Versar INC.

SITE INVESTIGATION OF SELECTED MINE SITES NEAR JUNEAU, ALASKA

Prepared for:

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1.0 INTRODUCTION

Several historical mine sites in the Juneau, Alaska, area have recently been evaluated by the Alaska Department of Environmental Conservation (ADEC) and the United States Environmental Protection Agency (EPA). These investigations have included sites owned by the City and Borough of Juneau (CBJ) and Alaska Electric Light and Power Company (AEL&P). The results of sampling in Silver Bow Basin have indicated that heavy metals may be present in concentrations above background levels in the area of the Perseverance mill and Ebner Falls (Tryck, Nyman, and Hayes, 1987). Because the CBJ and AEL&P are concerned about the possibility of the suspected contamination causing environmental impairment, Versar was authorized to conduct an investigation of the Silver Bow Basin, the tailings deposited at and near tidewater along Douglas Island, the Alaska Juneau Mine (AJ) rock dump, and the Treadwell cyanide mill and tailing sites. The goal of the investigation was to determine if metals are present in high enough concentrations to raise concerns about environmental impairment, and to determine if special management practices are necessary.

2.0 ENVIRONMENTAL SETTING

2.1 Site Location and Demographics

The sites to be investigated are in or near the City of Juneau, Alaska. Access to Juneau is by boat or airplane. The population of Juneau is approximately 27,000. The locations of the study areas are shown in Figure 2-1.

The Perseverance site and Ebner Falls are located in Silver Bow Basin, an undeveloped recreational area approximately two miles east of downtown Juneau. Steep, forested mountains surround the basin and the Juneau Ice Field covers the top of the mountains to the east. Gold

