fine material) from the cyclone flows to a middlings thickener. The cyclone underflow (coarse material) flows to the regrind ball mill. The valueless gangue minerals (e.g., quartz) settle and flow out the bottom of the flotation cells to the tailings thickener.

"The first column flotation cell is used to "clean" (remove unvaluable minerals) the froth from the first three Wemco cells. The froth from the first column cell reports to the final concentrate thickener. The tailing or underflow of the first column cell is pumped to a cyclone for size classification.

"The thickened middlings concentrate is sent to two banks of first cleaner flotation cells. Concentrate overflow from the first cleaner cells is sent directly to the second column cell. The tailings are sent to the cleaner scavenger cells. Second column cell concentrate overflow goes directly to the concentrate thickener and the tailings report back to the first cleaner flotation.

"The cleaner scavenger froth concentrate is pumped to a cyclone for size classification. The cleaner scavenger tailing flows to the tailings thickener."

- Comment 19. The sentence has been changed to refer only to water removal from the emergency overflow basin.
- Comment 20. The text has been changed to read: "Four toe ponds (two north toe ponds, toe pond number two, and south toe pond) are located along the toe of the west dam,..."
- Comment 21. The purpose of the map is to show the relationship between various elements in the tailings disposal area. The legend of the map notes that it is "Not to Scale." In addition, the text now includes a note that emphasizes that the map is not drawn to scale.
- Comment 22. The text now reads: "Tailings impoundment design allows for the addition of approximately 40 feet in height before design capacity is reached. ASARCO estimates that the remaining reserves will require 20 feet in additional height over the next 7 to 10 years."
- Comment 23. The text now notes that "...according to ASARCO, wood products are no longer burned."
- Comment 24. The text has been changed to read: "According to ASARCO, dilute acids and other wastes from the wet chemistry laboratory are disposed of in lab sinks that drain to the flotation cells."
- Comment 25. The report referred to by ASARCO was compiled by the Montana Department of State Lands and was furnished to EPA by the Department.
- Comment 26. The text now reads: "The well water is currently sampled monthly for coliform and a chlorinator is available for use if needed."
- Comment 27. ASARCO's position has been noted in the report.
- Comment 28. ASARCO's position has been noted in the "Tailing Impoundment" section (the "Conclusions" section, which contained the wording on which ASARCO commented, has been deleted).

