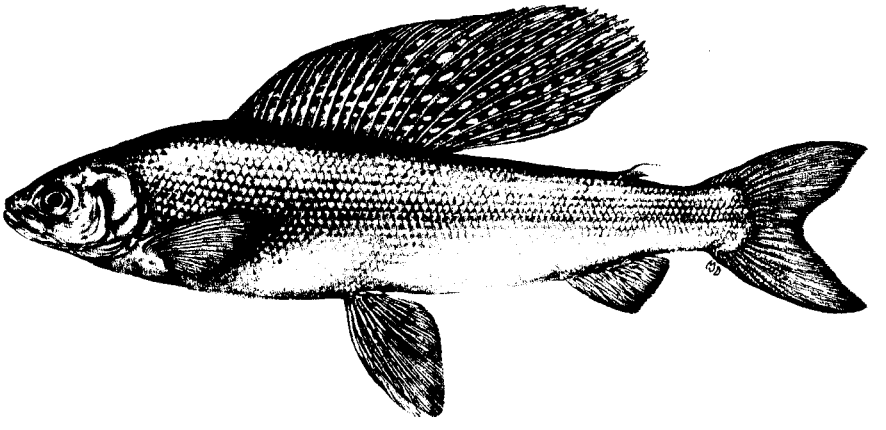
RED DOG USE ATTAINABILITY ANALYSIS
AQUATIC LIFE COMPONENT

By

Phyllis Weber Scannell

Technical Report No. 96-1



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Introduction

Authority

The US Environmental Protection Agency's (USEPA) water quality standards regulation (40 CFR 131.1.(j)) establishes the requirement that states or tribes conduct a use attainability analysis when either designating uses which do not include the "fishable/swimable" uses or when designating new subcategories of the "fishable/swimable" uses which require less stringent criteria.

Purpose

The purpose of this Use Attainability Analysis is to identify streams in the Wulik River drainage that do not support the currently designated uses for aquatic life. Natural background water quality and metals concentrations may limit aquatic populations. Aquatic life is defined in this document to include all aspects of the aquatic community: fish, macroinvertebrates, microinvertebrates, periphyton, and macrophytes. Existing uses are defined under 18 AAC.70.990 (20):

> "existing uses" means those uses actually attained in a waterbody on or after November 28, 1975.

and under 40 CFR Sec. 131 E:

> "existing uses" means those uses actually attained in the waterbody on or after November 28, 1975.

Description of Streams Considered for Reclassification

All of the streams considered for reclassification in the Wulik River drainage are located in northwest Alaska, approximately 95 km (59 mi) north of Kotzebue (Figure 1). Middle Fork Red Dog Creek flows adjacent to the Red Dog ore body, a large lead - zinc deposit that currently is mined by Cominco Alaska Inc. The following is a description of the streams considered in this document for reclassification to eliminate the aquatic life criteria. Water quality and fisheries data collected during baseline studies (1979-1982) represent pre-mining conditions because no disturbance had occurred in these drainages at that time.