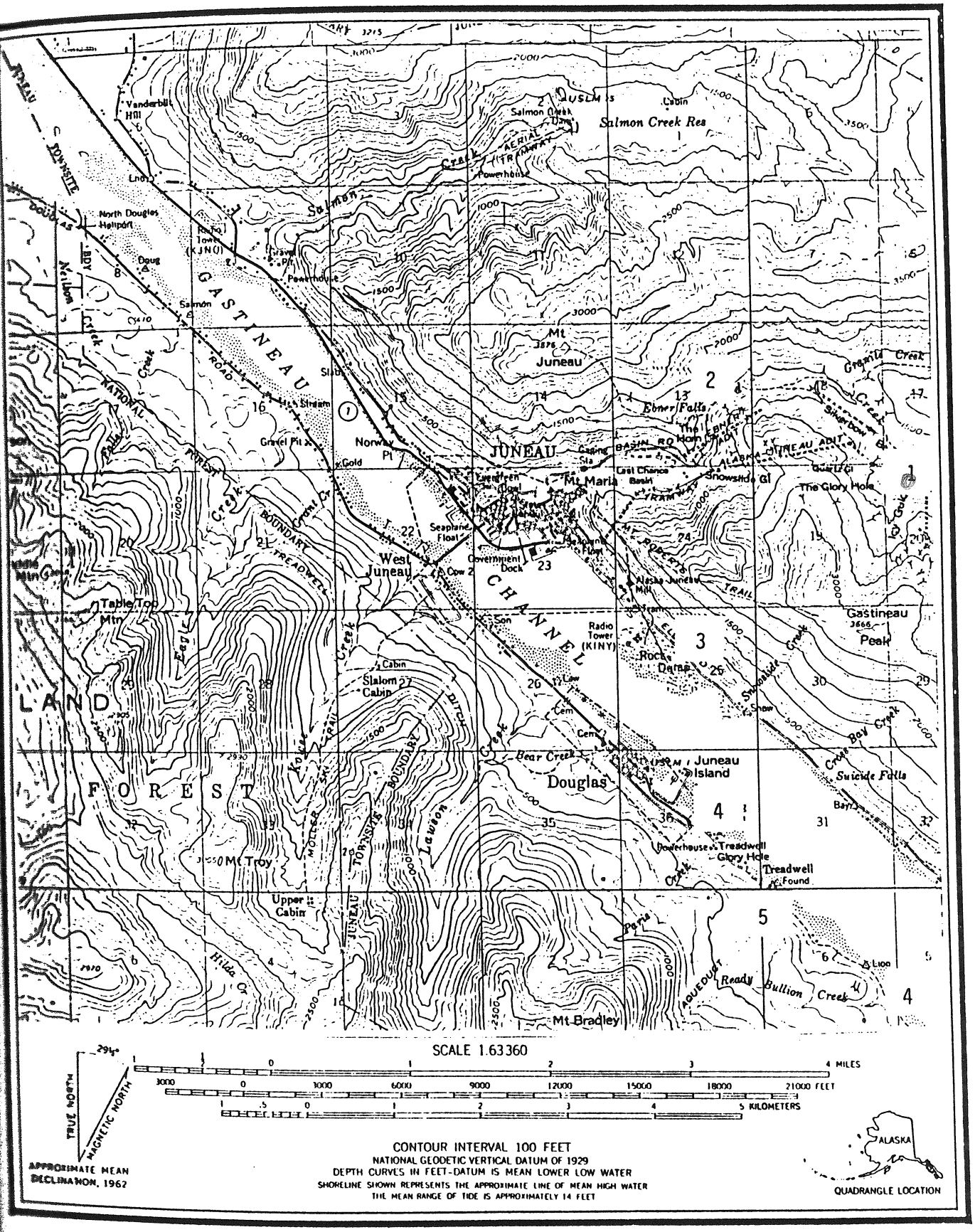

Figure 2-1. Map Showing the Locations of the Perseverance Area (1), Upper Ebner Falls (2), the AJ Rock Dump (3), the Douglas Island Tailings (4), and the Treadwell Cyanide Mill (5)

Creek flows to the west through the center of the basin and discharges over Ebner Falls, a narrow gap at the western end of the basin, to Last Chance Basin. The Perseverance Mine is near the east end of the basin. The only developed access is a hiking trail, which originates in Last Chance Basin west of Silver Bow Basin. The Alaska Juneau glory hole, a large open pit mine, is located to the west of the Perseverance mill site. The Webster mill site is located approximately 500 feet upstream from Ebner Falls.

The AJ rock dump begins one-half mile southeast of downtown Juneau and extends 2,800 feet to the southeast at tidewater in Gastineau Channel. The rock dump includes both unprocessed waste rock from the mine, and tailings from the gold extraction process. The only structures on the rock dump are communications satellite dishes, a Union Oil tank farm located on the northwest end of the rock dump, and the Juneau wastewater treatment plant located at the southeast end. Because the mountains border the channel so closely, the area adjacent to the rock dump has not been developed.

The tailings located along Gastineau Channel on Douglas Island, are from the operations of the Treadwell Group mines. The Sandy Beach area, on the northwest end of the tailings, has been developed as a recreational area and includes softball fields, a soccer field, tennis courts, and a picnic area. Residences are located to the west, uphill from Sandy Beach. Tailings from the Treadwell Group mining operations extend virtually continuously in a southeast direction from Sandy Beach to the Ready Bullion Mine, a distance of approximately 8,000 feet. Included in this area are the Treadwell cyanide mill tailings, which were deposited at tidewater approximately 4,000 feet southeast of Sandy Beach at tidewater, and also at the mill site, which is 500 feet inland from the channel. Most of the tailings on Douglas Island are located

along a steep, forested, undeveloped area, which is used primarily as a recreational area for day trips by hikers.

2.2 Climate

The climate in the Juneau area is characterized by high precipitation, frequent cloudiness, and moderate temperatures due to the maritime influences which prevail along the coast of southeastern Alaska. The rugged, mountainous terrain surrounding Juneau produces large variations in local climatic conditions. The mean annual temperature is 40.2 degrees Fahrenheit (^{o} F). Temperatures range from 44^{o} F to 64^{o} F during June, July, and August, to between 17^{o} F and 38^{o} F during the November through February winter season. Occasional periods of severe cold occur when winds originating in northwestern Canada, known as "Taku Winds," flow into the area over the mountain passes and the Juneau Ice Fields. Juneau lies within the path of most storms crossing the Gulf of Alaska and experiences high precipitation. The mean annual precipitation is 53.17 inches, including 102.9 inches of snowfall. Approximately 68 percent of the snowfall occurs during December, January, and February. Monthly precipitation ranges from less than three inches in April, to an average of 7.74 inches in September.

