



Site Inspection Report Kennicott Mine Kennicott, Alaska

EPA REGION X

Contract No. 68-W9-0046
Work Assignment No. 46-23-0JZZ
Work Order No. 4000-019-010-4100
Document Control No. 4000-019-010-AAAY

April 1995



SITE INSPECTION REPORT
Kennicott Mine
Kennicott, Alaska

Prepared for

U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Contract No. 68-W9-0046
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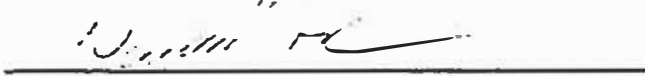
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SITE INSPECTION REPORT
Kennicott Mine
Kennicott, Alaska
Site Identification No. AKD983073123

Site Name/Address

Kennicott Mine Site
Near Wrangle-St. Elias National Park and Preserve
Kennicott, Alaska 99566

Latitude 61°28'58.3"N and Longitude 142°53'14.3"W

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ABSTRACT

Pursuant to United States Environmental Protection Agency (EPA) Contract No. 68-W9-0046, a sampling Site Inspection (SI) of Kennicott Mine located in Kennicott, Alaska was conducted. Kennicott Mine operated as a copper mine from 1911 to 1938 in an area now surrounded by the Wrangell-St. Elias National Park and Preserve. Mine tailings, oil spills, and other results of mine operations remain at the site and are potential sources of contamination for surrounding human and ecological receptors.

The objectives of this SI were to:

- Characterize potential source areas throughout the mine's mill town.
- Determine if any contamination at areas identified as potential sources has migrated into nearby surface water bodies.
- Evaluate the potential for source particulates to migrate via the air pathway.
- Evaluate the potential for contaminants to impact human and ecological receptors.

To achieve these objectives, 20 surface and subsurface soil samples, 8 sediment samples, 5 surface water samples, and 8 wipe samples were collected by Roy F. Weston, Inc. (WESTON®) in July 1994. Samples were analyzed for some or all of the following: Target Analyte List inorganics, volatile organic compounds (VOCs), base neutral acids (BNAs), polychlorinated biphenyls (PCBs), pesticides, and/or grain size. In soil and sediment, all analyses except grain size were analyzed through EPA's Contract Laboratory Program. Metals analysis of water samples, analysis of wipe samples, and analysis of grain size were performed by the EPA Region X laboratory in Port Orchard, Washington.

SECTION I

INTRODUCTION

Pursuant to United States Environmental Protection Agency (EPA) Contract No. 68-W9-0046, WESTON conducted a Site Inspection (SI) of Kennicott Mine located in Kennicott, Alaska. The SI was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The SI process is intended to document a threat or potential threat to public health or the environment as posed by a site, to identify whether a potential emergency situation exists that may require an immediate response, to document the presence or absence of uncontained or uncontrolled hazardous substances on a site, and to confirm site characteristics and area receptor information collected during the preliminary assessment. In addition, the SI process is intended to collect sufficient data to enable evaluation of the site's potential for inclusion on the National Priorities List (NPL) and, for those sites determined to be NPL candidates, establish priorities for additional action. The SI process does not include extensive or complete site characterization, contaminant fate determination, or quantitative risk assessment.

A Preliminary Assessment (PA), the first step in the CERCLA/SARA process, was conducted in 1992 to review existing information on the site and its environs to assess the threat, if any, posed by the site to public health, welfare, or the environment and to determine if further investigation (an SI) under CERCLA/SARA was warranted. After reviewing the PA, EPA decided that further investigation of Kennicott Mine would be necessary to more completely evaluate the site using EPA's Revised Hazard Ranking System (HRS) criteria. The HRS assesses the relative threat to human health and/or the environment associated with the actual or potential releases of hazardous substances at a site.

This document presents a summary of the objectives, activities, and results of the Kennicott Mine SI. Included are descriptions of site background information and potential migration or exposure pathways (Section 2), sampling activities and analytical requirements (Section 3), a discussion of sample results (Section 4), and conclusions regarding the site (Section 5).

SECTION 2

BACKGROUND

2.1 OWNERSHIP

Surface and subsurface land at Kennicott Mine is currently owned by a variety of private entities. Kennecott Corporation of Salt Lake City, Utah, which operated the mine, retains ownership of the subsurface land. The Great Kennicott Land Company, a limited partnership based in Anchorage, Alaska, purchased the surface property in the early 1960s. The Great Kennicott Land Company divided the property into approximately 500 parcels, approximately 90 of which have been sold to private individuals. The majority of the parcels which have been sold are located in the mill town area. (Gilbert 1994; Harrower 1994; Schurtz 1994).

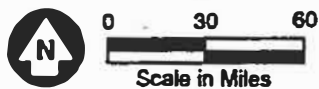
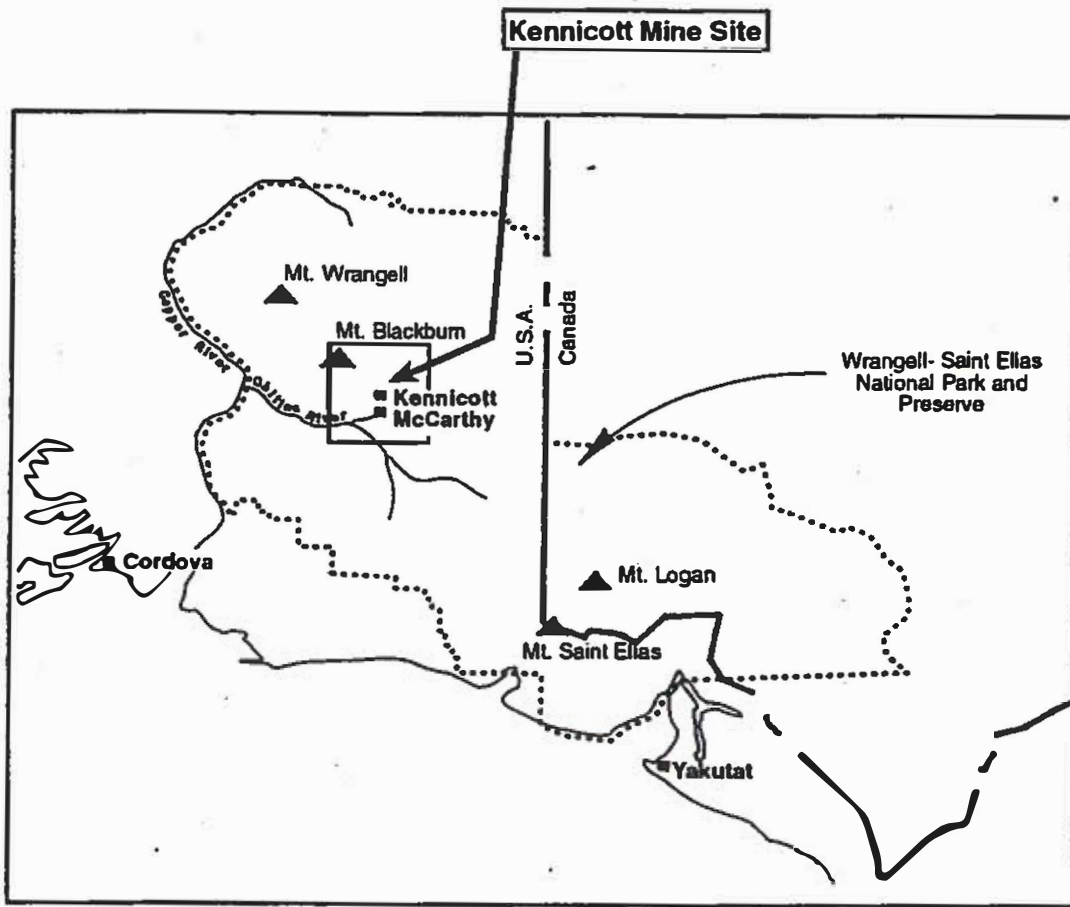
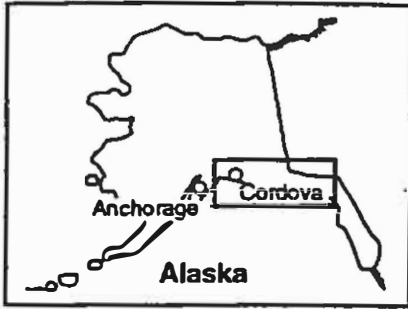
2.2 SITE LOCATION AND DESCRIPTION

The Kennicott Mine is an abandoned copper mine surrounded by the Wrangell-St. Elias National Park and Preserve, 5 miles north of the town of McCarthy, Alaska, in Township 4 South, Range 14 East, Sections 21, 22, 27, 28 and 33. (Figure 2-1). Global Positioning System (GPS) readings collected by WESTON personnel at the center of the mill town indicated that the latitude is 61° 28' 58.3" North and the longitude is 142° 53' 14.3" West.

The Kennicott Mine consists of a mill town, five mines and associated roads and tramways. The mill town (the primary focus of this SI), contains a variety of abandoned buildings—the largest of which include the mill, power plant, and leaching and flotation plant (Figure 2-2). The mill town is backed by Bonanza Ridge to the northwest, the location of five former mines. The mines—Erie, Jumbo, Glacier, Mother Lode, and Bonanza—were connected to the mill town by roads, trails, and aerial trams when the mine was operational. The mill town and mines cover approximately 3,000 acres (Figure 2-3).

The mine, designated the Kennicott National Historic Landmark (through a historical error, Kennicott is the geographic name and Kennecott is the mining company name), has been identified by the National Trust for Historic Preservation as one of the nation's eleven most endangered historic properties. Although it is remote, the Kennicott Mine site attracts a number of visitors. In 1987, the owners of the site proposed selling all 3,000 acres of the mill town and mine areas to the National Park Service, although, at this time, the sale has not been made. (NPS 1993/94).

The mine is surrounded by the Wrangell-St. Elias National Park and Preserve and borders the Kennicott Glacier to the southwest. In the vicinity of the Kennicott Mine, the Wrangell-St. Elias National Park and Preserve is composed of lands designated as park, preserve and



Source: America North/
EMCON, Inc., 1992

Kennicott Mine Vicinity Map

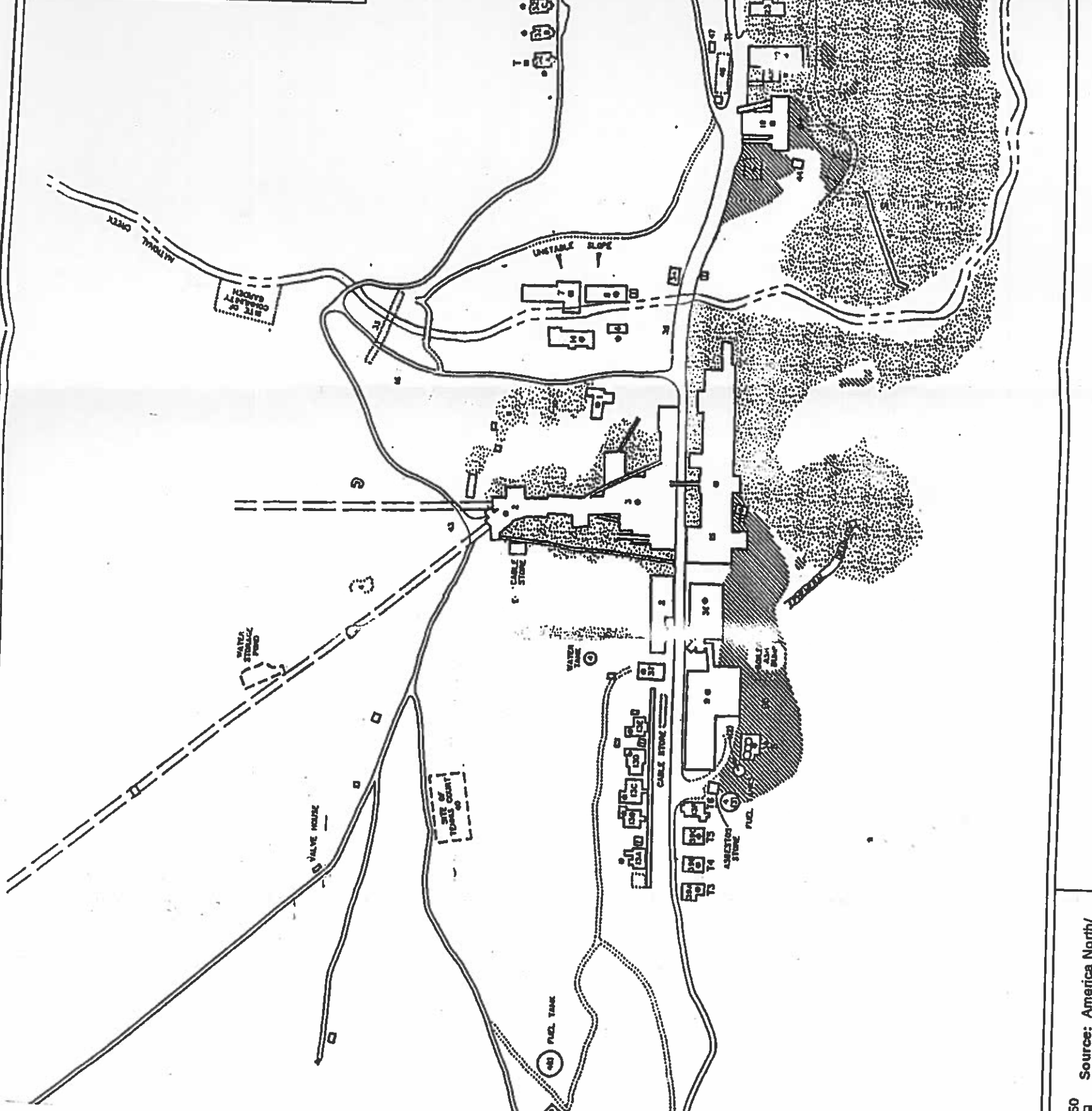


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April 1995

FIGURE
2-1

Building Explanation	
30	REAR OFFICE
31	OFFICE
32	OFFICE
33	OFFICE
34	OFFICE
35	OFFICE
36	OFFICE
37	OFFICE
38	OFFICE
39	OFFICE
40	OFFICE
41	OFFICE
42	OFFICE
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95	OFFICE
96	OFFICE
97	OFFICE
98	OFFICE
99	OFFICE
100	OFFICE

Explanation	
[Symbol]	BUILDING
[Symbol]	ROAD OR TRAIL
[Symbol]	CRACK
[Symbol]	AERIAL TRUNKWAY
[Symbol]	TAILINGS
[Symbol]	BARBARE & INDUSTRIAL SCRAP DUMP
[Symbol]	SURFACE STORAGE TANK
[Symbol]	FINDHOUSE
[Symbol]	DAMP AREAS DESCRIBED IN TEXT
[Symbol]	PICTURELET LOCATION PAST AND PRESENT
[Symbol]	SEWAGE OUTFALL
[Symbol]	LEACHFIELD
[Symbol]	BUILDING WITH ASBESTOS



Kennicott Mill Town Map

0 125 250
Scale in Feet

Source: America North/
EMCON, Inc., 1982

4000-19-10-4100
April 1995

WESTON
CONSULTANTS

wilderness preserve, each with distinct management practices. Only at the remote Erie Mine does the Kennicott Property border on designated park land. All other bordering land is designated preserve. The tramway to Jumbo Mine and the associated Junction Station occupy preserve land (NPS, 1992).

2.3 SITE OPERATIONS AND WASTE CHARACTERISTICS

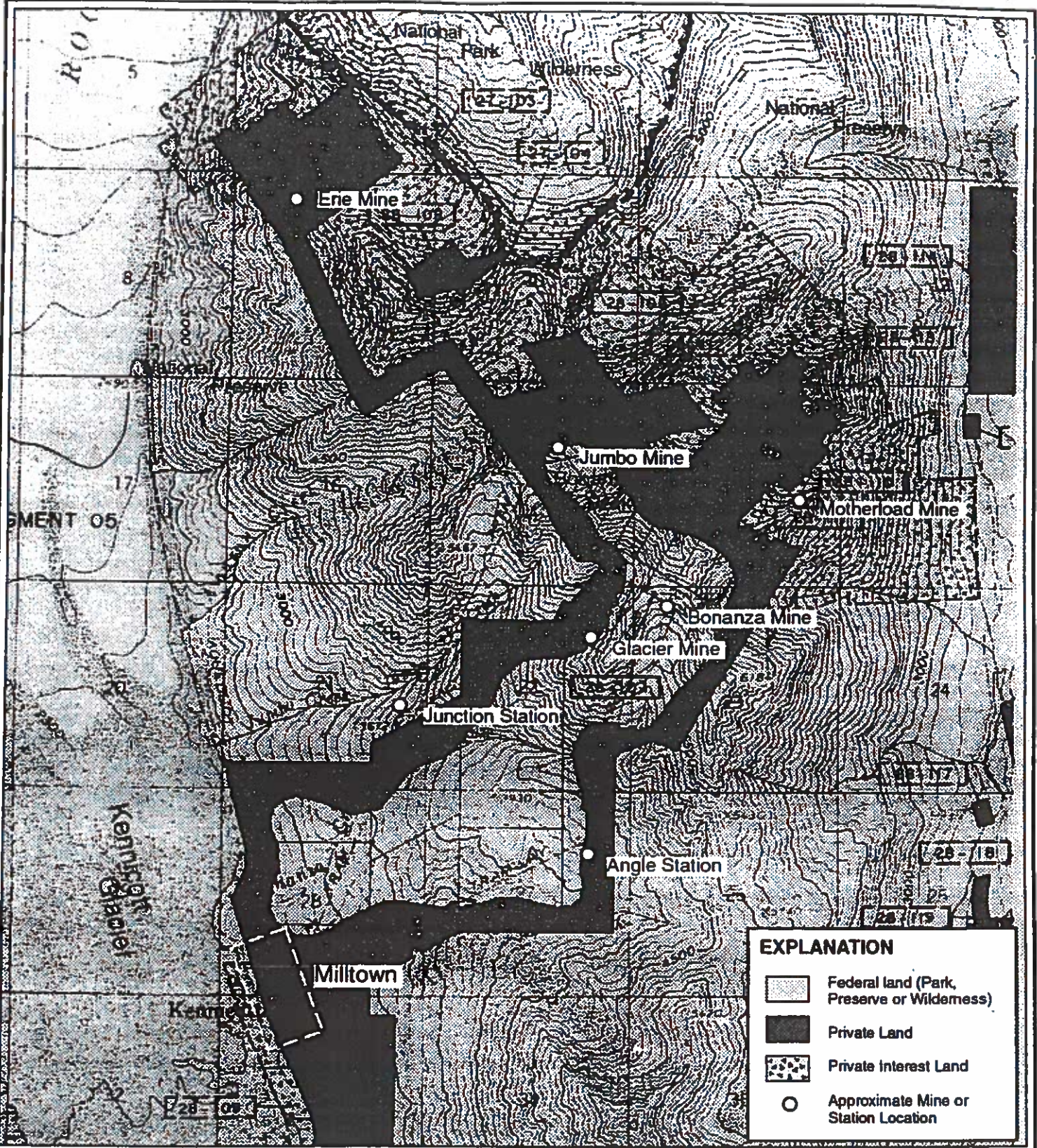
From 1911 to 1938, the mine produced over 590,000 tons of copper which was transported by rail to the port town of Cordova and shipped to a smelter in Tacoma, Washington (Kay and Miller, 1990). Operations included the extraction of chalcocite ore (copper sulfide) from limestone at the five mines along Bonanza Ridge and transport of the ore to the mill town. At the mill town, the ore was crushed and gravity-sorted in the mill building and shipped by rail to Cordova, Alaska. Tailings were deposited on-site. After 1916, an ammonia leaching and flotation plant was used to further refine the ore prior to shipment. By 1938, low copper prices and the discovery of ore bodies elsewhere led to the closure of the mines and abandonment of the railroad. After closure, there were efforts to demolish buildings on the site and perform surface mining. The mine was nominated in 1977 to the National Register of Historic Places and became a National Historic Landmark in 1986 (Kay and Miller, 1990). Current use is mainly recreational.