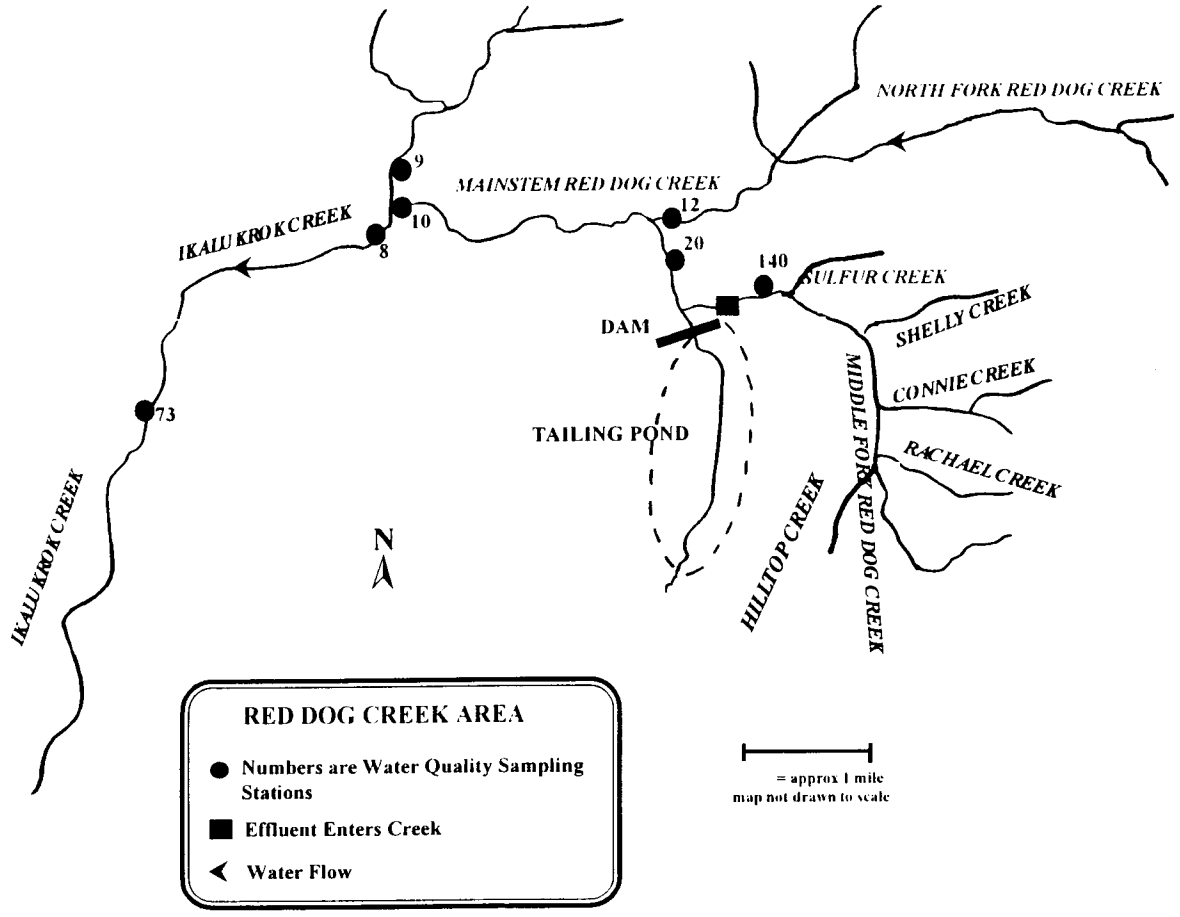

Figure 1. Locations of streams considered for reclassification of aquatic life use. Water quality sampling stations are shown on the map.

Ikalukrok Creek

Three segments of Ikalukrok Creek were considered in this study: Ikalukrok Creek from the headwaters to the confluence with Red Dog Creek, Ikalukrok Creek below the confluence with Red Dog Creek to Dudd Creek, and Ikalukrok Creek below Dudd Creek.

Ikalukrok Creek above the confluence with Red Dog Creek (Figure 2) has a drainage area of 150 km^2 (59.2 mi^2). The creek flows through mineralized zones and red iron flocculant and white aluminum flocculant are prevalent in side channels, smaller tributaries, and backwater areas. Stream bed rocks frequently are stained orange from iron precipitate. During 1992, Ikalukrok Creek above Red Dog Creek had a high mean monthly flow of 17.3 m^3/s (610 cfs) and a low flow of 0.02 m^3/s (0.58 cfs). At Station 9, stream width ranges from 2 to 7 m (7 to 24 ft) (up to 21 m or 68 feet in high flow years), with depths ranging from 0.15 to 1.2 m (0.5 to 4 feet). The stream bed at Station 9 consists of gravel, cobbles, and rocks. This section of Ikalukrok Creek has not been disturbed by mining or other human activity.