2.3 Surface Water

The nearest surface water to the Perseverance mill site is Gold Creek, which is located approximately 50 feet to the north. According to a University of Alaska publication cited in a previous study of the Perseverance area (Tryck, Nyman, and Hayes, 1987), the stream has an average flow rate of 110 cubic feet per second. The actual flow rate of the stream varies widely during the year. A tributary to Gold Creek, Lurvey Creek, is located 500 feet southeast of the site. Gold Creek flows into the Gastineau Channel approximately 4.5 miles downstream from the mill site. Gold Creek serves as a recharge source for the water supply of the City and Borough of Juneau. The CBJ water supply wells

are located approximately 3.5 miles downstream from the Perseverance site.

2.4 Geology

The geology of Southeastern Alaska is dominated by a series of northwest trending synclinoriums and anticlinoriums, and high angle strike-slip faults. These structures have been developed by several periods of folding and in excess of 150 miles of right lateral movement along the faults. Juneau is on the eastern edge of a synclinorium which is part of the Juneau-Mitkoff-Gravina structural low. This structural unit is bounded on the east by the Coast Crystalline Belt, which underlies the mainland, and extends to the west into the Insular Belt, which underlies the islands of the Alexander Archipelago. The Coast Crystalline Belt is comprised of a core of igneous rocks flanked by detrital and volcanic sedimentary rocks. The igneous rocks are part of the Coast Range Batholith, a complex composite pluton from Jurassic to Tertiary in age. These rocks are primarily granitic in composition, but mafic and ultramafic rocks are commonly found as dikes and sills in adjacent rocks, and as magmatic segregations within the batholith. The sedimentary rocks which flank the Coast Range Batholith are Paleozoic to Mesozoic in age, and have been regionally and contact metamorphosed into gneiss, schist, slate, and greenstone. The igneous dikes and sills enclosed in the sedimentary rocks have been, in places, similarly metamorphosed. The degree of metamorphism decreases toward the west, away from the batholith.

The rocks underlying Juneau and Douglas Island are part of the Juneau Gold Belt, a local subdivision of the Coast Crystalline Belt. The rocks hosting the gold deposits are slate, schist, metagabbro, and greenstone. Mineralization associated with the gold throughout the belt includes galena, pyrite, sphalerite, pyrrhotite, arsenopyrite, chalcopyrite, and tetrahedrite. The deposits toward the western side of

are capable of sustained yields in excess of 1,000 gallons per minute. This yield is believed to be typical for valley bottom aquifers throughout the Juneau area (USGS, 1974, Siegel, 1988).

Although no studies have been undertaken to specifically define ground water flow through the soils developed on the mountainsides in the Juneau area, some empirical observations have been made in the Thane area, which is located approximately three miles southeast of Juneau. The aquifers in the soils developed on the mountainsides in the Thane area have lower transmissivities than those in Last Chance Basin and in valley bottom reservoirs in the Juneau area. The wells in Thane, which must typically be completed to depths of greater that 100 feet, show substantial drawdown at pumping rates of less than 50 gallons per minute. The ground water flow in the Thane area is expected to be typical for the mountain slopes in Silver Bow Basin and on Douglas Island.

3.0 PREVIOUS WORK

The only previous work reported for the areas of concern are two studies near the Perseverance Mine. The first was conducted for ADEC by Tetra Tech, Inc. Two soil samples from the area of the Perseverance mill were analyzed for total lead and leachable lead using the Extraction Procedure Toxicity Test (EPTT) (Tetra Tech, 1984). Sample Number 83100411 contained 2,600 milligrams per kilogram (mg/kg) of total lead. The leachate generated in the EPTT contained 5.2 milligrams per liter (mg/l) of lead. Sample 84050704 contained 5,000 mg/kg of total lead, and the EPTT leachate contained 0.12 mg/l of lead.