Inventories of hazardous waste and sampling investigations have identified areas of environmental concern including approximately 600,000 cubic yards of mill tailings, the boiler ash pile, the Power Plant Oil Spill, asbestos and lead paint in mill town buildings, remaining quantities of fuel oil and ammonia in storage tanks, and numerous small spills and waste piles. Creeks running through the site and uncontrolled access to potentially contaminated areas provide potential exposure and migration pathways to residents, tourists and surrounding sensitive environments.





2.4 REGULATORY HISTORY

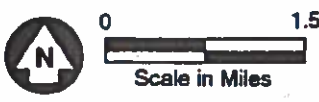
In October 1990, the University of Alaska School of Engineering conducted a study identifying potential areas of hazardous waste at the mine (Kay and Miller, 1990). The purpose of the study was to identify areas on which future investigations should focus. A Site Investigation was performed in 1992 by America North/EMCON, Inc., for Kennecott Corporation, to characterize soil, groundwater, and surface water conditions at the mine site as well as arrange removal of potentially hazardous wastes (America North/EMCON, 1992). In 1991, Asbestos General, Inc., performed a survey of the site and recommended asbestos removal (Asbestos General Inc., 1991).

In September of 1992, Alaska Department of Environmental Conservation (ADEC), completed a PA of the site in which they identified hazards requiring further characterization.



EXPLANATION

-  Federal land (Park, Preserve or Wilderness)
-  Private Land
-  Private Interest Land
-  Approximate Mine or Station Location



Source: NPS, 1992

Kennicott Mine Site Map



4000-19-10-3300
June 1994

FIGURE
2-3

A potential hazardous waste site disposition form was completed concurrent with the PA, recommending an SI for Kennicott Mine. In July 1994, a site investigation of the Kennicott Mine was conducted by WESTON for the EPA.

2.5 CONDITIONS DURING SITE VISIT

From 26 July through 29 July WESTON personnel, accompanied by representatives of Kennecott Corporation and their consultants, EMCON Alaska, Inc., visited the site. Additional information was obtained from the contacts listed in Appendix A. The following sections discuss existing conditions at the site. Due to the magnitude of the mine, the inspection focused on the mill town and areas downgradient of town.

2.5.1 Mill Town Buildings

Site reconnaissance and sampling activities allowed inspection of a number of the mill town buildings including the leaching and flotation plant, power plant, mill building, store, bunkhouse, foundry and various cottages.

The leaching and flotation plant contained numerous metal and wooden stave tanks at either end (averaging approximately 15 to 20 feet in diameter to a height of 15 feet) used for storage and ammonia leaching. At least one of the metal tanks was tilted, suggesting instability in the foundation. As identified in the Site Investigation (America North/EMCON, 1992), two of the ammonia tanks still contained dilute ammonia solution. The elevated central portion of the building contained the absorber, condenser and evaporator tanks. At the time of the visit, water was flowing through the building beneath the southernmost tanks. Where it exited the building on the west side, the water created a channel through the tailings and joined National Creek at the bottom of the slope. It appeared as if the water had historically run through the plant; the channel could be seen in old photographs of the site (photographs contained in the Kennicott Lodge, date unknown) and some of the ammonia leaching tanks appeared to have been designed to drain into the channel. Ice reportedly formed on the plant floor each year and was visible during the site visit. As part of the asbestos removal, tailings were spread on the plant floor to a depth of 1 to 3 feet to cap residual asbestos that could not be removed from flooring material.

The power plant contained four boilers roughly 4,000 cubic feet in size. The boilers had been filled with polystyrene foam and sealed with welded metal plates to contain interior asbestos. Oil was present in floor trenches and was thought to be flowing from an upgradient fuel tank [Figure 2-2, tank 4(1)] which still contained approximately 26,600 gallons of oil (America North/EMCON, 1992). According to asbestos removal personnel, the oil can be observed flowing in the floor utility corridors when the ambient temperature reaches 80 degrees. The bottom of the utility corridors is reportedly soil, and it has been hypothesized that the oil spill

downslope of the power plant may partially represent oil seeping from the power plant utility corridors (American North/EMCON, 1992).

The mill building contained much of the historic processing equipment. Some ore bins contained small amounts of finely ground ore concentrate, and some shaking tables still contained small amounts of lubricating oil.

The store, bunkhouse, foundry, refrigeration plant, and various cottages were also visited. No suspected contamination or sources were identified in any of these buildings except the foundry. Soil below the foundry building appeared to be of a similar color as the ore concentrate found in the mill building, suggesting spillage or disposal of concentrate in the area.

2.5.2 Potential Sources of Contamination

The potential sources of contamination—the tailings pile, the Power Plant Oil Spill, the boiler ash pile, and several dumps—were inspected during the site visit.

2.5.2.1 Tailings Pile

The tailings pile, estimated to contain approximately 600,000 cubic yards of tailings (America North/EMCON, 1992), was distributed irregularly downslope of the mill town. Over time, the tailings appeared to have shifted downslope and broken through containment cribbing. National Creek, which during mining operations was routed through a conduit under the tailings pile, has since carved a course through the tailings.

The tailings were gravelly in nature and no wind-generated dust was observed during the time spent at the site. Disturbance of the tailings from walking and road construction, however, generated visible dust that was carried by a light wind. Blue and green pieces of azurite and malachite were observed throughout the tailings pile.

At the time of the site visit, roads had been cut through the tailings pile and tailings appeared to have been used throughout the mill town and along the road to McCarthy for ground cover and fill. Reportedly, the McCarthy airport, 3.5 miles south of the mill town, was surfaced with mine tailings.

In two roads cut through the tailings pile below the leaching and flotation plant, layers of oil were seen as deep as 5 feet. The oil appeared to have migrated downward through the coarser grained tailings and had a strong hydrocarbon smell. Below the leaching and flotation plant, a seep flowed from beneath the tailings pile over bedrock. The seep had stained surrounding rocks red.

The potential for inorganic chemicals in the tailings to leach into groundwater was evaluated during the 1992 site investigation conducted by EMCON, Inc., for the Kennecott Corporation. Thirty tailings samples were collected and analyzed for total sulfide (EPA Method 9030) and leachable metals (EPA Method 1312 Synthetic Precipitation Leachate Procedure). No sulfides were detected in any of the samples. Of the eight inorganics included in the leach test (silver, arsenic, barium, cadmium, chromium, mercury, lead, and selenium), only barium was detected. Barium was detected at concentrations ranging from 0.1 to 0.3 mg/L, which were well below the Resource Conservation and Recovery Act (RCRA) criterion (100 mg/L). Based on these results, it was concluded that the potential for acid generation and leaching of metals was low. (EMCON Alaska, Inc., 1992).

2.5.2.2 Power Plant Oil Spill

The oil spill below the power plant and fuel tanks 4(2) and 4(3) (Figure 2-3) had a hard asphalted crust extending downslope to an area of tar-like ponded oil. The asphalted surface was difficult to break with a pick.

2.5.2.3 Boiler Ash Pile

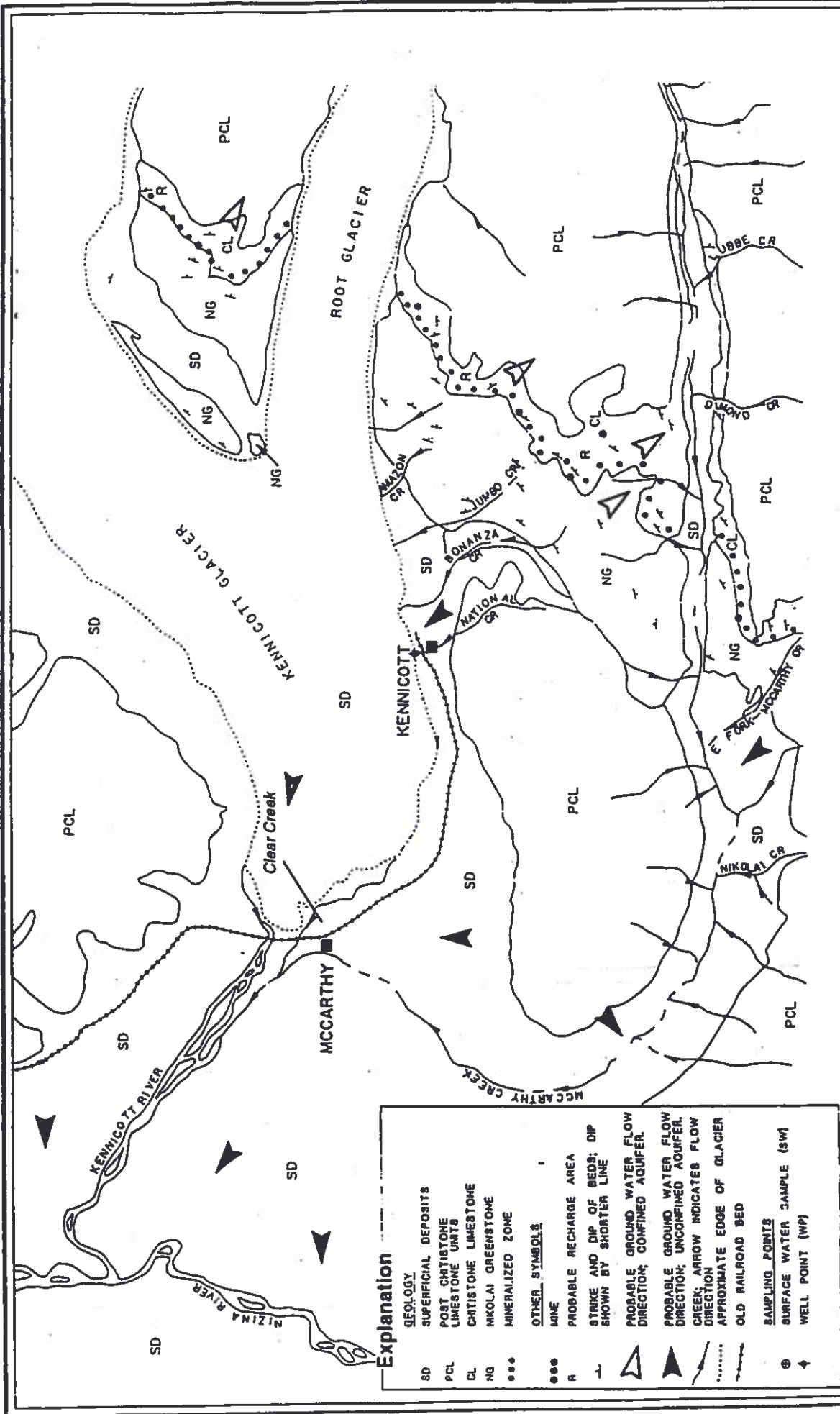
The boiler ash pile, located on the west side of the power plant and foundry, consisted of dark dry granular material mixed with bits of rusted metal and glass. It is unknown if the pile was boiler ash or was generated from activities at the adjacent foundry (Kay, 1994). This pile was subsequently capped by the Kennecott Corporation during remedial activities in September 1994 (see Section 2.7 - Summary of Remediation Activities).

2.5.2.4 Dumps

Dumps of rusty 55-gallon drums and other containers, metal scrap, mechanical parts, and fabric-like garbage were strewn throughout the mill town. The largest dump, containing hundreds of rusty 55-gallon drums, covered approximately 12,000 square feet at the southwest edge of the tailings pile, down a steep slope from the mill town. Three or four of the drums appeared to contain residual dark oily material and the rest were empty. The condition of the drums and the age of the labels on other debris in the pile indicated that they were deposited there at the time of mining operations.

2.5.3 Drainage and Water Supplies

Drainage patterns around the site are presented in Figure 2-4. National Creek, which runs through the tailings pile, and Jumbo Creek, which drains Bonanza Ridge downslope of the mine sites, were clear fast-flowing creeks which terminated beneath the Kennicott Glacier. There were no reports of fish in the creeks; their presence would be extremely unlikely due to the barrier of the glacier to upstream travel. A surface water intake in National Creek was observed above the mill building. It consisted of a 1-inch-diameter PVC pipe and was



Explanation

GEOLOGY	
SD	SUPERFICIAL DEPOSITS
PCL	POST CRISTOBITE LIMESTONE UNITS
CL	CRISTOBITE LIMESTONE
NG	NIKOLAI GREENSTONE
•••	MINERALIZED ZONE
•••	OTHER SYMBOLS
R	PROBABLE RECHARGE AREA
-	STRIKE AND DIP OF BEDS; DIP SHOWN BY SHORTER LINE
▲	PROBABLE GROUND WATER FLOW DIRECTION; UNCONFINED AQUIFER
▶	PROBABLE GROUND WATER FLOW DIRECTION; CONFINED AQUIFER
▶	PROBABLE GROUND WATER FLOW DIRECTION; UNCONFINED AQUIFER
▶	CREEK; ARROW INDICATES FLOW DIRECTION
—	APPROXIMATE EDGE OF GLACIER
—	OLD RAILROAD BED
⊙	SAMPLING POINTS
⊕	SURFACE WATER SAMPLE (SW)
⊖	WELL POINT (WP)

Drainage Patterns

FIGURE 2-4

Source: America North/
EMCON, Inc., 1992



4000-19-10-4100
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thought to supply the Kennicott Lodge and/or the resident in Cottage 24. As discussed above, National Creek was previously directed under the tailings pile and dammed above the mill town bridge. The creek has returned to its course but the dam and conduit are still visible. Where the creek runs through the tailings pile, its banks are composed of tailings, and, although it has cut down to bedrock in many locations, tailings likely compose some of the creek's bed material. A surface water intake pipe was observed serving the cottages at the north end of the mill town but was thought to receive water from a spring or water tank above the power plant rather than National Creek. No surface water intakes in Jumbo Creek were observed.

Kennicott River, composed of the meltwater of the Root and Kennicott glaciers near the town of McCarthy, was extremely silty with a fine grey material. There was no visibility below the water surface. Water flowing from the valley, including the runoff from the mill town, was thought to flow along bedrock under the glacier and emerge in Kennicott River. Dye deposited in National Creek as reported in the Site Investigation report (America North/EMCON, 1992) appeared in the Kennicott River in four days. The rapid movement of water under the glacier was evidenced when, during the site visit, a lake up the valley released its contents below the glacier (due to a broken ice dam) causing the Kennicott River to rise 6 feet. Surface water sampling in McCarthy occurred prior to this event.

McCarthy Creek, which joins an arm of the Kennicott River below the town of McCarthy is less silty than the Kennicott River. McCarthy Creek drains the east side of Bonanza Ridge while the Kennicott River drains the west side.

Clear Creek, a series of creeks and springs between the Kennicott River and McCarthy Creek provides drinking water to McCarthy. Numerous hoses, presumed to be private surface water intakes, as well as the pumphouse for McCarthy Lodge, were observed in Clear Creek. Spring water likely comes from shallow groundwater that is recharged by the Kennicott River and McCarthy Creek but the exact source of the springs is unknown. Unlike the Kennicott River and McCarthy Creek, Clear Creek is not opaque or silty.

2.5.4 Asbestos Removal

Removal and containment of asbestos from the mill town were being completed by Technical Services, Inc. (TSI) during the site visit. Two EMCON Alaska personnel were performing asbestos air monitoring. All six personnel involved in the asbestos removal were housed in the mill town at the Kennicott Lodge and the two former schoolhouses (Figure 2-4, Buildings 23 and 27). Removal activities began in May 1994 and were scheduled to finish in August 1994. The only suspected asbestos-containing material (ACM) in any mill town building or dump was inside four power plant boilers which had been sealed and filled with polystyrene foam to contain internal asbestos. In the boilers, small amounts of suspected ACM could be seen where the foam had not made a complete seal. Although WESTON did not perform a

complete asbestos survey, a member of the WESTON field team was a certified Building Inspector as defined by the Asbestos Hazard Emergency Response Act.

2.5.5 Population

There is one permanent resident living in Cottage 24, located directly adjacent to the tailings pile, in the mill town. A family of five lives approximately 1 mile down the road toward McCarthy. The permanent population of McCarthy was reported to be 20 to 30 people.

Kennicott Lodge, in the mill town, employs approximately 15 people during the summer months. Employees are lodged in bunkhouses adjacent to the Kennicott Lodge and in cottages on the north end of the mill town. As discussed previously, there were six people involved in the asbestos removal project living in the mill town this summer.