Ikalukrok Creek from the confluence with Red Dog Creek downstream to Dudd Creek contains periodic elevated concentrations of metals from the natural mineralization upstream and from mineralization along Red Dog Creek. At Dudd Creek (Station 7), widths range from approximately 3.5 to 40 m (12 to 130 feet) and depths range from 0.3 to 1.2 m (1 to 4 ft). Temperatures range from 0 to 10°C during open flow. Ikalukrok Creek (Figure 2) has a 485.8 km^2 (184 mi^2) drainage area, with 320 km^2 (124 mi^2) below the confluence of Red Dog Creek.

Mainstem Red Dog Creek

Mainstem Red Dog Creek (Figure 3) has a drainage area of 64 km^2 (24.6 mi^2) of which 10 km^2 (3.8 mi^2) does not contribute to the flow because it is impounded behind the tailing dam. During 1992, Red Dog Creek had a high mean monthly flow of 5.4 m^3/s (191 cfs) and a low flow of 0.0045 m^3/s (0.16 cfs). Widths of the creek range from 3.5 to 18 m (12 to 60 ft), with depths ranging from 0.06 to 0.5 m (0.2 to 1.7 feet) (R. Kemnitz, pers. comm., USGS Water Resources Division, Fairbanks). The stream bed contains gravel, small cobble, and a few small boulders. The creek has some meander and areas where it has shifted locations. Temperatures range from 0°C in the winter to 10°C in summer.

Figure 2. Ikalukrok Creek at Station 8.

Figure 3. Mainstem Red Dog Creek at Station 10.

Middle Fork Red Dog Creek

Middle Fork Red Dog Creek (Figure 4 at Station 20 and Figure 5 at Station 140) has a drainage area of 12 km^2 (4.74 mi^2), of which 1 km^2 (0.4 mi^2) does not contribute to the flow. During the 1991 water year, Middle Fork had a high mean monthly flow of 1.25 m^3/s (44.0 cfs) and a low flow of 0.004 m^3/s (0.15 cfs). The creek has wide meanders with average channel widths from 3 to 10 m (10 to 30 ft), with depths from 0.03 and 0.45 m (0.1 and 1.5 feet). Cominco Engineering Services Ltd. (reported in EBA Engineering Inc [1991]) reported that Red Dog Creek continues to flow with subsurface water flow at a rate of about 0.03 m^3/s (1 cfs) through the winter months.

Cominco Engineering Services Ltd. (1983) described the water quality in Middle Fork Red Dog Creek:

> The mainstem on Red Dog Creek [above North Fork of Red Dog Creek, now called Middle Fork Red Dog Creek] adjacent to, and running over the ore body is currently a zone of natural degradation which is hostile to aquatic life. High metal concentrations, particularly zinc, lead, and cadmium prevail in this part of the creek largely as a result of direct contact with exposed mineralization and, more significantly, from surface drainage emanating from the main part of the orebody on the west side of the creek. As an illustrative example, concentrations of zinc in the summer average in the 15 to 20 mg/L range and a typical mass loading of this metal discharged downstream can be in excess of one half ton per day.

The creek was diverted into a lined, perched ditch in March 1991 to separate upstream water from water seeping through the ore body. Below the ditch is a constructed French drain to allow subsurface water from both sides of the lined ditch to flow into the seepage ditch. The substrate of the diversion ditch is constructed of a gravel layer and a surface of coarse rip rap to protect the synthetic liner. Prior to diversion, Middle Fork Red Dog Creek flowed over some of the more highly mineralized and leachable zones of the Red Dog deposit.

Tributaries to Middle Fork Red Dog Creek

Information on tributaries flowing into the north side of the ore body (Figure 1) is limited to a few measurements of water quality collected in the baseline studies (Dames and Moore 1983 and EVS and Ott Water Engineers 1983). These are small tributaries of <1 to <10 cfs summer flow. Dames and Moore (1983) described the tributaries:

Figure 4. Middle Fork Red Dog Creek at Station 20.