Because the Perseverance mill is included on the EPA's list of suspected hazardous waste sites, and is located upstream from the CBJ water intake system, ADEC retained Tryck, Nyman and Hayes (TNH) and Science Applications International Corporation (SAIC) to evaluate the site to determine if releases of hazardous wastes from the site present

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an imminent or substantial danger to public health, welfare, or the environment. The results of the investigation, which are summarized below, were presented in a report titled "Suspected Uncontrolled Hazardous Waste Site Inspections, Perseverance Mill, Juneau, Alaska," dated September, 1987. In July, 1986, the TNH/SAIC project staff traveled to Juneau, Alaska, to review pertinent files and interview people familiar with the Perseverance mill. The staff reviewed regional and state ADEC files, EPA Region X CERCLIS files, United States Geological Survey well inventory data, and United States Bureau of Mines Records. A review of the CBJ monitoring data showed the water supplies from Gold Creek sources to be of excellent quality, and within federal and state drinking water standards. Project staff also interviewed ADEC personnel and private citizens who were familiar with the site. Based on their interpretation of the available information, TNH/SAIC concluded that the mill site might be contaminated with heavy metals and cyanide, and represented a potential source of contamination for Juneau's water supplies. It was recommended that a site visit and field sampling should be conducted to further evaluate the potential hazards of the area.

A site inspection of the Perseverance mill was conducted on November 12, 1986. The inspection included visual observation of the site, and collection of soil, stream sediment, surface water, and ground water samples. Poor weather conditions and snowfall forced the project staff to modify their original sampling and site observation plans. A total of six soil samples were collected (including one replicate sample); the depth of sampling was limited to between two and six inches because the ground was frozen. Three samples of stream sediments were collected from Gold Creek, including one sample taken two miles downstream from the mill site. No information was provided on the size fraction of the sediments which were analyzed. Four of six soil sample locations and two of the three sediment samples were reported to have elevated concentrations of lead, mercury, arsenic, and zinc. The two samples which contained the highest

concentrations of heavy metals were selected for the EPTT. The leachate from sample DA3 was found to contain 5.6 mg/l of lead, and the leachate from sample S1 was found to contain 5.2 mg/l of lead. Both of these samples slightly exceed the proposed federal TCLP limits of 5.0 mg/l of lead. No other metals exceeded the TCLP limits. None of the samples analyzed contained cyanide. A summary of the soil and stream sediments sample analyses is presented in Table 3-1. Some of the samples underwent field tests to measure pH. The pH measurements ranged from 3.96, in soil believed to contain mine tailings, to 8.14 in stream sediments two miles downstream from the Perseverance mill. Background soil samples had a pH of 5.2.

Four surface and two ground water samples were collected during the site visit. Ground water samples were collected from seeps, and may have also contained some surface water. Analyses did not indicate significant levels of heavy metal contamination. Zinc, the only metal measured above detection limits, was present at levels of less than one percent of the drinking water standard of 5.0 mg/l. The specific conductance of the two ground water samples, as measured in the field, was 680 and 3,200 micromhos per square centimeter.

Based on the results of the analyses of the samples, site observations, and background research, the following recommendations which are pertinent to this work plan were made: a minimum of 21 soil borings, six within the unvegetated area and 15 at other locations near the Perseverance mill, should be drilled to collect soil samples from three, nine, and 15 feet for chemical analysis for lead, zinc, arsenic, and mercury; the hazardous characteristics of soil samples with significant concentrations of heavy metals should be quantified using the EPTT; an unspecified number of stream sediment samples should be collected along the course of Gold Creek from the head of Silver Bow Basin to the CBJ water intake for analysis for lead, zinc, arsenic, and

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Table 3-1. Summary of the Results of the Chemical Analyses of Soil and Stream Sediment Samples[1]