There were at least five seasonally occupied cottages in the mill town and an unknown number along the McCarthy Road. Kennicott Lodge was filled to capacity during the site visit, and there were numerous tourists visiting the mine.

2.6 POTENTIAL CONTAMINANT TRANSPORT PATHWAYS/RECEPTORS

This section discusses the potential pathways for migration of contaminants from site sources. Potential receptors are also described for each pathway. As previously discussed, this inspection focuses on the mill town and areas downgradient of town.

2.6.1 Groundwater Pathway

2.6.1.1 Site Geology and Hydrogeology

The Kennicott Mine is located along the south slope of the Wrangell Mountains, near the termini of the Kennicott and Root glaciers. The principal geologic formations underlying the Kennicott mine are late Triassic Chitstone Limestone underlain by the older mid-to-late Triassic Nikolai Greenstone. Copper mineralization occurred in the dolomitized limestone at the contact between the two layers (Kay and Miller, 1990).

Groundwater has not been well-characterized in the area due to the difficulty of distinguishing groundwater from surface water along the exposed bedrock and beneath the glacier. The greenstone and limestone units are not considered productive aquifers, and the glacial moraine aquifer bordering the Kennicott Glacier is subject to a high level of dilution from glacial meltwater (America North/EMCON, 1992).

Groundwater on Bonanza Ridge would be expected to flow along the bedrock layer and feed into the creeks draining the ridge or into the mix of surface water and glacial meltwater

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beneath the glacier. The majority of this mix is assumed to feed the Kennicott River. The spring which creates Clear Creek in McCarthy would also likely be fed, in part, by this mix.

2.6.1.2 Groundwater Usage in Area

There are no known effective aquifers beneath the site and no known drinking water wells in Kennicott or McCarthy. Groundwater contamination from the mines or mill town activity would likely be intercepted by surface water bodies at the site.

2.6.2 Surface Water Pathway

The surface water pathway is evaluated below for potential impacts to drinking water supplies, the human food chain, and environmental receptors. This pathway is typically evaluated for migration via two components: overland flow, and groundwater discharges to surface water.

2.6.2.1 Overland Flow

Hydrology

Surface water bodies in the vicinity of Kennicott Mine have been formed by glacial meltwater, groundwater discharges, and runoff; in certain areas these components are difficult to distinguish. Runoff drains from Bonanza Ridge in a westerly direction towards the Kennicott Glacier; a series of creeks facilitate the runoff, and include National Creek, Bonanza, Jumbo, and Amazon Creek (see Figure 2-4). These creeks flow into the Kennicott Glacier Valley and infiltrate the ground surface, becoming a part of the Kennicott Glacier Valley aquifer. This aquifer is projected to flow in a southerly direction beneath the Kennicott Glacier and emerge as surface water for the Kennicott River. The volume of water from the creeks along Bonanza Ridge is projected to be a very small contribution to the aquifer in comparison to the volume of meltwater and groundwater discharges along the valley sides (America North/EMCON, Inc., 1992).

Of the creeks draining Bonanza Ridge, National Creek is the only creek that flows through the mill town, which is located adjacent to the southeastern edge of the Kennicott Glacier. National Creek was observed during the site visit as receiving seepage from the tailings pile. Based on observations made during the site visit and the dye test conducted during the Site Investigation, National Creek disappears into the ground surface roughly 20 feet from the glacier (approximately 1/2-mile past the mill town), is presumed to travel as shallow groundwater/surface water beneath the southeastern edge of the glacier, and is released into the Kennicott River at the town of McCarthy (America North/EMCON, Inc., 1992).

In addition to the Kennicott River, several surface water bodies occur along the ablation, or melting, zone of the Kennicott Glacier, including a group of springs and creeks collectively

referred to as Clear Creek. Due to the glacial moraine deposits in this area, the various surface water bodies may be hydraulically connected. McCarthy Creek, which originates from runoff along the ridge east of Bonanza Ridge, joins the Kennicott River approximately 1.5 miles south of McCarthy. A hydraulic connection may also occur between McCarthy Creek and the other surface water bodies near the ablation zone.

Target Distance Limit

The 15-mile target distance limit (TDL) for this site begins at the mill town where the seepage from the tailings pile flows into National Creek, and includes: a) approximately 0.5-mile length of National Creek prior to entering the Kennicott Glacier Valley aquifer, b) the 3.5-mile length beneath the Kennicott Glacier into the Kennicott River, c) 5 miles along the Kennicott River until it flows into the Nizina River, and d) and 6 miles along the Nizina River. Clear Creek and McCarthy Creek, although not specifically identified within the TDL, may be hydraulically connected to the Kennicott River near McCarthy.

2.6.2.1.1 Potential Receptors

Drinking Water Supplies

No drinking water intakes have been documented along the 15-mile TDL.

Intakes outside the TDL include the Kennicott Lodge water supply system and the McCarthy Lodge water supply. The principal intake for Kennicott is operated by the Kennicott Lodge, and is located upstream of the mill building along National Creek, outside the TDL. The intake for the McCarthy Lodge is in Clear Creek, which may be hydraulically connected to the segment of Kennicott River near the town of McCarthy. Several hoses, presumed to be residential intakes, were observed in Clear Creek during the site visit.

Human Food Chain

The migration of fish into National Creek is unlikely due to the obstruction by the Kennicott Glacier. No fisheries harvest data are reported by the Alaska Department of Fish and Game (ADFG) for the Kennicott and Nizina rivers. Mechanical wheel-net fishing in the Chitina River was observed by WESTON during the site visit (Beierle, 1995). According to one ADFG representative, only hook-and-line fishing is permitted in these rivers. Native Americans fishing in these rivers would be required to obtain a permit (Scarzi, 1995). Permits are used by the state to monitor fishing activities and, in some cases, harvests.

Environmental Targets

The Kennicott and Nizina rivers may support small coho salmon fisheries (ADEC, 1992) for fish spawning in McCarthy Creek. In addition to coho salmon, these rivers are migration routes for sockeye and king salmon. Migratory fish enter the basin at the mouth of the

Copper River near Cordova, and may migrate to the Kennicott River by swimming up the Copper, Chitina, and Nizina rivers.

According to the U.S. Fish and Wildlife Service, there are no listed, proposed, or candidate threatened or endangered species in the area (Rappoport, 1994).

2.6.2.2 Groundwater Discharges to Surface Water

Due to the likelihood for groundwater in the vicinity of the site to discharge to the surface water bodies that comprise the TDL, the potential receptors associated with groundwater discharges to surface water are assumed to be the same as those described for the overland flow component.

2.6.3 Soil Exposure Pathway

The site contains uncovered waste piles, including the tailings pile (600,000 cubic yards), and the boiler ash pile (approximately 200 cubic yards). There are also areas of potentially contaminated soil, such as the Power Plant Oil Spill area (79,000 square feet) and other areas affected by lead paint from the mill buildings, smaller spills, and dump sites (ADEC, 1992; America North/EMCON, 1992).

Although the site is remote and there are few permanent residents and workers nearby, the property is fully accessible and the historical nature of the site makes it attractive for tourists. One full-time resident lives in Cottage 24 directly adjacent to the tailings pile. A family lives year-round approximately 1 mile south of Kennicott along the Kennicott-McCarthy Road. Seasonal workers at Kennicott Lodge occupy buildings on the site. McCarthy has a population of approximately twenty people. Although the Park Service does not keep accurate numbers of visitors to Kennicott, it estimates that 47,000 people visit the park each year (NPS, 1994).

Due to the remoteness and seasonal population variation at the site, it is difficult to estimate the surrounding residential population that could come into contact with contaminated soil. However, based on the site visit, permanent population was estimated as follows:

Distance	Residential Population
0 to 1/4 mile	1
1/4 to 1/2 mile	0
1/2 to 1 mile	5
1 to 2 miles	0
2 to 3 miles	0
3 to 4 miles	30

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2.6.4 Air Pathway

Particulate migration from sources (e.g., tailings pile) is a potential source of exposure. The potential sources are not covered and could be spread to downwind areas. Based on site observations, the predominant wind direction was assumed to be down the valley toward McCarthy.

Asbestos removal activities occurring in the summer of 1994 were monitored by air sampling equipment to ensure that airborne asbestos generated by the removal was not leaving the buildings where work was conducted. Air migration of asbestos prior to removal may have occurred; however, no evaluation of asbestos migration was performed.

The Wrangell-St. Elias National Park and Preserve border the site, and are considered sensitive environments and major recreational areas.

2.7 SUMMARY OF REMEDIATION ACTIVITIES

EMCON Alaska, Inc., was contracted by the Kennecott Corporation to perform remedial activities at the mill town between 1992 and 1994 (EMCON Alaska, Inc., 1995). The activities are summarized below.

In 1992, small quantities of materials located in buildings and dumps (laboratory and/or ore processing chemicals, hospital drugs, electrical batteries, etc.) were containerized and removed. Lubricating oil, transformer oil, and grease were containerized in drums or overpacks.

In 1993, a removal of friable asbestos containing material (ACM) was conducted by Technic Services under contract with the Kennecott Corporation. ACM was removed from all buildings (except the power and leaching plants) and from the utility corridor system.

In September 1994, several activities were completed, including:

- The removal of ACM from the power and leaching plants was completed.
- The boiler ash pile was contained beneath a cap of concrete.
- Two tanks located in the leaching and flotation plant were stabilized. The tanks originally contained a solution of ammonia and dissolved metals. The contents were treated to precipitate copper from the ammonia solution. The remaining solution was drained from the tanks. The tanks, with the copper precipitate (copper sulfide), were subsequently welded or otherwise sealed to prevent access.

- Six above ground storage tanks used for fuel oil were drained and cleaned: 4(1), 4(2), 27(1), 29(2), 27(3), and 27(4).
- Drums of oil and grease collected during 1992 cleanup activities were removed from the site.
- A weathered spill of bunker fuel oil west of the Power Plant was stabilized by heating with a propane burner and combining with sand and gravel to produce asphalt.

Samples of the boiler ash pile were collected by WESTON during the site visit in July 1994, prior to the cap placement.

Based upon the drawings prepared by EMCON Alaska, Inc., the stabilized oil spill was located further west of the oil spill area sampled during the site visit.

SECTION 3

SAMPLING ACTIVITIES AND ANALYTICAL REQUIREMENTS

Surface and subsurface soil, surface water, sediment, and dust sampling were performed between 27 July and 29 July 1994 in accordance with the site *Sampling and Analysis Plan* (WESTON, 1994a) and Site Inspection Quality Assurance Program Plan (QAPP) (WESTON, 1994b). Split samples were collected by representatives of EMCON Alaska, Inc., consultants to the Kennecott Corporation.

3.1 OBJECTIVES

As mentioned in Section 1, an SI is intended to gather sufficient data to enable evaluation of a site's potential for inclusion on the NPL. Accordingly, the following sampling objectives were defined for the Kennecott Mine SI:

- Characterize potential sources.
- Assess the potential for source contaminants to impact human health and/or the environment through soil exposure or migration to surface water, groundwater, or air.

Due to the magnitude of the mine, sampling efforts focused on potential contaminant sources at the mill town, and the migration and exposure pathways associated with these sources. To accomplish these objectives, the following general field activities were conducted:

- A reconnaissance of the property and research of past uses to locate potential sources and locations of potential releases to the environment.
- Sampling of potential sources, including the Power Plant Oil Spill, boiler ash pile, tailings pile, and areas of suspected soil contamination.
- Collection of sediment and surface water samples from National Creek and Kennecott River to assess potential migration of contaminants to surface water.
- Collection of wipe samples in the mill town and town of McCarthy to assess potential dust migration.
- Collection of soil samples from downwind areas to assess the potential of surface deposition from air migration.

3.2 SAMPLE TYPES, NUMBER, LOCATIONS, AND RATIONALE

Forty-four samples were collected from the Kennicott Mine site, including fourteen samples collected from potential contaminant sources. The remainder of the samples were collected to either assess potential contaminant migration from site sources, or to meet quality assurance/quality control (QA/QC) requirements. Table 3-1 lists the number, location, depth and rationale for each source, migration, or QA/QC sample. Figure 3-1 shows the locations of all source and dust samples. Figure 3-2 shows the locations of surface water and sediment samples.

3.3 SAMPLING METHODS AND ANALYTICAL REQUIREMENTS

3.3.1 Sampling Methods

This section describes the methods used by WESTON to collect background, source, surface water, sediment, and soil samples. Additional information is provided in the QAPP (WESTON, 1994b).

3.3.1.1 Source Sampling

Samples from potential sources and background areas were collected to a depth of 1 foot with a stainless-steel spoon or, for greater depths, with a stainless-steel hand auger. The hand auger was used for sampling the tailings pile, with the exception of two samples. Samples (surface and subsurface) at Station SS008 were collected with a stainless-steel spoon, rather than a hand auger, at the surface and at depth because they were collected from alongside a road cut. All potential source samples were placed into a stainless-steel bowl, homogenized, and placed into labeled, laboratory-cleaned sample jars. Samples to be analyzed for volatile organic compounds (VOC) were placed directly into laboratory-cleaned sample jars, taking care to leave minimum head space. Filled jars were placed into resealable plastic bags and placed on ice for shipment. For samples that were analyzed for metals only, disposable plastic trowels and bowls were used to minimize the need for decontamination and minimize the possibility of cross-contamination.

3.3.1.2 Downwind Area Soil Sampling

In order to assess the potential for contaminant transport by wind, samples were collected from the uppermost foot of soil at two downwind locations using a stainless steel hand auger. Three intervals were collected at each location: 0 to 1 foot, 1 to 6 feet, and 6 to 12 feet. Sampling methods were performed as described in Section 3.3.1.1.

Table 3-1—Sample Types, Numbers, Locations, and Rationale

Sample Matrix	Number of Samples Collected	Sample Type(s)	Sample Location(s)	Rationale
Soil (including material from wastepiles)	20	Seven surface (0-12") grab samples	Power plant oil spill (4, including one duplicate), boiler ash pile (2), tailings pile drum dump (1)	Characterize potential sources
		Two surface (0-12") grab samples	Background locations north of the mill town	Characterize background conditions
		Five soil surface and subsurface intervals (only five out of six actually taken due to shallowness of tailings at Station SS006)	Three locations in the tailings pile	Characterize tailings pile as a potential source
		Six hand auger boring intervals at 0"-2", 2"-6", and 6"-12"	Two off-site locations south of the mill town	Assess potential for particulate migration
		Three 0 to 6 inch grab samples	National Creek including one background sample above mill town, one in the tailings pile, and one below the tailings pile	Establish background and downgradient conditions to assess potential migration from source areas
		One 0 to 6 inch grab sample	Jumbo Creek	Assess potential migration from mines along Bonanza Ridge
Sediment	8	One 0 to 6 inch grab sample	McCarthy Creek background location	Establish background conditions
		Two 0 to 6 inch grab samples	Clear Creek surface water intakes (includes one duplicate)	Assess potential releases to surface water near intakes
		One 0 to 6 inch grab sample	Kennicott River	Assess potential migration from source(s)

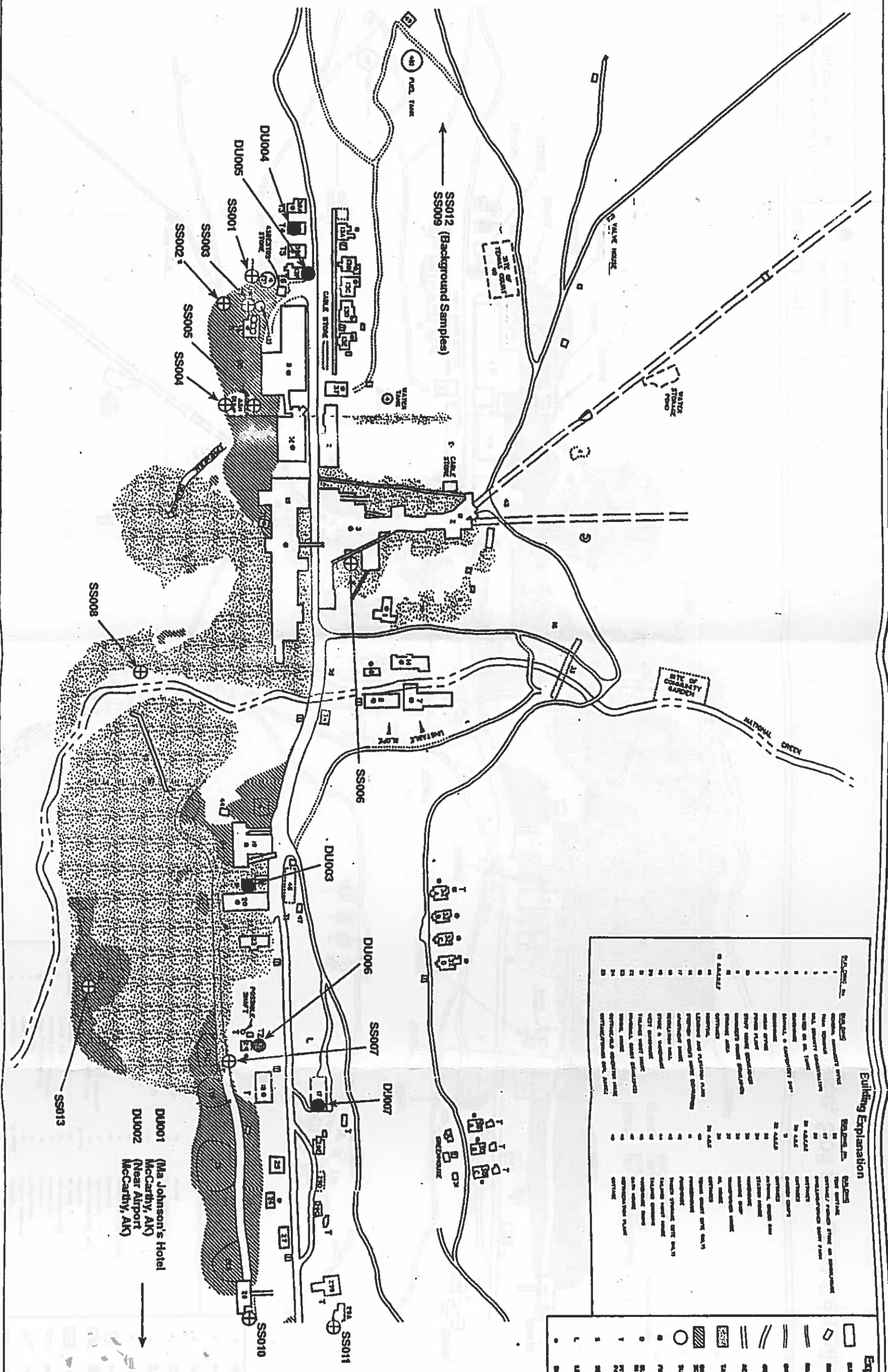
(Continued)