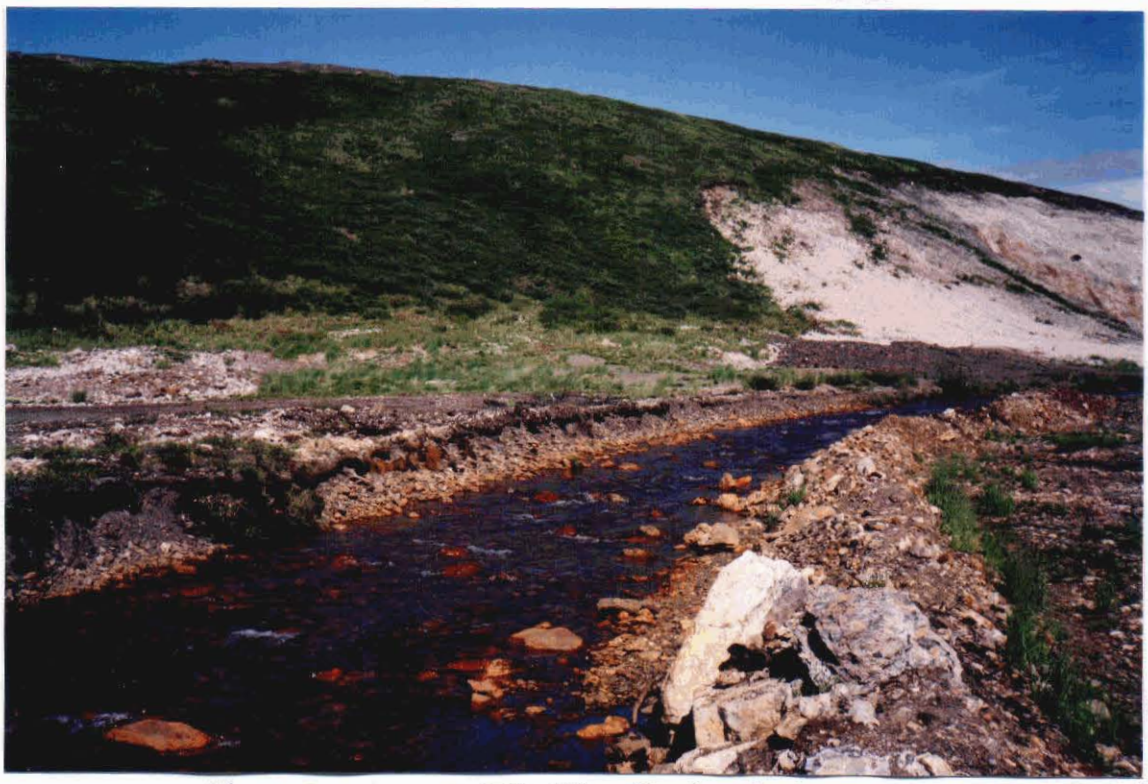

Figure 5. Middle Fork Red Dog Creek at Station 140.

> Many of the tributaries exhibited high quality water compared to the mainstem. Water at stations 34 [Sulfur Creek], 38 [Shelly Creek], 40 [Connie Creek], and 47 (Rachael Creek) during summer was highly oxygenated with 11.0 to 13.0 mg/L of dissolved oxygen. . . . Conductivity levels ranged from 70 to 330 *u*mho/cm at 25°C. pH was slightly low, ranging from 6.3 to 7.1, and alkalinity concentrations were generally low (7.9 to 74 mg/L).

Tributaries flowing into the northeast side of the ore body are not affected by mineral development. Except during periods of high rainfall, these creeks were reported in baseline studies to have clear water with low turbidity. Turbidity ranged from 0.37 to 24 NTU. The high value (24 NTU) was measured at station 38 in July when flow was high.

Sulfur Creek

Sulfur Creek is a small, intermittent stream (Figure 1 and 6) flowing into the northwest side of the ore body. The creek is steep, with stair-step pools. Flows are intermittent; the creek stopped flowing in late July 1995. The stream bed is medium sized cobble with orange stain from iron precipitate.