Sample No.	Lead (ug/g)	Zinc (ug/g)	Arsenic (ug/g)	Mercury (ug/g)
	Total Metals			
MDL[2]	4.0	0.75	10.0	0.02
U1	10.9	133	12.5	BDL[3]
U2	11.2	119	12.2	BDL
S1	3,160	519	974	347
DA1	2,640	747	1,260	8.99
DA2	3,310	275	1,130	14.8
DA3	5,950	657	1,580	16.2
DA3R	4,200	313	742	29.7
UEFS	404	177	45.8	12.8
MD1	654	312	121	0.38
	Extraction Procedure Toxicity Test			
	Lead (mg/l)	Zinc (mg/l)	Arsenic (mg/l)	Mercury (mg/l)
TCLP limits	5.0	NE[4]	5.0	0.2
S1	5.2	0.05	0.005	<0.001
NA3/NA3R	5.6	0.12	0.007	<0.001

[1]Source: TNH/SAIC, 1987

[2]MDL: method detection limit

[3]BDL: below detection limits

[4]NE: not established

mercury; water samples should be collected from site runoff, Gold Creek, and within the mine for analysis for lead, zinc, arsenic, and mercury; and a determination of the depth to ground water and the relationship of the aquifers in Silver Bow and Last Chance Basins should be made.

In addition to the work discussed above, the site was scored using the EPA Hazard Ranking System. The results of the scoring have not been made available to Versar.

An investigation of the Thane Mine dump site was conducted by Environment and Ecology (EE) for the United State Environmental Protection Agency. The report of the study was released in May, 1988. Although the study did not cover the same area as the Versar investigation, the environmental setting, the deposit mined, the mining and milling methods used, and the tailings produced are similar, and the results provide additional data which can be used to facilitate the interpretation of the results of this study. Of primary interest in the EE report, are the results of the analyses of tailings for total metals and analysis by EPTT. The lead in the tailings ranged from 4.8 mg/kg to 193 mg/kg, the zinc ranged from 44 mg/kg to 366 mg/kg, and the arsenic ranged from 7.4 mg/kg to 62 mg/kg. The samples with the lowest concentrations of metals were collected in an area where stream sediments have mixed with the tailings, and, in some locations, constitute the largest part of the sample. The concentrations of all of the metals detected in the EPTT were at least two orders of magnitude below the maximum allowable concentration.

4.0 SAMPLING PROCEDURES

A work plan for the collection and analysis of samples in the study areas was given to ADEC for review prior to beginning the work. Mr. Steve Haavig and Mr. Jeff Hock of ADEC reviewed the plan and written comments were sent to Mr. David Stone of AEL&P on June 22, 1988. In response to the comments, the procedures to be used were described in

Therefore, any environmental impact of the metals and cyanide will occur at the location in which they are deposited.

8.2 Perseverance Mine Area

Although metals from the mining and milling operations can be detected in the entire area between the mill and the tailings disposal area, a noticeable environmental impact can be seen only in the tailings disposal area. The level of contamination appears to drop off rapidly to the west of the tailings disposal site, and the results of the chemical analyses show that Gold Creek has not been impacted by the presence of the tailings. Although lead was found to marginally exceed the limit for the EPTT, there is no evidence, with the exception of the lack of vegetation in the tailings disposal area, that any environmental impairment has occurred. The greatest concern is that hikers could be adversely affected by contact with the metals in the tailings disposal area.

There are three management alternatives for the wastes: monitor the wastes to ensure that changing conditions do not create environmental hazards; cap the wastes; or remove the wastes. The monitoring program would consist of an evaluation of the results of the regular sampling and analysis of the municipal water supply conducted by the CBJ, semi-annual analysis of water samples collected downstream from the tailings disposal area, and maintenance of the sign at the site which warns of potential hazards as a result of the presence of the tailings. The main advantage of this method is the low cost. The main disadvantage is that it permits contact with the tailings if hikers choose to ignore the sign. Capping the wastes would consist of covering the tailings with an soil or talus from the area around the site. In addition, an impermeable, synthetic liner could be laid over the tailings underneath the natural cover. The advantages of this alternative are that it limits contact with the tailings and decreases the infiltration of storm water which