Table 3-1—Sample Types, Numbers, Locations, and Rationale

Sample Matrix	Number of Samples Collected	Sample Type(s)	Sample Location(s)	Rationale
Surface Water	5	One grab sample	National Creek background location	Characterize background conditions
		One grab sample	McCarthy Creek background location	Characterize background conditions
		Two grab samples	Clear Creek surface water intakes (includes duplicate)	Assess potential releases to surface water near intakes
		One grab sample	Seep below leaching and flotation plant	Assess potential migration to surface water from tailings pile
			Mill town and McCarthy buildings (includes one blank)	Assess potential migration of airborne particulates
Dust	8	Eight wipe samples	Not applicable	Assess potential contamination of samples from sampling procedures
QA/QC	3	Transfer blank	Not applicable	Assess potential contamination of volatiles during shipping
		Two trip blanks	Not applicable	
Total	44			

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1:5000
 1/4" = 100'



Building Explanation	
1	Building
2	Roof Area Reserved
3	Site of Contaminated Area
4	Water Storage Tank
5	Water Storage Pond
6	Water Meter
7	Water Valve
8	Water Meter
9	Water Valve
10	Water Meter
11	Water Valve
12	Water Meter
13	Water Valve
14	Water Meter
15	Water Valve
16	Water Meter
17	Water Valve
18	Water Meter
19	Water Valve
20	Water Meter
21	Water Valve
22	Water Meter
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32	Water Meter
33	Water Valve
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37	Water Valve
38	Water Meter
39	Water Valve
40	Water Meter
41	Water Valve
42	Water Meter
43	Water Valve
44	Water Meter
45	Water Valve
46	Water Meter
47	Water Valve
48	Water Meter
49	Water Valve
50	Water Meter

Explanation	
1	Building
2	Roof Area Reserved
3	Site of Contaminated Area
4	Water Storage Tank
5	Water Storage Pond
6	Water Meter
7	Water Valve
8	Water Meter
9	Water Valve
10	Water Meter
11	Water Valve
12	Water Meter
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44	Water Meter
45	Water Valve
46	Water Meter
47	Water Valve
48	Water Meter
49	Water Valve
50	Water Meter

Source, Soil and Dust Sampling Map

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Scale in Feet: 0, 125, 250

Source: America North/
 EMCON, Inc., 1992

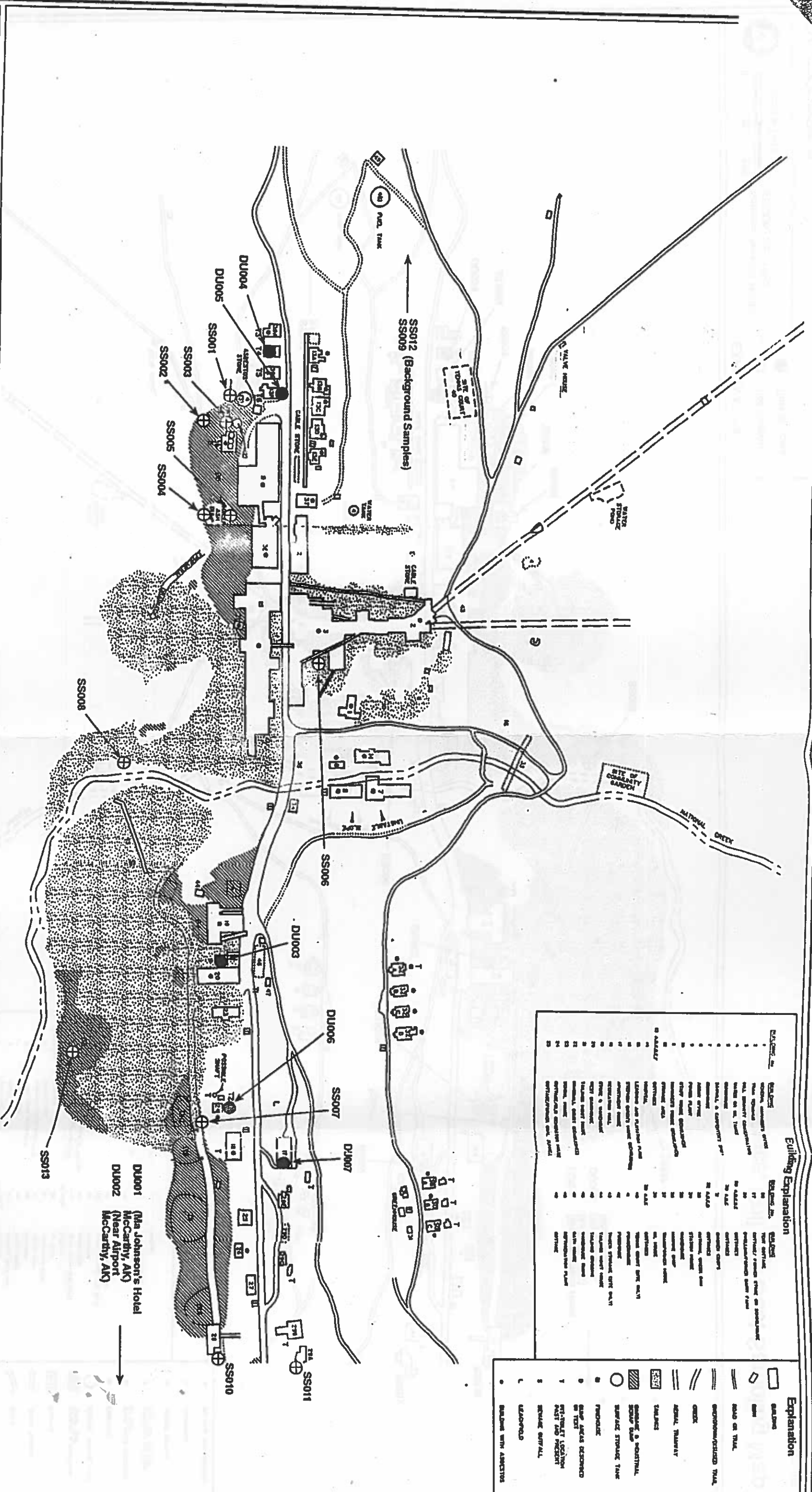
4000-15-13-1100
 April 1995

EXPLANATION

⊕ Soil Samples

● Dust Samples

15000



Building Explanation	
DU001	McCarthy's Hotel
DU002	McCarthy's Hotel
DU003	McCarthy's Hotel
DU004	McCarthy's Hotel
DU005	McCarthy's Hotel
DU006	McCarthy's Hotel
DU007	McCarthy's Hotel
SS001	Soil Sample
SS002	Soil Sample
SS003	Soil Sample
SS004	Soil Sample
SS005	Soil Sample
SS006	Soil Sample
SS007	Soil Sample
SS008	Soil Sample
SS009	Soil Sample
SS010	Soil Sample
SS011	Soil Sample
SS012	Soil Sample
SS013	Soil Sample
DU001	Dust Sample
DU002	Dust Sample
DU003	Dust Sample
DU004	Dust Sample
DU005	Dust Sample
DU006	Dust Sample
DU007	Dust Sample

0 125 250
Scale in Feet

Source: America North/
EMCON, Inc., 1992

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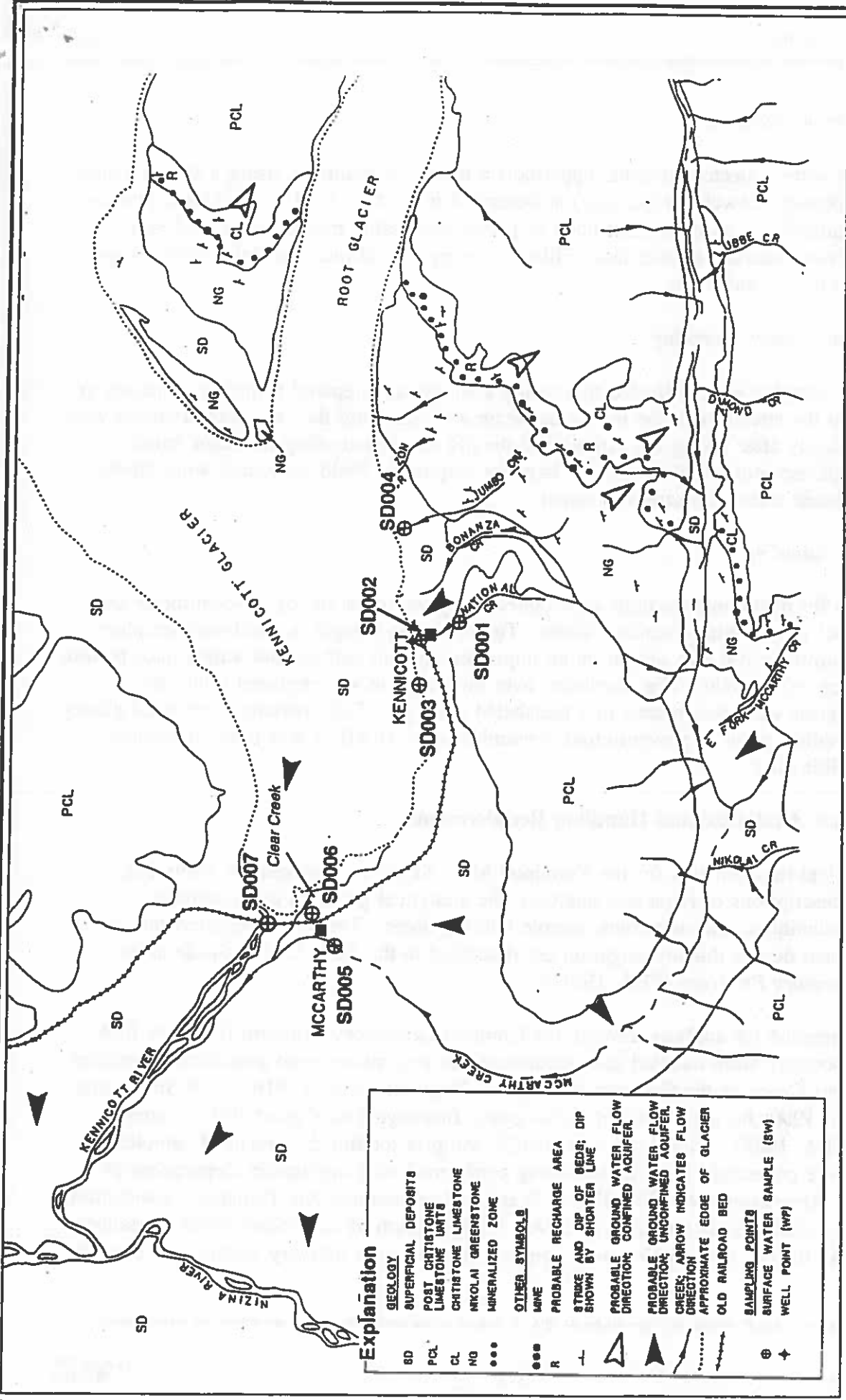
4000-15-13-1100
April 1995

EXPLANATION

⊕ Soil Samples

● Dust Samples

Source, Soil and Dust Sampling Map



Explanation

GEOLOGY	
SD	SUPERFICIAL DEPOSITS
PCL	POST CHISTSTONE LIMESTONE UNITS
CL	CHISTSTONE LIMESTONE
NG	NKOLAI GREENSTONE
•••	MINERALIZED ZONE
OTHER SYMBOLS	
•••	MINE
R	PROBABLE RECHARGE AREA
—	STRIKE AND DIP OF BEDS; DIP SHOWN BY SHORTER LINE
△	PROBABLE GROUND WATER FLOW DIRECTION; CONFINED AQUIFER
▶	PROBABLE GROUND WATER FLOW DIRECTION; UNCONFINED AQUIFER
→	CREEK; ARROW INDICATES FLOW DIRECTION
-----	APPROXIMATE EDGE OF GLACIER
-----	OLD RAILROAD BED
SAMPLING POINTS	
⊕	SURFACE WATER SAMPLE (SW)
+	WELL POINT (WP)

Surface Water and Sediment Sampling Map

FIGURE 3-2

0 0.5 1 1.5
Scale in Miles

Source: America North/
EMCON, Inc., 1992

4000-19-10-4100
April 1995

WESTON
ENGINEERS ARCHITECTS CONSULTANTS

3.3.1.3 Sediment Sampling

Grab samples were collected from the uppermost 6 inches of sediment, using a stainless-steel or plastic disposable trowel (metals only) as described in Section 3.3.1.1. Sediment samples were homogenized in a stainless-steel bowl or plastic disposable trowel and placed into labeled, laboratory-cleaned sample jars. Filled jars were placed into resealable plastic bags and placed on ice for shipment.

3.3.1.4 Surface Water Sampling

Surface water samples were collected by placing a laboratory-prepared sampling container at mid-depth into the stream with the mouth upstream and removing the cap. Preservatives were added immediately after taking the sample and the pH was tested using indicator strips. Bottles were placed into resealable plastic bags for shipment. Field personnel wore gloves that were replaced after each sampling event.

3.3.1.5 Dust Sampling

Wipe samples for dust contamination were collected by wiping a 10- by 10-centimeter area with glass wool wetted with deionized water. To collect the sample, a cardboard template wrapped in aluminum foil was placed on an unpainted smooth surface and wiped once bottom to top and once left to right. The aluminum over the template was replaced after each sample. The glass wool was placed in a pre-labeled glass jar. Field personnel changed gloves after each sampling event to prevent cross-contamination. An effort was made to sample areas with visible dust.

3.3.2 Sample Analytical and Handling Requirements

Sample analytical requirements for the Kennicott Mine SI are summarized in Table 3-2. Included are descriptions of requested analyses, the analytical program used, sample-preservation techniques, and maximum sample holding times. The bottle requirements for samples collected during this investigation are described in the *EPA User's Guide to the Contract Laboratory Program* (EPA, 1991b).

All samples intended for analysis through the Contract Laboratory Program (CLP) or EPA Region X Laboratory were handled and documented in accordance with procedures specified in EPA's *User's Guide to the Contract Laboratory Program* (EPA, 1991b), CLP Statements of Work (EPA, 1990a,b), and *National Enforcement Investigations Center Policies and Procedures* (EPA, 1985). Duplicates and QA/QC samples totaling 5 percent of samples for each matrix were collected. Sample packaging conformed with applicable Department of Transportation Regulations (49 CFR 171-177) and/or International Air Transport Association (IATA, 1993) guidelines, as specified in EPA's *Compendium of Superfund Field Operations Methods* (EPA, 1987). All samples were shipped via overnight delivery within four days of

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Table 3-2—Sample Analytical Requirements

Sample Matrix	Number of Samples Collected	Sample Location(s)	Analytical Requirements	Analytical Program ^a	Preservation Technique	Maximum Holding Time	
Soil (including material from waste piles)	8	Soil from power plant oil spill (4, including one duplicate)	VOCs, BNAs, Pesticides, PCBs	CLP RAS	ice	14 days ^b	
		Tailings pile drum dump (1) Tailings pile subsurface sample at road cut (1)	metals particle size (surface tailings pile sample only)	CLP RAS EPA Lab	none none	6 months none	
	2	Background soil north of the mill town (2)					
		Boiler ash pile	BNAs metals	CLP RAS CLP RAS	ice none	14 days ^b 6 months	
Sediment	10	Surface and/or subsurface intervals from two locations in the tailings pile (3)	metals particle size (one surface tailings pile sample only)	CLP RAS EPA Lab	none none	6 months none	
		Tailings pile surface sample at road cut (1)					
		0-2", 2"-6", and 6"-12" soil sample intervals from two locations south of the mill town (6)					
Sediment	4	National Creek background (1)	VOCs, BNAs, Pesticides, PCBs	CLP RAS	ice	14 days ^b	
		McCarthy Creek background (1) Clear Creek surface water intakes (2; including duplicate)	metals	CLP RAS	none	6 months	

(Continued)

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Table 3-2—Sample Analytical Requirements

Sample Matrix	Number of Samples Collected	Sample Location(s)	Analytical Requirements	Analytical Program ^a	Preservation Technique	Maximum Holding Time
Sediment	4	National Creek (2)	metals	CLP RAS	none	6 months
		Jumbo Creek (1)				
		Kennicott River (1)				
Surface Water	5	National Creek background location (1)	metals (low concentration)	EPA Lab	HNO ₃ to pH < 2; ice	6 months
		McCarthy Creek background location (1)				
		Clear Creek surface water intakes (2; includes duplicate)				
		Seep below leaching and flotation plant (1)				
Dust	8	Mill town and McCarthy buildings (includes one blank)	priority pollutant metals (excluding mercury)	EPA Lab	none	6 months
QA/QC (surface water)	1	Transfer blank	metals (low concentration)	EPA Lab	HNO ₃ to pH < 2; ice	6 months
QA/QC (soil/ sediment)	2	Trip blanks	VOCs	CLP RAS	HCL to pH < 2; ice	14 days

^a Labs are specified in the following manner:

EPA Lab: Analysis performed by EPA Region X Lab

CLP RAS: Analysis performed under CLP contract, Routine Analytical Services

^b For volatiles, extraction and analysis must be performed within 14 days; for BNAs, pesticide, and PCBs, extraction must occur within 14 days and analysis within 40 days.

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DCN 4000-19-10-AAA.Y

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12 April 1995
PK10/SEA

collection.