Shelly Creek

Shelly Creek flows into Middle Fork Red Dog Creek from the northeast (Figures 1 and 7). The creek is small, densely vegetated by willows, and stained with iron precipitate. Few water quality data have been collected on Shelly Creek.

Connie Creek

Connie Creek is the largest of the tributaries (Figures 1 and 8). The creek flows through a wide, shallow channel. Water depths are less than 20 cm during summer flows. The creek bottom is medium cobble with some staining.

Rachael Creek

Rachael Creek, at the headwaters of Middle Fork Red Dog Creek is a small, partially undercut stream flowing from the base of Deadlock Mountain. In 1994 the creek was sampled and found to contain high concentrations of Al and Zn. Elevated Al and Zn concentrations in the bypass ditch (Station 140) and in Rachael Creek in August 1994 suggests that high rainfall during this time period increased metals concentrations in Rachael Creek.

Figure 6. Sulfur Creek.

Figure 7. Shelly Creek.

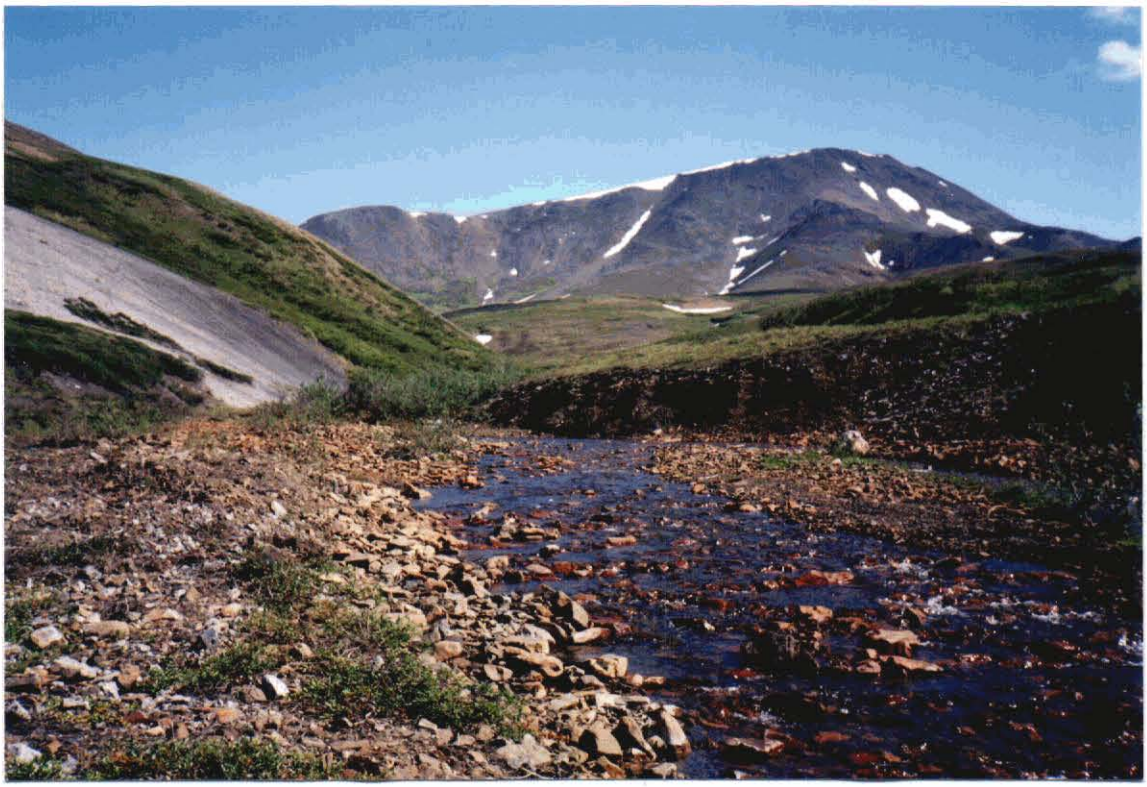

Figure 8. Connie Creek.