could leach metals from the tailings. The disadvantages are the cost, and the excavation of material to cap the tailings could lead to erosion and transportation of sediment to Gold Creek. The third alternative would require the excavation and transportation of the wastes to another site. The advantage to this alternative is that it removes the tailings from the area. The disadvantages are that it merely moves the tailings to another area, but does not provide for treating the tailings to decrease their inherent potential for environmental impairment; the cost; and the possibility that disturbing the tailings could increase the short term potential to contaminate Gold Creek by increasing the release of metals to the ground water, or by spills of the tailings into the creek during the removal operations. Because the impact of the contamination is limited to the tailings disposal area, human contact with the tailings is limited, no problems have been documented as a result of human contact, and the benefits, if any, to be gained by selecting the second or third alternatives are marginal compared to the cost of implementing them, the first alternative should be selected for management of the tailings. or combo 1+2

8.3 Ebner Falls

The mercury in the sediments below the Webster mill does not pose a threat of environmental impairment. Neither the water sample collected immediately downstream from the sediment sample location nor the regular sampling by the CBJ have detected mercury in the water in Gold Creek. Because mercury has a very low solubility and dissolved mercury tends to adsorb tightly onto sediments near the source, it is recommended that the only action to be taken is to examine the results of the regular CBJ municipal water analyses for the presence of mercury.

8.4 Douglas Island Tailings

The results of the analyses of the samples from Douglas Island show that there are no materials present which could be classified as

hazardous waste. Although the tailings on Sandy Beach have trace amounts of mercury, the results of the EPTT demonstrate that the mercury is tightly bound to the beach sediments.

The data suggest that all of the metals and the cyanide in the tailings and soil at the Treadwell cyanide mill are relatively immobile. Therefore, the Treadwell cyanide mill tailings do not appear to pose a threat to the environment. No further action is recommended for the Douglas tailings.

8.5 Alaska Juneau Rock Dump

No material has been identified as hazardous waste at this site. No further action is recommended for the rock dump.

9.0 RECOMMENDATION

To reduce the risk of environmental impairment at the sites examined, the CBJ and AEL&P should address the following recommendation.

- 88-11-1: A monitoring program consisting of evaluations of the results of the regular sampling and analysis of the municipal water supply conducted by the CBJ, semi-annual analysis of water samples collected downstream from the tailings disposal area, and maintenance of the sign at the site warning of potential hazards as a result of the presence of the tailings should be implemented immediately. The monitoring program should be formalized with written procedures. Written results of each monitoring episode should be maintained. The monitoring program should include an examination of the results of the analyses for indications that mercury is being released from the Ebner Falls site.

10.0 APPENDICES

Appendices A through E comprise the technical appendix to this report. The contents of the appendix are listed below.

Appendix A. Site Visit Photographs

Appendix B. Chain of Custody Forms

Appendix C. Laboratory Report of the Chemical Analyses of the Tailings, Soil, and Sediment Samples

Appendix D. Laboratory Report of the Chemical Analyses of the Water Samples

Appendix E. Laboratory Report of the Extraction Procedure Toxicity Tests

PHOTO IDENTIFICATION SHEET

TYPE OF CAMERA: Olympus Infinity

JOB NO.: JJ4050

TYPE OF FILM: Kodak 100

SITE NAME: Treadwell Mine

Frame No.	Roll No.	Date	Time	Taken By	Witnessed By	Description of Photo
1	1	9/14/88	1400	W. Richards	D. Stone AEL&P	Cyanide tailings on beach near the cyanide plant.
2	1	9/14/88	1410	W. Richards	D. Stone AEL&P	Cyanide tailings located adjacent to the cyanide plant. Note surface water.
3	1	9/14/88	1410	W. Richards	D. Stone AEL&P	Pachuka tanks at the cyanide plant.
4	1	9/14/88	1430	W. Richards	D. Stone AEL&P	Foundry building located near the Mexican Mill site.
5	1	9/14/88	1455	W. Richards	D. Stone AEL&P	Treadwell 300 mill site. Powerhouse in upper right.
6	1	9/14/88	1455	W. Richards	D. Stone AEL&P	Treadwell 300 mill site. Many creeks flowing to Gastineau Channel in this area.
7	1	9/14/88	1455	W. Richards	D. Stone AEL&P	Sandy Beach--composed of tailings from the Treadwell mills.