3.3.3 Equipment Decontamination

Equipment decontamination, when necessary, was performed in accordance with the *Sampling and Analysis Plan* (WESTON, 1994a). Decontamination procedures for hand augers, sampling spoons, and bowls consisted of the following steps:

1. Alconox detergent wash
2. Tap water rinse
3. Methanol rinse (potential hydrocarbon contamination only)
4. Hexane rinse (potential hydrocarbon contamination only)
5. Distilled water rinse
6. Air dry away from potential sources of contamination (i.e., splashes)
7. Wrap in aluminum foil (shiny side out)
8. Store in plastic bags

All equipment was decontaminated between sampling events so as to prevent cross-contamination. All nonhazardous solid waste generated during field operations was bagged and disposed.

SECTION 4

SAMPLE RESULTS AND DISCUSSION

This section discusses the analytical results for background, source, sediment, surface water, dust, and soil samples collected by WESTON between 27 July and 29 July 1994 and analyzed in accordance with the EPA Region X contract laboratory program (CLP). Photographic documentation is presented in Appendix B. Chain-of-custody forms are presented in Appendix C, and data quality assurance review memoranda, including validated data, are presented in Appendix D.

Tables presented in the following sections generally include all data for analytes identified in at least one sample above individual sample quantitation limits (SQL) reported in analytical laboratory results.

All concentrations, except wipe samples, are expressed in mg/kg or $\mu\text{g/L}$ for inorganics and in $\mu\text{g/kg}$ or $\mu\text{g/L}$ for organics. Wipe samples are expressed in $\mu\text{g}/10\text{ cm}^2$.

For purposes of this report, "elevated" concentrations are defined using Table 2-3 of the EPA HRS model criteria for observed release. In addition to these requirements, the concentration must be attributable to on-site sources for activities to be termed an observed release. The HRS criteria are as follows:

- If the sample measurement is less than the SQL, no observed release is established.
- If the sample measurement is greater than or equal to the SQL, and the background concentration is not detected (or less than the detection limit), an observed release is established when the sample measurement equals or exceeds the background SQL.
- If the sample measurement is greater than or equal to the SQL, and the background concentration equals or exceeds the detection limit, an observed release is established when the sample measurement is 3 times or more above the background concentration.

In general, discussions of data from samples that were collected to assess the potential for contaminant migration are restricted to those results that meet HRS criteria for observed releases. These data are highlighted in bold type in tables presented in this section.

Similarly, when referring to source data that meet the HRS criteria described above, these data are used to indicate areas of observed contamination (as opposed to observed releases) when evaluating soil data. These values are also highlighted in bold type for data tables of source sample results.

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Aluminum, calcium, iron, magnesium, sodium, and potassium are common earth crust metals which are not generally considered toxic at environmental levels. They are primarily used in water mass tracing which is beyond the scope of this report. These elements will not be discussed in this report.

4.1 SOURCE SAMPLE RESULTS

The following sections discuss analytical results for source samples collected at the Power Plant Oil Spill, the boiler ash pile, and the tailings pile (including the drum dump area). Background soil samples used for determination of elevated concentrations in soil (areas of observed contamination) were collected along the carriage road that parallels the glacier at two locations north of the mill town near Jumbo Creek. Because only the oil spill area is considered a contaminated soil source, areas of observed contamination are only highlighted for this source.

As previously discussed, the boiler ash pile was sampled by WESTON prior to the placement of a concrete cap by the Kennecott Corporation.

4.1.1 Power Plant Oil Spill

Three samples were collected from the oil spill in oil-saturated or "asphalted" soil downslope of fuel tanks 4(2) and 4(3) and analyzed for inorganics, VOCs, semivolatiles (BNAs), and PCBs. Two samples were collected near the tanks at the top of the slope and one sample was collected near pooled oil at the bottom of the slope. Background reports indicate that the material was released from nearby tanks containing Bunker C oil (America North/EMCON, Inc., 1992; Kay and Miller, 1990; EMCON Alaska, Inc., 1995). Under CERCLA Section 101(14) and (33), commonly referred to as the Petroleum Exclusion, petroleum is excluded from the definition of a hazardous substance, pollutant, or contaminant. Organic chemicals associated with the petroleum product are therefore not evaluated as contaminants for this site. Detections are presented for informational purposes only. A copy of the CERCLA Eligibility Checklist identifying this exempt material is provided in Appendix E, CERCLA Eligibility Checklist.

In general, however, inorganic chemicals are not principal constituents of petroleum products. Therefore, inorganic chemicals are evaluated as potential contaminants for this site. Elevated chemicals were highlighted in bold to indicate areas of observed contamination.

As discussed in Section 2.7, the material from which these samples were collected does not appear to be in the same location as the oil spill that was asphalted by the Kennecott Corporation in September 1994.

The following discussions summarize sample results by analytical group. Sample results for organic and inorganic analyses performed on all samples for this source are presented in Appendix D, Data Validation Reports.

Inorganics

Table 4-1 contains inorganic results for samples collected in the Power Plant Oil Spill area. In oil-saturated soil samples collected near fuel tanks 4(3) and 4(2) (Stations SS001 and SS003), 12 inorganic elements were detected at elevated concentrations, indicating areas of observed contamination. Maximum concentrations of elevated inorganics included antimony (479 mg/kg), arsenic (50.7 mg/kg), barium (316 mg/kg), cadmium (4.5 mg/kg), cobalt (68.7 mg/kg), copper (1690 mg/kg), lead (359 mg/kg), mercury (1.3 mg/kg), nickel (1500 mg/kg), selenium (9.4 mg/kg), vanadium (1800 mg/kg), and zinc (266 mg/kg).

No elevated concentrations of inorganics were detected in the downslope area (Station SS002) near pooled oil at the bottom of the hill below the tanks.

Volatile Organics

Three VOCs, including 1,1,2,2-tetrachloroethane; total xylenes; and toluene were detected from 1 to 2 µg/kg in samples collected throughout the oil spill area (see Table 4-2). The detections were below the SQL and, due to the Petroleum Exclusion, are not considered contaminants for this site.

Semivolatile Organics

No semivolatile organic compounds were detected in the samples collected from the Power Plant Oil Spill.

Pesticide/PCBs

No PCBs or pesticides were detected in the samples collected from the Power Plant Oil Spill. Pesticide analysis was not requested by WESTON, but was performed by the lab.

4.1.2 Boiler Ash Pile

Two samples were collected from the boiler ash pile and analyzed for inorganics and BNAs. The samples were collected prior to the ash pile capping in September 1994. Sample results are summarized in the following sections by analytical group. Sample results for organic and inorganic analyses performed on all samples for this source are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-1.

Table 4-1—Source Characteristics: Power Plant Oil Spill and Boiler Ash Pile - Inorganics (mg/kg)*

Analyte	Background		Power Plant Oil Spill				Boiler Ash Pile	
	SS009-0	SS012-0	SS001-0	SS002-0	SS002-1 (dup.)	SS003-0	SS004-0	SS005-0
Antimony	0.52 UJ	0.78 UJ	479 J	0.55 UJ	0.42 UJ	1.3 UJ	165 J	10.6 J ^c
Arsenic	5.2	6.4 J	50.7 J	5.3	9.6	47.7	59	194
Barium	28.5 J ^b	31.9 J ^b	316 J	31.1 J ^d	36.4 J ^d	209	104	88.4
Beryllium	0.2 U	0.33 J ^c	0.25 U	0.2 U	0.2 U	0.21 U	0.21 U	0.42 J ^c
Cadmium	0.2 U	0.21 UJ	4.5 J	0.2 U	0.2 U	1.8	2.6	5.1
Chromium	21	17.6	20.1	12.3	12.7	18.1	96.7	10.2
Cobalt	10.6	10.1 J ^c	68.7	8.6 J ^d	8.2 J ^d	34.1	29.9 J ^c	6.8 J ^c
Copper	74.5 J	35.6 J	1,690 J	48 J	61.1 J	1,660 J	2,940 J	3,140 J
Lead	2.4	6.1 J	359 J	13.5	14.3	351	4,000	557
Manganese	303 J	330 J	306 J	234 J	269 J	215 J	1,980 J	205 J
Mercury	0.05 U	0.05 U	1.3	0.05 U	0.05 U	0.44	0.4	2.6
Nickel	20.9	19.5 J	1,500 J	29	34.3	758	118	37.2
Selenium	0.82 UJ	0.86 UJ	3.5	0.81 UJ	0.81 UJ	9.4	0.85 UJ	1.0 J ^c
Silver	0.61 U	0.64 U	0.76 U	0.61 U	0.61 U	0.62 U	6.3 U	1.8 J ^c
Thallium	1.4 UJ	1.5 UJ	1.8 UJ	1.5 J ^d	1.4 UJ	1.4 UJ	1.5 UJ	1.6 UJ
Vanadium	38.7	23.4 J	1,800 J	35.6	43.8	1,010	84 J ^c	42.7
Zinc	35.9 J	27.7 J	185 J	35.7 J	36.5 J	266 J	608 J	353 J

- * All source samples were collected from 0 to 1 foot below the surface.
 - Where no background values were detected above the contract-required detection limit (CRDL), the lower CRDL from the CLP, adjusted for percent solids, was used.
 - Value positively identified but the concentration is below the CRDL.
 - Values positively identified but at concentrations below the CRDL were not used to determine areas of observed contamination.
- Bold** values qualify as areas of observed contamination.
U indicates that the value was not detected.
J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met

Table 4-2—Source Characteristics: Power Plant Oil Spill - Organics (ug/kg)

Analyte	Background			Power Plant Oil Spill*		
	SS009-0	SS012-0	SS001	SS002-0	SS002-1	SS003-0
Volatile Organic Compounds						
1,1,1,2-Tetrachloroethane	10 U	11 U	1 J ^b	1 J ^c	1 J ^b	10 U
Xylene (total)	10 U	11 U	1 J ^b	1 J ^c	10 U	10 U
Toluene	10 U	11 U	11 U	2 J	10 U	10 U
Semivolatile Organic Compounds						
Phenanthrene	330 U	360 U	7300 J ^b	10000 U	51000 U	11000 J ^b
Pyrene	330 U	360 U	8700 J ^b	44000	75000	14000 J ^b
Chrysene	330 U	360 U	57000 U	32000	43000 J ^b	7700 J ^b
Fluoranthene	330 U	360 U	57000 U	3100 J ^b	9500 J ^b	52000 U
Benzo(a)anthracene	330 U	360 U	57000 U	16000	21000 J ^b	52000 U
Benzo(a)pyrene	330 U	360 U	57000 U	12000	51000 U	52000 U
Benzo(b)fluoranthene	330 U	360 U	57000 U	10000 U	8100 J ^b	52000 U
Benzo(k)fluoranthene	330 U	360 U	57000 U	10000 U	12000 J ^b	52000 U

* All source samples were collected from 0 to 1 foot below the surface.
 • Value positively identified below CRQL.
 • This analyte was not detected when this sample was reanalyzed.
 Organic analytical results from the Power Plant Oil Spill samples were not used for source characterization.
 U indicates that the value was not detected above its CRQL.
 J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met.

Inorganics

Table 4-1 contains soil sample results for inorganics in the boiler ash pile. Eleven inorganics were detected above background in at least one of the two samples.

Volatile Organics

Volatile organic analyses samples collected from the boiler ash pile were not submitted to the laboratory for analysis.

Semivolatile Organics

Table 4-3 contains soil sample results for organics in the boiler ash pile. Eight analytes were detected above background in at least one of the two samples.

Table 4-3—Boiler Ash Pile Characteristics - Organics (µg/kg)

Analyte	Background		Boiler Ash Pile ^a	
	SS009-0	SS012-0	SS004-0	SS005-0 ^b
Semivolatile Organic Compounds				
Phenanthrene	330 U	360 U	1200	610
Pyrene	330 U	360 U	1000	300 J ^c
Chrysene	330 U	360 U	1800	1100
Fluoranthene	330 U	360 U	680 J ^c	360 J ^c
Benzo(a)anthracene	330 U	360 U	930 J ^c	300 J ^c
Benzo(a)pyrene	330 U	360 U	430 J ^c	340 J ^c
Benzo(b)fluoranthene	330 U	360 U	2300	510 J ^b
Benzo(k)fluoranthene	330 U	360 U	2500	500 J ^b
Naphthalene	330 U	360 U	260 J ^c	250 J ^c
2-Methylnaphthalene	330 U	360 U	360 J ^c	490
Dibenzofuran	330 U	360 U	110 J ^c	85 J ^c
Anthracene	330 U	360 U	1200	77 J ^c
Carbazole	330 U	360 U	120 J ^c	370 U

(Continued)

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Table 4-3—Boiler Ash Pile Characteristics - Organics (µg/kg)

Analyte	Background		Boiler Ash Pile ^a	
	SS009-0	SS012-0	SS004-0	SS005-0 ^b
Dibenzo(a,h)anthracene	330 U	360 U	470 J ^c	44 J ^c
Benzo(g,h,i)perylene	330 U	360 U	990 J ^c	140 J ^c
Nitrobenzene	330 U	360 U	1000 U	220 J ^c
Phenol	330 U	360 U	1000 U	99 J ^c
4-Methylphenol	330 U	360 U	1000 U	100 J ^c
2,4-Dimethylphenol	330 U	360 U	1000 U	120 J ^c
Acenaphthene	330 U	360 U	1000 U	46 J ^c
Fluorene	330 U	360 U	1000 U	60 J ^c
Indeno(1,2,3-cd)pyrene	330 U	360 U	1100	100 J ^c

^a Samples were collected from 0 to 1 foot below the surface.

^b Data from the reanalysis of this sample are presented when the reanalysis concentration was greater than the original concentration.

^c Value positively identified below CRQL.

Other organics not listed were not detected (qualified U) in any of the samples shown.

U indicates that the value was not detected above its CRQL; the value indicated is the CRQL.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met or because the concentration is below the CRQL.

Pesticide/PCBs

No PCBs or pesticides were detected in the samples collected from the boiler ash pile. Pesticide analysis was not requested by WESTON, but was performed by the lab.

4.1.3 Tailings Pile

The tailings pile was sampled in four locations, including the hillside south of the mill building (SS006), near Cottage 24 (SS007), downslope of the leaching and flotation plant (SS008), and in the drum dump (SS013). All areas were sampled at the surface; subsurface samples were also collected near Cottage 24 and downslope of the leaching and flotation plant. All samples were analyzed for metals. The subsurface sample below the leaching and flotation plant was also analyzed for organics due to the presence of an oily substance in coarse-grained layers. The drum dump sample was analyzed for organics to determine potential spillage from drums. Sample locations were presented in Figure 3-1.

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Inorganics

Due to the large number of analytes detected in this source, the discussion below is restricted to those analytes that were detected at three times or more above the concentration of the background sample for that analyte. The full list of detected inorganics is summarized in Table 4-4. The following discussions summarize sample results by analytical group. Sample results for organic and inorganic analyses performed on all samples for this source are presented in Appendix D, Data Validation Reports.

Copper ranged from 2,920 mg/kg below the leaching and flotation plant to 29,400 mg/kg near Cottage 24. Arsenic was also detected at a minimum concentration below the leaching and flotation plant (186 mg/kg) and a maximum concentration near Cottage 24 (705 mg/kg). Silver was detected at a maximum concentration near Cottage 24 of 16.6 mg/kg. The remaining elevated metals were detected at the following maximum concentrations: barium (80 mg/kg), cadmium (16.9 mg/kg), lead (539 mg/kg), mercury (6.5 mg/kg) and zinc (128 mg/kg).

Volatile Organics

No VOCs were detected in either of the two samples analyzed for organics.

Semivolatile Organics

No SVOCs were detected in the tailings pile sample. In the drum dump sample (Station SS013) phenanthrene and pyrene were detected but at concentrations below their SQLs.

Pesticide/PCBs

No PCBs or pesticides were detected in the samples collected from the tailings pile. Pesticide analysis was not requested by WESTON, but was performed by the lab.

4.2 SAMPLE RESULTS: SEDIMENT AND SURFACE WATER

Surface water and sediment samples were collected to assess impacts to surface water bodies from mining activities. Sediment samples were collected from National Creek, Jumbo Creek, Kennicott River, McCarthy Creek, and Clear Creek. Surface water samples were collected from National Creek, McCarthy Creek, and Clear Creek. All sediment and surface water samples were analyzed for metals. The National Creek and McCarthy Creek background sediment samples and the Clear Creek sediment samples were also analyzed for VOCs, BNAs, pesticides and PCBs.

Table 4-4—Source Characteristics: Tailings Pile - Inorganics (mg/kg)

Analyte	SS006-0010 S. of mill bldg. 0-1'	SS007-0010 near cottage 24 0-1'	SS007-0040 near cottage 24 4-5'	SS008-0010 roadcut below L&F plant 0-1'	SS008-0050 roadcut below L&F plant 5'(grab)	SS013-0 drum dump 0-1'
Antimony	6.8 J*	1.7 UJ	0.76 UJ	0.47 UJ	0.76 UJ	3.3 J*
Arsenic	477	705	530	186	372	515 J
Barium	80	13.6 J*	12.8 J*	4.7 J*	7.6 J*	65.2 J
Cadmium	6.7	13	11.8	12.9	15.2	16.9 J
Chromium	3.7	8.1	1.6 J*	1.9 J*	0.97 J*	10.9
Cobalt	11.2 U	5.3 J*	11.4 U	11.1 U	11.2 U	11.1 U
Copper	17,800 J	29,400 J	5,460 J	2,920 J	3,410 J	6,240 J
Lead	166	31.6	15.8	4.5	2.8	539 J
Manganese	144 J	171 J	105 J	116 J	113 J	392 J
Mercury	4.6	3.6	6.5	1.7	1.8	5.5
Nickel	7.1 U	9.4	7.2 U	7.0 U	7.1 U	8.3 J
Silver	13.1	16.6	16	3.4 J*	3.0 U	11.6
Vanadium	6.8 J*	20.2	4.0 J*	6.7 J*	6.0 J*	8.4 J
Zinc	21.4 J	103 J	3.3 UJ	6.9 J*	3.7 UJ	128 J

* Value positively identified below CRDL.

See Table 4-1 for background sample results.

U indicates that the value was not detected.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met.

Note: Beryllium, selenium, and thallium were not detected (qualified U) in any sample.

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4.2.1 Sediment Sample Results

Background sediment samples were collected at National Creek upstream of the Kennicott Lodge drinking water intakes, Jumbo Creek, and McCarthy Creek. Although the original purpose of the Jumbo Creek sample was to assess potential migration from possible sources along Bonanza Ridge, the sample was ultimately used to represent background conditions, due to its location upgradient of the mill town. Depending upon the location of the sediment sample, Jumbo Creek was paired with the other nearest background sample. For instance, Jumbo Creek data were combined with McCarthy Creek data to assess background conditions for Clear Creek. Similarly, Jumbo Creek data were combined with the National Creek background data to assess background conditions for National Creek past the mill building.

Table 4-5 summarizes sediment data for National Creek, Jumbo Creek and the Kennicott River. Table 4-6 summarizes sediment data for Jumbo Creek, McCarthy Creek and Clear Creek. Sample results for organic and inorganic analyses performed on all sediment samples are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-2.

Inorganics

In sediment samples collected from National Creek, arsenic, cadmium, copper, and mercury were elevated above background. Arsenic, at a maximum concentration of 129 mg/kg, and copper, at a maximum concentration of 1,100 mg/kg, were higher at the sample collected just below the tailings pile (SD002). Further downstream (Station SD003), cadmium was found at a maximum concentration of 15.7 mg/kg and mercury at a maximum concentration of 0.84 mg/kg.

No metals were elevated in the Kennicott River sediment sample (SD007).

In the sample collected from Clear Creek, near the surface water intakes for the town of McCarthy, copper was elevated above background at a concentration of 475 mg/kg. Background for Clear Creek was based on McCarthy Creek and Jumbo Creek samples.

Volatile Organics

No volatile organic compounds were detected in any of the sediment samples collected.

Semivolatile Organics

In the Clear Creek duplicate sample (SD006-1), 4-methylphenol was detected, but at a concentration below its CRQL.

Table 4-5—Inorganics in Sediment - National Creek and Kennicott River (mg/kg)

Analyte	SD001-0 National Creek background	SD004-0 Jumbo Creek background	SD002-0 National Creek (tailings pile)	SD003-0 National Creek (below tailings)	SD007-0 Kennicott River
Antimony	1.0 UJ	1.6 UJ	0.87 UJ	0.53 UJ	0.75 UJ
Arsenic	12.4	16.2	129	103	9.3
Barium	116	45.6 J*	136	48.9 J*	31.2 J*
Cadmium	0.26 U	0.26 U	5.5	15.7	0.25 U
Chromium	13.6	21.8	12.5	10.2	12.4
Cobalt	10.4 J*	23.9	12.6 J*	6.9 J*	7.0 J*
Copper	33.9 J	113 J	1,100 J	1,050 J	33.3 J
Lead	5.1	0.78 U	11.3	8.3	1.9
Manganese	864 J	448 J	982 J	311 J	242 J
Mercury	0.17	0.06 U	0.41	0.84	0.08 J*
Nickel	23.5	36.2	22.1	12.3	13.8
Silver	0.78 U	0.78 U	0.8 U	1.0 J*	0.74 U
Vanadium	39	97.6	46	21.6	32.3
Zinc	64.4 J	51 J	78.4 J	38.2 J	32.2 J

* Values positively identified below CRDL were not used for observed release determination.

B values qualify as observed releases.

U indicates that the value was not detected.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met.

Note: Beryllium, selenium, and thallium were not detected (qualified U) in any release sample.

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Table 4-6—Inorganics in Clear Creek Sediment (mg/kg)

Analyte	SD004-0 Jumbo Creek background	SD005-0 McCarthy Creek background	SD006-0 Clear Creek	SD006-1 Clear Creek (duplicate)
Antimony	1.6 UJ	0.96 UJ	2.0 UJ	1.9 UJ
Arsenic	16.2	5.7	21.1	22.8
Barium	45.6*	93.5	97.3 J*	90.4 J*
Cadmium	0.26 U	0.27 U	0.92 J*	0.49 U
Chromium	21.8	22.1	37.7	32
Cobalt	23.9	9.4 J*	15.5 J*	16.1 J*
Copper	113 J	29.7 J	475 J	278 J
Lead	0.78 U	3.9	11.1	9.0
Manganese	448 J	375 J	526 J	511 J
Mercury	0.06 U	0.07 U	0.29 J*	0.16 J*
Nickel	36.2	22.5	34.4	27.3
Vanadium	97.6	48.4	66.3	64.1
Zinc	51 J	62.4 J	94.6 J	81.5 J

* Value positively identified below CRDL.

Data from Clear Creek samples were not used to determine observed releases.

U indicates that the value was not detected.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met or because the concentration is below the CRDL.

Note: Beryllium, selenium, silver, and thallium were not detected (qualified U) in any sample.

Pesticide/PCBs

No PCBs or pesticides were detected in any of the sediment samples collected. Pesticide analysis was not requested by WESTON, but was performed by the lab.

4.2.2 Surface Water Sample Results

Five surface water samples were collected and analyzed for metals at low concentrations. One sample and its field duplicate were collected upstream of the surface water intakes in Clear Creek (Station SD006), and one sample was collected at the tailings pile seep below the leaching and flotation plant (Station SP001). Background samples were collected in National Creek (Station SD001) and McCarthy Creek (SD005). Sample results for inorganic analyses performed on all surface water samples are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-2.

Table 4-7 summarizes the surface water sample results for metals detected in at least one Clear Creek or seep sample. Metals detected at less than 5 times the concentration detected in the transfer blank (TF001-3) were not included.

Arsenic was detected in Clear Creek surface water samples at concentrations equal to or greater than the background sample quantitation limit of 1.0 µg/L. The concentration is below the proposed federal maximum contaminant level (MCL) for arsenic of 50 µg/L but above the cancer risk screening concentration listed in EPA's HRS chemical data tables (EPA, 1991a) of 0.02 µg/L.

Copper and arsenic qualified as observed releases in the tailings pile seep sample at concentrations of 74.8 µg/L and 8.34 µg/L, respectively. The copper concentration is below applicable drinking water standards, and arsenic is below its proposed MCL but above the cancer risk screening level. Barium was positively identified but did not qualify as an observed release. The seep is not a known drinking water source, but is a migration pathway for metals from the tailings pile to National Creek surface water.

Table 4-7—Surface Water Sample Results

Analyte (µg/L)	10-SW-SD001-0 National Creek Background	10-SW-SD005-0 McCarthy Creek Background	10-SW-SD006-0 Clear Creek	10-SW-SD006-1 Clear Creek Duplicate	10-SW-SP001-0 Tailings Pile Seep
Arsenic	1.0 U	1.0 U	1.1 J	1.0 J	8.34
Barium	29.4	31.8	23.3	24.3	43.6
Copper	3.0 U	3.0 U	5.7 ^a	5.9 ^a	74.8
Lead	0.82 J	0.61 J	0.98 J ^a	0.50 U	0.99 J ^a
Manganese	1.6 J	15.3	1.0 U	1.0 U	1.0 U
Zinc	12.0 J	12.0 J	5.4 J ^a	4.0 U	20.4 ^a

^a indicates that the concentration was below 5 times the transfer blank, and is treated as an undetected value.

Bold values qualify as observed releases.

Data from Clear Creek samples were not used to determine observed releases.

Analytes not listed were not detected (qualified U) in the samples from Clear Creek or the seep.

U indicates that the value was not detected above its SQL.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met or because the concentration is below the SQL.

4.2.3 Discussion of Surface Water and Sediment Sample Results

Surface water and sediment results can be summarized as follows:

- In National Creek, metals characteristic of the tailings pile were elevated in sediment and seep surface water flowing into the creek. There are no human or ecological receptors in National Creek, but it is the main pathway for metals to reach Kennicott River and Clear Creek.
- There were no significant elevated concentrations in the sediment sample collected from Kennicott River.
- Arsenic was elevated in surface water samples from Clear Creek near the McCarthy surface water intakes, slightly above its cancer screening level (EPA, 1991a). Copper was elevated in sediment. There are no applicable health-based standards for evaluating elevated concentrations of copper in sediment. Although copper was detected above background in Clear Creek surface water samples, detected concentrations were below five times that detected in the transfer blank. Therefore, these data could not be used to determine observed releases.
- A clear connection between the spring feeding Clear Creek and National Creek has not been established. However, the dye test performed for the 1992 SI (America North/EMCON, 1992) established a hydraulic connection between National Creek

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and surface water bodies at the toe of the glacier, likely through shallow subsurface flow. The same flow would potentially supply or impact the Clear Creek spring, since Clear Creek is located near the dye monitoring stations (at Lake 17 and the Kennicott River), which received detectable concentrations of dye deposited in National Creek.

4.3 SAMPLE RESULTS: SOIL

Areas of observed contamination identified in the oil spill area discussed in Section 4.1 are also potential areas of human exposure to soil contamination. No other samples were collected to explicitly evaluate the soil exposure pathway.

4.4 AIR MIGRATION SAMPLE RESULTS AND DISCUSSION

The following sections discuss the methods used to evaluate potential air migration of particulates. This type of analysis is normally outside of the scope of an SI, but was performed here due to the large quantity of exposed sources and potential for migration. Methods used to evaluate the air pathway were dust sampling, off-site surface soil sampling, and particle-size analysis.

Unlike data for sources (i.e., boiler ash pile) or receptors (i.e., surface water bodies), these sample data were not intended to establish a quantitative observed release, which would require ambient air data. Rather, the samples were intended to determine whether there was a gradient which would suggest air migration from source areas. For example, if dust migration were occurring, a gradient showing increasing concentrations from north to south in the mill town and diminishing again south of the mill town would be expected.

4.4.1 Wipe Sample Results

Seven dust samples and one blank sample (to assess contamination of the glass wool sampling material) were collected at five locations in the mill town, at the McCarthy airport and at Ma Johnson's hotel in McCarthy. The samples were collected over a 10-square-centimeter surface area. Table 4-8 lists samples in a general north-to-south progression. This arrangement roughly corresponds to an upwind to downwind arrangement. Concentrations are expressed in $\mu\text{g}/10\text{cm}^2$. Sample results for priority pollutant metals analyses performed on all wipe samples are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-1.

Of the priority pollutant metals (excluding mercury) analyzed, arsenic, cadmium, copper, lead, and silver were detected in at least one wipe sample (see Table 4-8). All other metals were either not detected or were found at concentrations less than 5 times the concentration

Table 4-8—Wipe Sample Results ($\mu\text{g}/10 \text{ cm}^2$)

Analyte	DU004-0 Cottage 39B	DU005-0 Cottage 13F	DU003-0 Refrigeration Plant	DU006-0 Cottage 24	DU007-0 Kennicott Lodge	DU002-0 McCarthy Airport	DU001-0 Hotel In McCarthy
Arsenic	1.33	1.97	8.58	0.1 U	0.24 J	3.11	0.912
Cadmium	U	U	0.394	0.097 J	U	U	U
Copper	18.2	21.8	247	U	2.58	16	7.52
Lead	97.4	7.79	50.8	18.2	0.59 U	24.8	6.09
Silver	.032 J	0.05 J	0.088 J	0.015 J	0.02 J	0.042 J	0.026 J

• Samples are arranged in table in a general north (upwind) to south (downwind) orientation.

J Indicates that the associated numerical value is an estimated quantity because quality control criteria were not met.
 U Indicates that the value was not detected. The qualifier without an associated numerical value indicates that concentration was less than five times the concentration detected in control sample (DU008) and cannot be considered positively identified.

Note: Antimony, beryllium, selenium and thallium were analyzed for but not detected in any sample. Chromium and nickel were not detected at concentrations greater than 5 times concentrations detected in control sample and cannot be considered positively identified.

detected in the blank sample (DU008; the 5-fold margin was used to ensure that concentrations detected represented site conditions rather than residual metals on the glass wool used to sample dust).

No strong trends were indicated by analytical results for cadmium, silver, and lead. Levels of copper and arsenic gradually increased in the first three north-to-south wipe samples, with low concentrations in Cottage 39B (Station DU004) and 13F (Station DU005) and maximum concentrations in the refrigeration plant (Building 48: Station DU003).

4.4.2 "Downwind" Surface Soil

The top foot of soil at two locations south and downwind of the main mill town, near Cottage 29A and near the dairy, were sampled at three intervals (0-1, 1-6, and 6-12 inches). The purpose of the sampling was to assess transport, mainly by wind, of tailings and contaminated soil to areas that were considered to be at a sufficient distance (roughly 1/4 mile) from actual mining activities. Concentrations near the surface were compared to concentrations at depth in order to identify any trends that suggested surface deposition of particulates from mill town sources. Analytical results are summarized in Table 4-9. Sample results for inorganic analyses performed on all downwind soil samples are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-1.

At the station near the dairy (SS010), six metals were elevated in the top 1 inch of soil from the two locations, including arsenic, barium, copper, lead, mercury, and zinc. All six of the metals exhibited a gradient, with elevated concentrations at the surface attenuating to lower concentrations at 6 to 12 inches.

At the station near the Cottage 29A (SS011), the same metals elevated near the dairy were also elevated at the surface interval, with the exception of arsenic. However, in this case, the 12-inch interval was higher than at least one of the overlying intervals for arsenic, barium, copper, and lead.

4.4.3 Particle Size Results

Particle-size analysis was performed on surface tailings samples collected near Cottage 24 (Station SS007) and at the western edge of the pile (Station SS008). The analysis was intended to characterize the size of the tailings particulate and determine whether suspendable and transportable particles were present. Although considerable discussion of the cut-off point for suspendable soil particle size exists, as a group, particles less than 100 μm in diameter encompass suspendable and transportable particles. Within this group, particles between 30 μm and 100 μm would be expected to settle within a few hundred feet from the source, while those less than 30 μm would be expected to be transported a considerable distance downwind (EPA, 1988).

Table 4-9—Inorganics in Downwind Surface Soil (mg/kg)

Analyte	SS010-0001 dairy 0-1"	SS010-0005 dairy 1-6"	SS010-0010 dairy 6-12"	SS011-0001 cottage 29A 0-1"	SS011-0005 cottage 29A 1-6"	SS011-0010 cottage 29A 6-12"
Antimony	0.98 UJ	0.61 UJ	0.64 UJ	1.0 UJ	1.1 UJ	1.7 UJ
Arsenic	39.9	5.6 J	5.8 J	11.8 J	7.8 J	19.2 J
Barium	170	48.5 J	40.6 J*	189 J	123 J	222 J
Beryllium	0.27 U	0.38 J*	0.46 J*	0.28 U	0.27 U	0.23 U
Cadmium	0.71 J*	0.22 UJ	0.21 UJ	0.89 J*	0.27 UJ	0.32 J*
Chromium	8.1	10.5	6.2	13.3	9.6	13.6
Cobalt	6.4 J*	9.7 J*	7.5 J*	9.3 J*	5.0 J*	8.2 J*
Copper	385 J	75.7 J	46.9 J	231 J	131 J	554 J
Lead	135	14.3 J	9.4 J	328 J	121 J	342 J
Manganese	372 J	452 J	470 J	686 J	575 J	549 J
Mercury	0.58	0.11 J*	0.05 U	0.19	0.18	0.15
Nickel	10 J*	11.1 J	7.6 J*	10.3 J*	8.9 J*	11.7 J
Vanadium	19.5	27.5 J	21.5 J	27.7 J	23.9 J	29.6 J
Zinc	124 J	48.5 J	38.4 J	225 J	74.7 J	187 J

* Values positively identified below the CRDL were not used for observed release determination.

Bold values qualify as observed releases (see Table 4-1 for background concentrations).

U indicates that the value was not detected.

J indicates that the contaminant was positively identified but the associated numerical value is an estimated quantity because quality control criteria were not met.

Note: Selenium, silver, and thallium were not detected (qualified U) in any sample.

Table 4-10 summarizes the results of the particle size analysis. Based on particle size results, 86 to 96 percent of the surface tailings particulate were greater than 1 mm in size. This corroborates field observations which identified the tailings as coarse, gravelly material. Only 1.6 to 4.0 percent of the surface tailings were less than 75 μm and would be expected to be suspendable and transportable. A fraction of this amount would be expected to be less than 30 μm , and transportable a larger distance.

Estimates of suspendable and transportable particle size are generalizations only. Actual estimates would depend on site-specific weather patterns such as wind speed, wind direction and presence of ice or snow over the tailings pile. It can be assumed, however, that a small fraction of the tailings pile particulate is small enough to become windborne, as was observed when the tailings pile was disturbed during the site visit.

Results for particle size analyses performed on the two tailings samples are presented in Appendix D, Data Validation Reports. Sample locations were presented in Figure 3-1.

4.4.4 Discussion of Sample Results for the Air Pathway

The metals detected at elevated concentrations in downwind soil samples—arsenic, barium, copper, lead, mercury, and zinc—were also detected at similar concentrations in the samples collected from the tailings pile, with the exception of barium. The occurrence of these metals in areas projected to be downwind of mining activities suggests the potential for particulate migration from the tailings pile. However, results from particle size analyses on the tailings pile samples indicate that only a small fraction (1.6 to 4 percent) of the tailings would be amenable to air migration. The possibility for other transport mechanisms should be considered; tailings were used throughout McCarthy and Kennicott for fill, road material, and the airport runway.

4.5 COMPARISON OF SOURCE SAMPLE RESULTS TO SURFACE WATER, SEDIMENT, AND SOIL SAMPLE RESULTS

This section compares the elevated detections of contaminants in surface water, sediment, and soil samples to the analytical results from source samples. This comparison is provided for each sample matrix included in the sampling program (surface water, sediment, and soil).

4.5.1 Surface Water

Of the surface water samples collected, only one was collected at the tailings pile source—the seep that flows into National Creek. Because the seep is assumed to be a slow-flowing, possibly intermittent stream, it was not included in the surface water TDL. Analytical results from the seep sample indicated elevated concentrations of arsenic and copper. Although

Table 4-10—Particle Size Results

Sieve Number	Particle Size	10-SB-SS007-0010 near Collage 24 Total weight: 553.6 g		10-SB-SS008-0010 west end of pile Total weight: 500.6 g	
		weight (g)	percent by weight	weight (g)	percent by weight
3/8"	9.5 mm	14.0	2.5 %	no data	no data
4	4.7 mm	176.8	32 %	249.8	50 %
8	2.36 mm	182	33 %	174.7	35 %
16	1.18 mm	102.1	18 %	57	11 %
30	600 μ m	23.7	4.3 %	4.2	0.8 %
50	300 μ m	12.9	2.3 %	1.1	0.2 %
100	150 μ m	9.2	1.7 %	2.1	0.4 %
200	75 μ m	10.3	1.9 %	4.1	0.8 %
<200	< 75 μ m	22.3	4.0 %	8.2	1.6 %

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insufficient data exists to allow a direct comparison of water concentrations to sediment concentrations, these inorganics were consistently detected in sediment samples collected along the TDL in National Creek.

Concentrations of arsenic were also detected in surface water samples from Clear Creek at levels above background; however, insufficient data exist to definitively include Clear Creek in the surface water TDL.

4.5.2 Sediment

As discussed in Section 2.6.2.1, the migration route for contaminants through surface water, or TDL, begins where the seep from the tailings pile enters National Creek, and includes the length along: a) National Creek (4 miles) b) the Kennicott River to its confluence with the Nizina River (5 miles), and c) 6 miles on the Nizina River after the confluence with Kennicott River. The point where the seep enters National Creek is the probable point of entry (PPE) for the contaminant migration pathway. Sediment samples were collected along the TDL in National Creek at the PPE, 1/2-mile downstream of the PPE in National Creek, and approximately 4 miles downstream of the PPE in the Kennicott River. A comparison of the analytical results indicates the reoccurrence of three inorganics—arsenic, cadmium, and copper—at consistently elevated concentrations, in the PPE and downstream National Creek samples. No inorganics were elevated in the Kennicott River sediment samples.

Arsenic, cadmium, and copper were detected in the tailings pile samples at concentrations higher than those detected in the PPE and downstream sediment samples.

Although no surface water bodies flow through the boiler ash pile or oil spill area sampled during this SI, the surface water TDL is presumed, based on area topography, to receive runoff from these areas. Copper was detected in these sources at concentrations higher than those detected in the PPE and downstream sediment samples.

4.5.3 Soil

Soil samples collected from areas projected to be downwind of sources and mining activities may also indicate areas of observed contamination. Although the transport mechanism is presently undetermined, arsenic, barium, copper, lead, mercury, and zinc were detected in both source samples and in downwind area soil samples. The concentrations of arsenic and copper in the downwind area soil samples are lower than those in detected in the boiler ash pile and oil spill area.

Of the six inorganics listed above, arsenic, copper, and mercury were also detected in downwind area soil samples at concentrations below those found in the tailings pile samples. This suggests the potential for migration of mine tailings, although the transport mechanism is unknown.

SECTION 5

CONCLUSIONS

The following conclusions may be drawn from the information gathered through this SI:

- There are no known drinking water wells near the site.
- Concentrations of arsenic, cadmium, copper, and mercury were elevated in sediment samples collected from National Creek. These inorganics are characteristic of elevated concentrations in the tailings pile. There are no ecological or human receptors for National Creek along the TDL.
- Copper and arsenic were elevated in the tailings pile seep water sample. The seep flows into National Creek.
- Arsenic was slightly elevated above the background in Clear Creek surface water. The concentration was below the MCL for arsenic but above its cancer screening level as identified in EPA's HRS chemical data tables (EPA, 1991a). Insufficient data exist to determine if Clear Creek is hydraulically connected to the TDL surface water bodies.
- The Kennicott and Nizina Rivers are migratory routes for anadromous fish. No fisheries data are reported for these rivers.
- The tailings pile and soil at the Power Plant Oil Spill contain elevated concentrations of inorganic hazardous substances. Due to a lack of any type of containment, workers, residents, and tourists may be exposed to contamination.
- Elevated metals were detected in soil samples collected 1/4-mile downwind of historical mining activities. These metals were also detected in higher concentrations in samples collected from the tailings pile and oil spill area. A comparison of source data to downwind area soil indicates the potential for site contaminants to have migrated or otherwise been transported from source areas to mill town buildings and downwind areas.

SECTION 6

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APPENDIX A
CONTACT LOGS

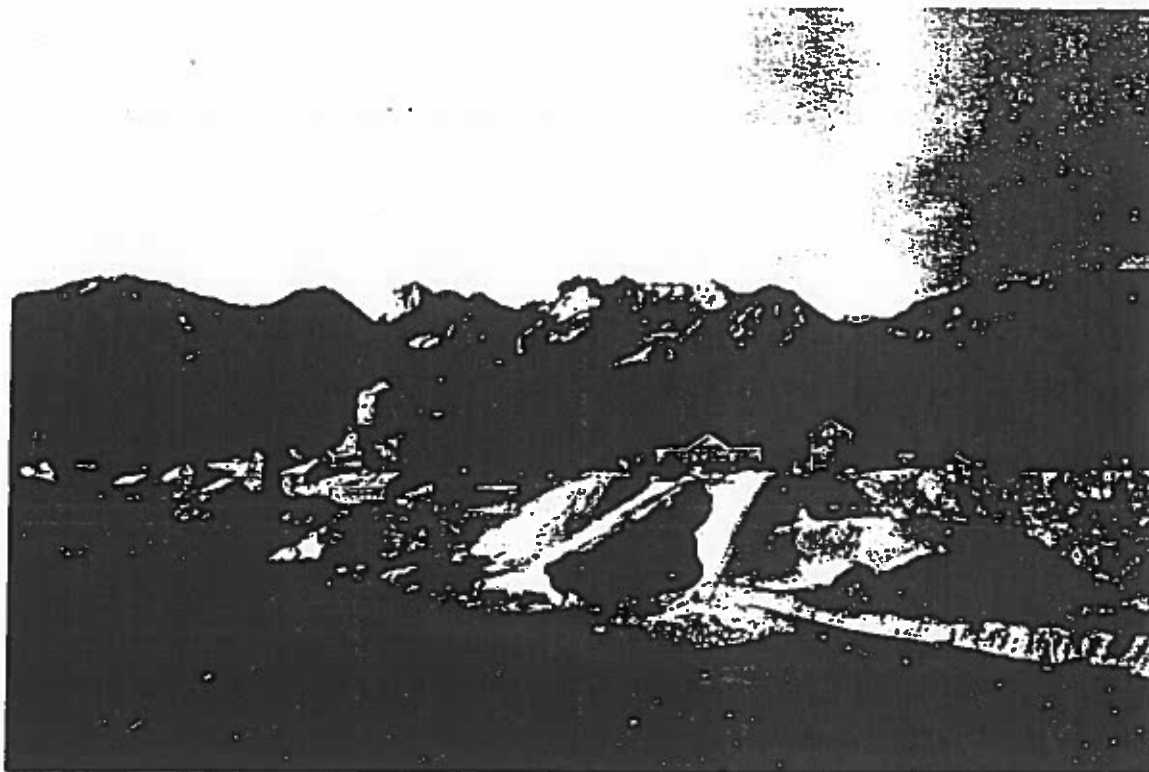
APPENDIX A
CONTACT LOGS

Person Contacted/ Number	Organization	Date	Subject
Kay, Simon (907) 562-3452	EMCON Alaska	5/24/94	EMCON Alaska's work at the site, site description, site contacts and sampling logistics
Potter, Beth (907) 586-8010	EMCON Alaska	5/13/94	Author of Preliminary Assessment for ADEC
Sosnowski, Jan (907) 257-2586	National Park Service	5/16/94 5/27/94	Provided topographical and property maps of Kennicott Private and public property designations around Kennicott
Fairchild, Laurie (907) 271-2788	U.S. Fish and Wildlife Service	5/12/94	Sensitive environments and endangered species
Personnel (907) 822-5234	National Park Service, Copper Center	5/16/94	Information on tourism at Kennicott
Gnath, Dennis (907) 267-2285	Alaska Department of Fish and Game	5/12/94	Surface water and fisheries
Keeler, Kevin (907) 257-2466	National Park Service	5/12/94	National Park Service information
Harrower, Jim (907) 345-2891	Great Kennicott Land Company	5/27/94	Permission to visit site
Rolluda, Monica (205) 553-0323	Environmental Protection Agency Region X	numerous calls	EPA Site Assessment Manager for the Kennicott Mine
Janes, Bill (907) 465-5208	Alaska Department of Environmental Conservation	5/13/94	State involvement with site
Kitagawa, Judy (907) 835-2824	Alaska Department of Environmental Conservation	5/13/94	McCarthy drinking water systems
Gilbert, Chuck (907) 257-2585	National Park Service	5/14/94	Information on land ownership and National Park Service involvement
Tauby, Tom (907) 822-3309	Alaska Department of Fish and Game	6/14/94	Fisheries
Krieger, Mike (907) 376-5038	Alaska Department of Environmental Conservation	6/24/94	Arrangements to accompany WESTON on-site
Beierle, Thomas (206) 842-3472	Roy F. Weston, Inc.	4/4/95	Site visit participant
Scarzi, Nicola (907) 822-3309	Alaska Department of Fish and Game	4/3/95	Surface water and fisheries
Bulkow, Susan (907) 376-5038	ADEC-Drinking Water Specialist	3/31/95	Public Water Supplies in McCarthy

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APPENDIX B

PHOTOLOG



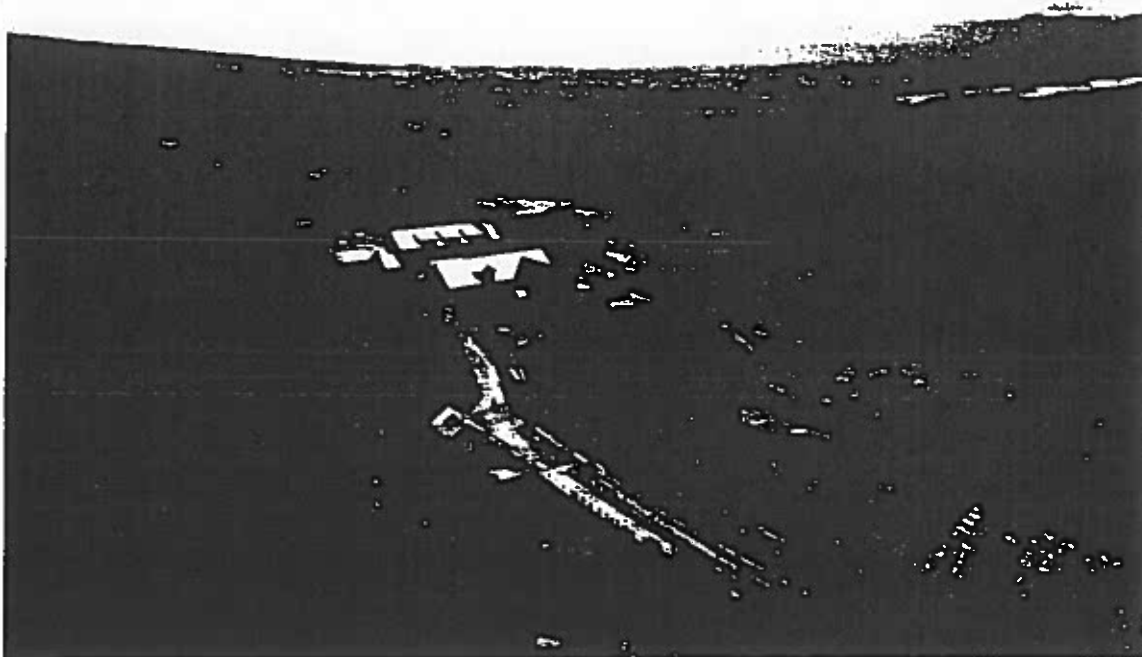
Mill town and Bonanza Ridge, looking northeast. Note tailings pile in center of photo and drum dump at right.

Kennicott Mine
AKD983073123
27 July 1994
Photographer: J. Livingstone



Mill building and bridge over National Creek from main road, looking north.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



View of mill town from top of mill building. Note glacier at center right.

Kennicott Mine
AKD983073123
27 July 1994
Photographer: J. Livingstone



Leaching and flotation plant from bridge over National Creek, looking north.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



Foundry building with power plant in background. Caution tape is for asbestos removal work.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



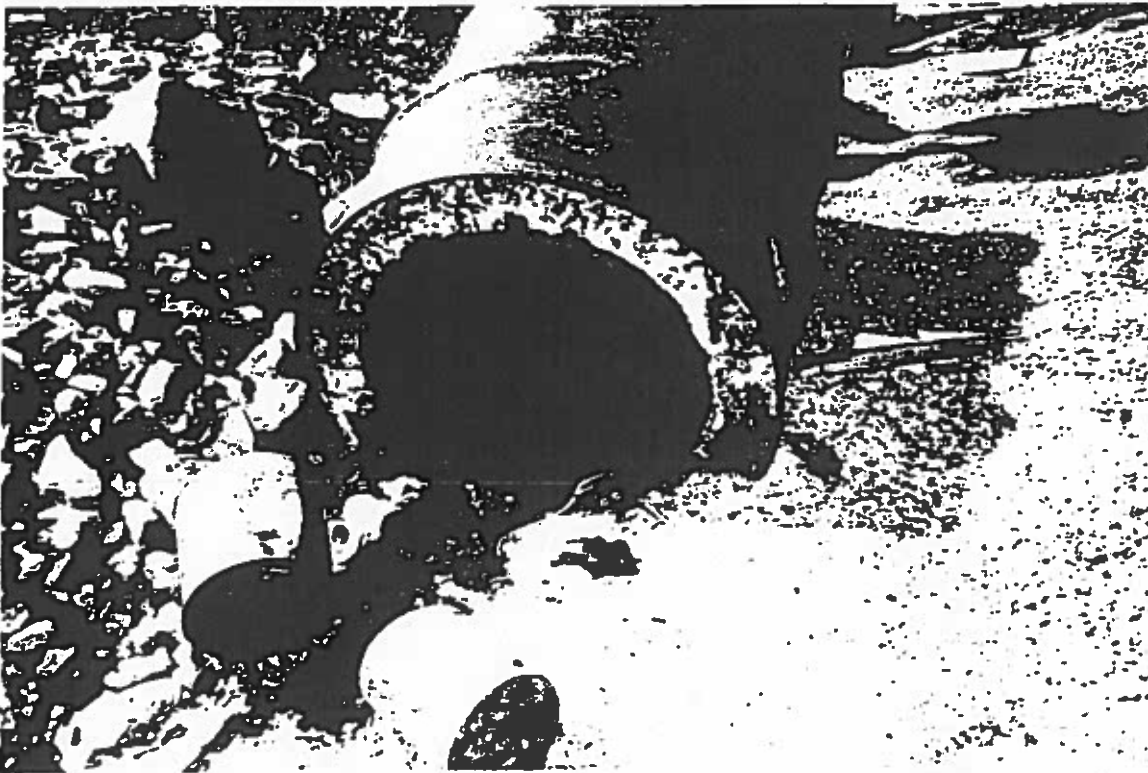
View of south mill town buildings. Cottage #24 at left, Kennicott Lodge in background. Soil boring station SS007 located at right.

Kennicott Mine
AKD983073123
28 July 1994
Photographer: J. Livingstone



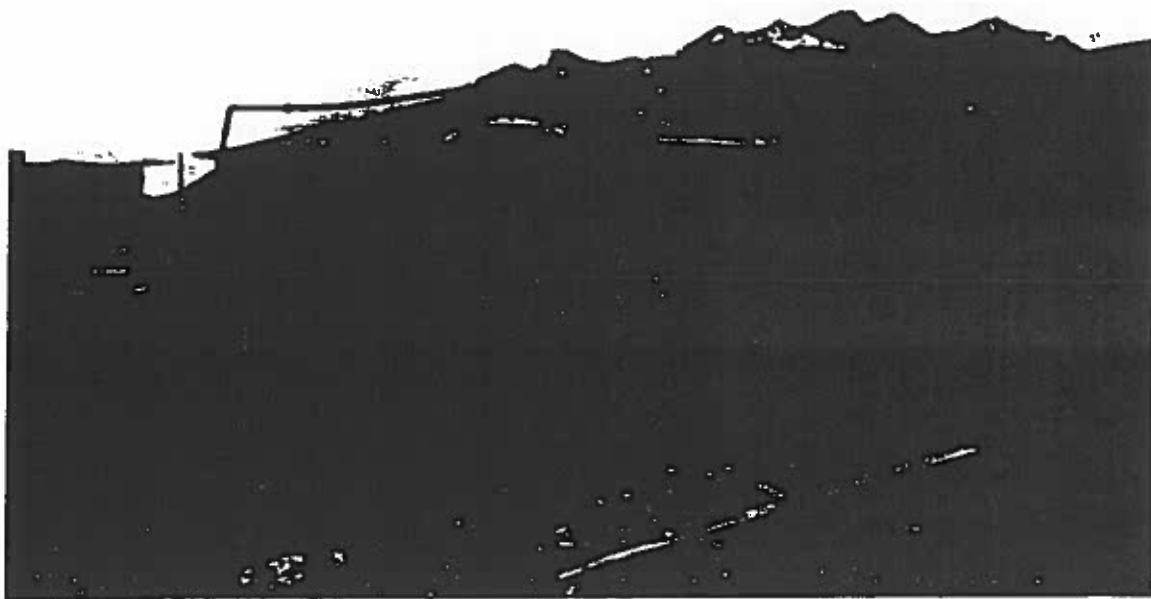
Tailings pile drum dump looking northeast from bottom of tailings pile.
Location of sample station SS013.

Kennicott Mine
AKD983073123
28 July 1994
Photographer: J. Livingstone



Oily material in drum in tailings pile drum dump.

Kennicott Mine
AKD983073123
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Photographer: J. Livingstone



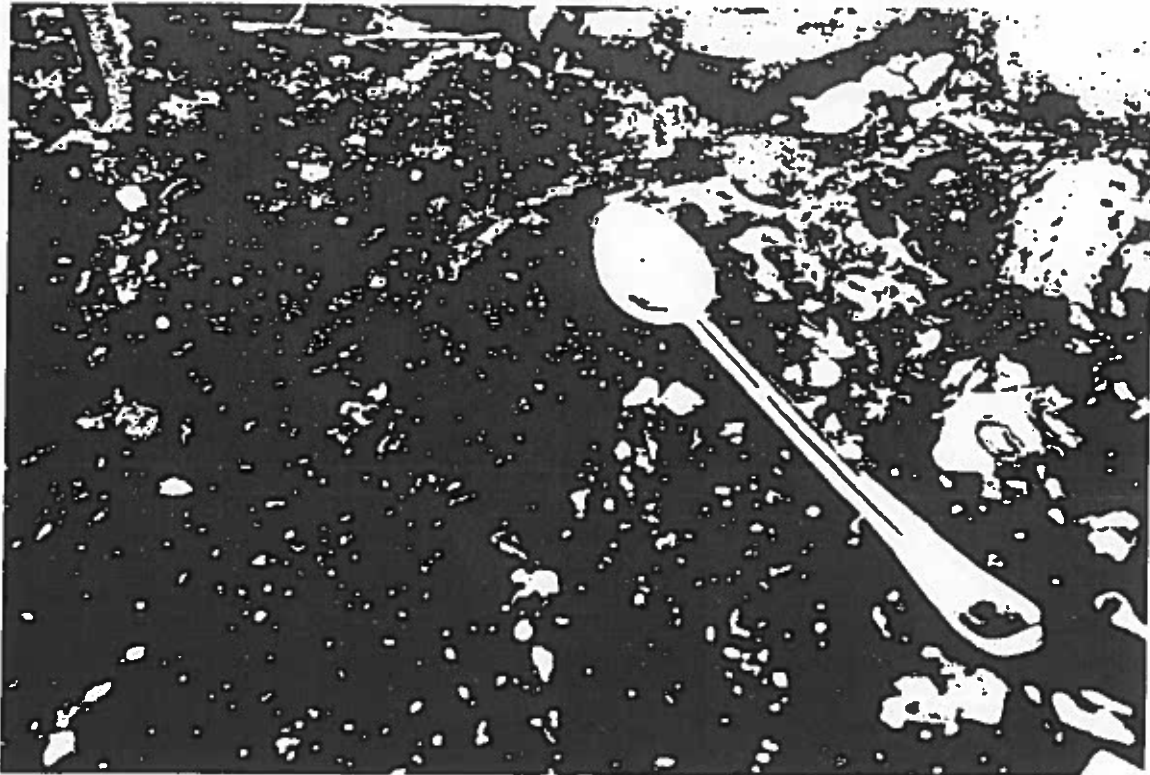
Fuel Tank 4(2), located above oil spill, looking west.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



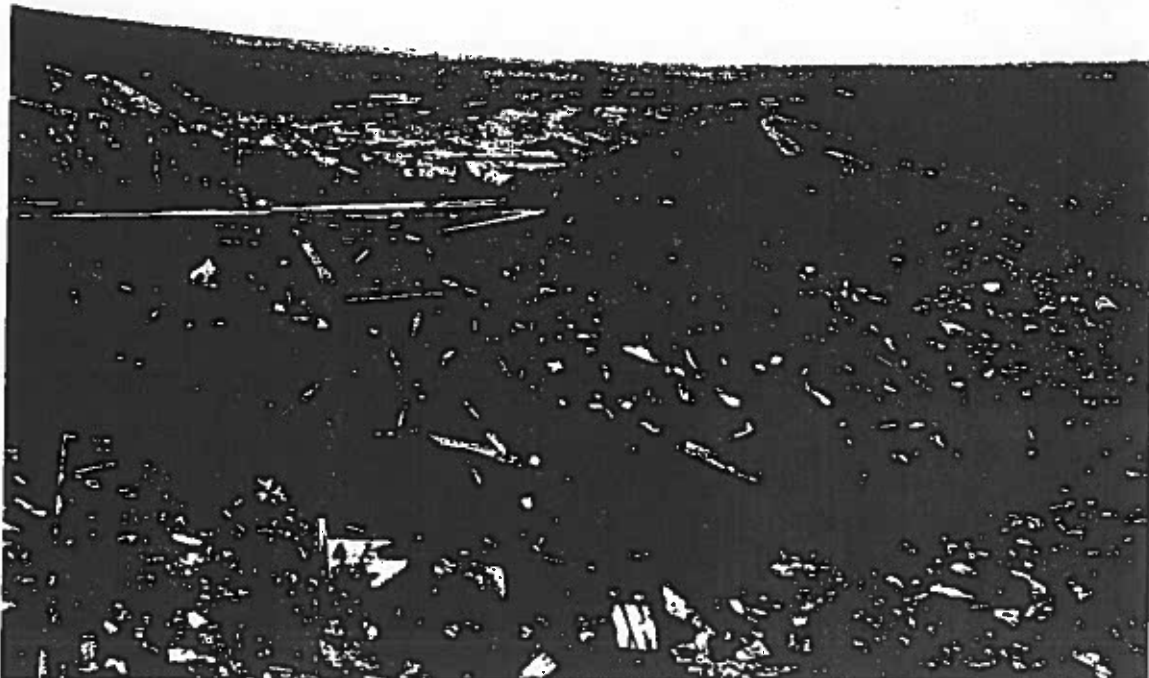
Oil spill area below fuel tanks 4(2) and 4(3).

Kennicott Mine
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26 July 1994
Photographer: J. Livingstone



Asphalted soil in oil spill area. Location of sample station SS003.

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Boiler ash pile looking south. Sample station SS004 located near wooden stake at top of pile.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



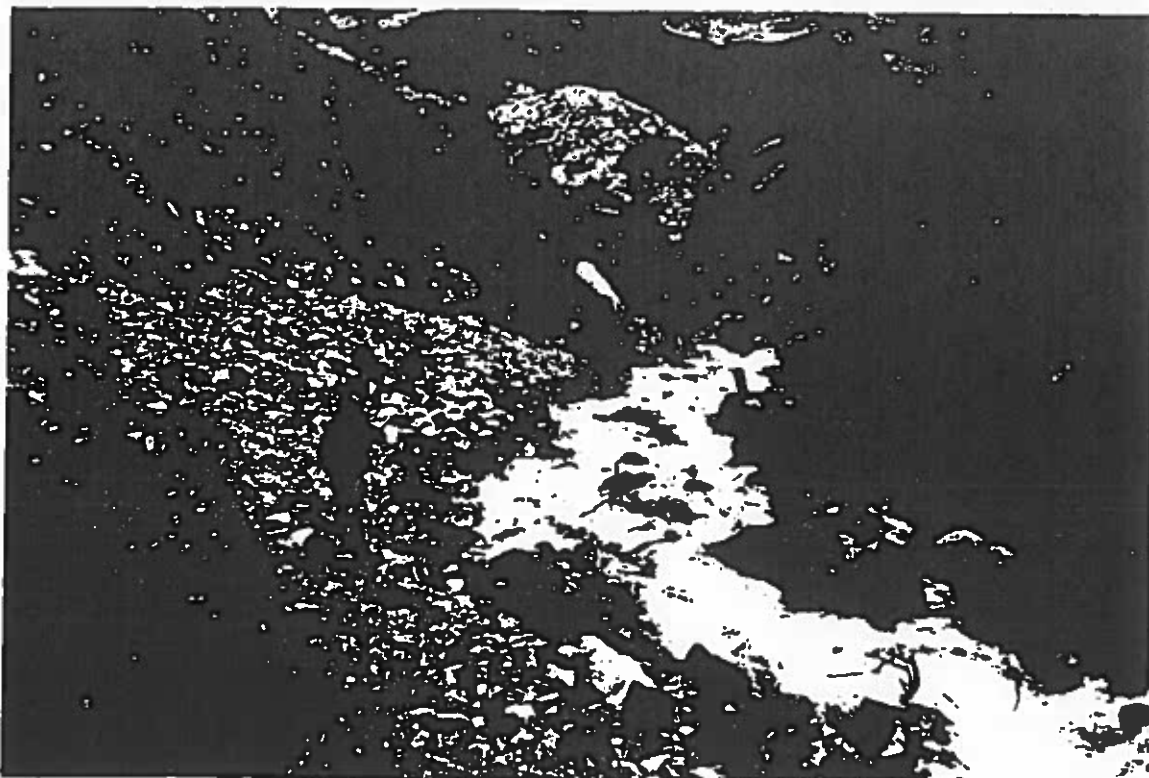
Tailings pile road cut exposing oil layers, looking east. Note darkened oil lenses throughout road cut and stained tailings at left.

Kennicott Mine
AKD983073123
28 July 1994
Photographer: J. Livingstone



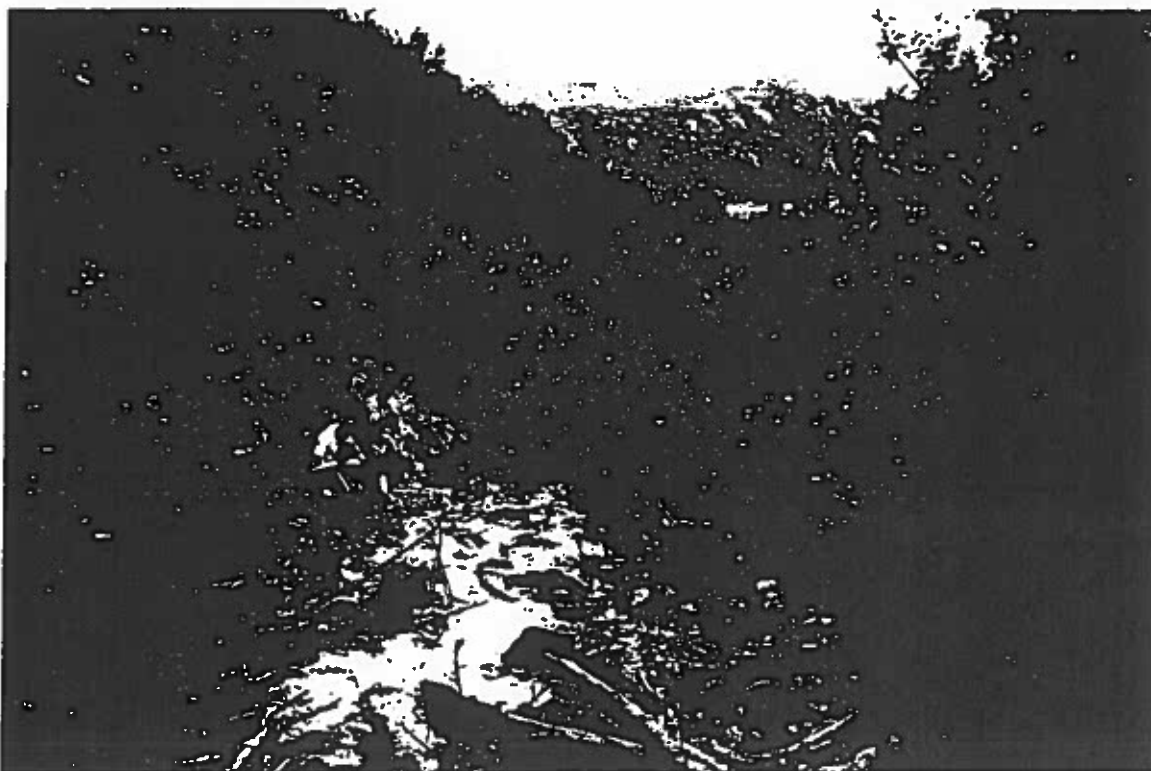
Seep over bedrock in tailings pile. Located below leaching and flotation plant, looking east. Corresponds to sample station SP001.

Kennicott Mine
AKD983073123
28 July 1994
Photographer: J. Livingstone



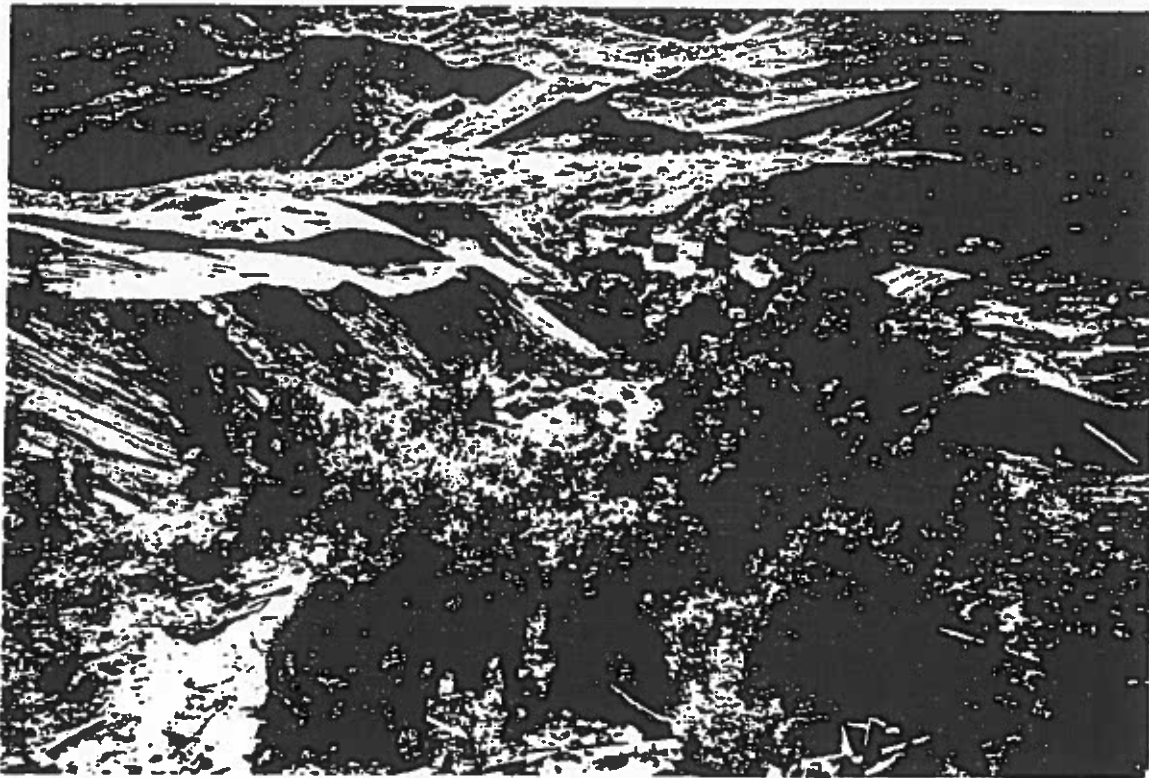
Jumbo Creek, looking west. Located below leaching station SD004.

Kennicott Mine
AKD983073123
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National Creek above mill town, looking west. Location corresponds to background sample station SD001.

Kennicott Mine
AKD983073123
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National Creek below mill town as it cuts through the tailings pile, looking west.

Kennicott Mine
AKD983073123
26 July 1994
Photographer: J. Livingstone



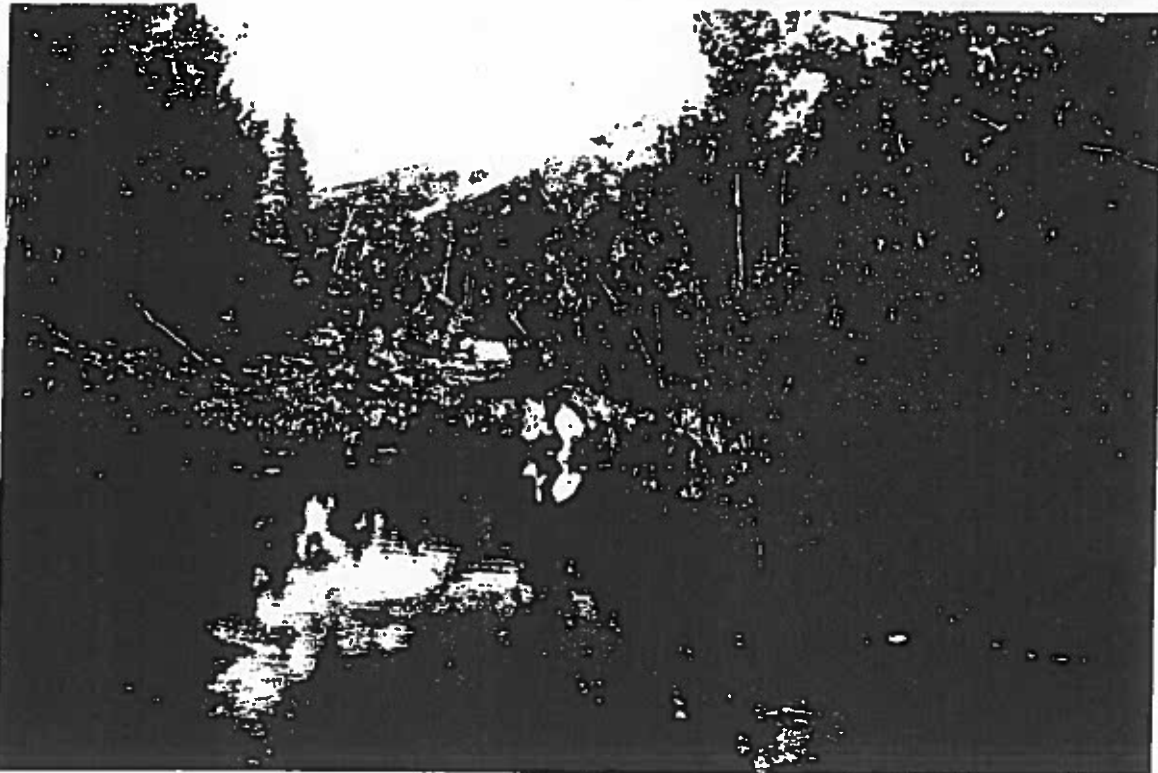
Kennicott River near McCarthy, looking north. Location corresponds to sample station SD007. Note silt in water.

Kennicott Mine
AKD983073123
27 July 1994
Photographer: J. Livingstone



McCarthy Creek near McCarthy, looking northwest. Location corresponds to sample station SD005.

Kennicott Mine
AKD983073123
27 July 1994
Photographer: J. Livingstone



Clear Creek near McCarthy surface water intakes, looking north. Location corresponds to sample station SD006.

Kennicott Mine
AKD983073123
27 July 1994
Photographer: J. Livingstone