Figure 9. Rachael Creek.

Hilltop Creek

Hilltop Creek is a small, possibly intermittent, creek flowing from the southeast side of the ore deposit north to Red Dog Creek. The creek flows into Red Dog Creek near the headwaters, near Connie and Rachael Creeks.

Reference Stream: North Fork Red Dog Creek

North Fork Red Dog Creek (Figure 10) was selected as a reference stream because it is in the same drainage and has limited mineralization. Therefore, climatic conditions and types of species expected to occur would be similar to the streams being considered for reclassification, with the exception of the effects of elevated metals concentrations from mineralization in the other streams.

North Fork Red Dog Creek has a drainage area of 41 km^2 (15.9 mi^2). During the 1992 water year, North Fork Red Dog Creek had a high mean monthly flow of 3.5 m^3/s (125 cfs) and low summer flows of 0.34 m^3/s (12 cfs). Widths range from 7 to 15 m (24 to 50 ft) and depths from 0.09 to 2 m (0.3 to 6 ft). The stream bed is characterized by gravel, rocks, and small boulders and is subject to shifting. Temperatures range from 0 to 10°C during open water flow. Mineral staining is not evident in North Fork Red Dog Creek.

Figure 10. North Fork Red Dog Creek.

Geology

The Red Dog Mine is located at approximately 68°13' N latitude by 163° W longitude in the southwestern DeLong Mountains, a component of the Brooks Range in Alaska's Arctic. Lying within the DeLong Mountains Quadrangle, the area termed the Red Dog Prospect is a rich surficial showing of copper, lead, zinc, and silver ore located throughout the upper reaches of the Red Dog Creek drainage. The geology was described by Dames and Moore (1983):

> The DeLong Mountains lie within the Rocky Mountain System and are characterized by low mountains, plateaus, and highlands of a rolling topography with summits between 300 and 1500 m. Most peaks in the southwestern area are less than 900 m in height and unglaciated; lower hills have been rounded by extreme weathering, although upthrust rock formations with jagged peaks are not uncommon. The area is underlain by continuous permafrost to depths in excess of 60 m. The regional geology is sedimentary with some evidence of later volcanic activity. The geology is Mesozoic, characterized by sandstone and shale of marine and non-marine origin.

Climate/Population

The area is treeless, frequently windswept with a mean annual temperature of 2 to 4°C. The area is remote, with access by airplane or summer barge. The mine site is approximately 90 km (55 miles) by gravel road from the ocean port.

Existing Classification

The State of Alaska classified all streams and rivers in the Wulik River drainage, including the Wulik River, Ikalukrok Creek, and Red Dog Creek and its tributaries for all uses under 40 CFR, Chapter 1, part 131, 131.10, and 18 AAC 70.055.

Recommended Changes to Aquatic Life Classification

The purpose of this study is to examine the appropriateness of the aquatic life classification for Mainstem Red Dog Creek; Middle Fork Red Dog Creek and its tributaries Rachael, Sulfur, Connie, and Shelly Creeks; and Ikalukrok Creek. Water quality and biological data collected during baseline studies were used to describe pre-mining conditions. Water quality and biological data from 1991 through 1995 were used to describe conditions after development of the Red Dog Mine. Water quality data collected between 1984 and 1990 were not used because the data were collected sporadically and because no comparable biological data were collected.

Water Quality Monitoring Stations

Water quality monitoring has been conducted throughout the Wulik River drainage since 1979, before development of the Red Dog Mine. Water quality monitoring after development of the Red Dog Mine was conducted at many of the same stations (Figure 1), using the same station numbers, as baseline monitoring conducted by Dames and Moore. Baseline monitoring conducted by EVS and Ott Water Engineers (1983) was done at many of the same stations; however, different station numbers were assigned. Where stations are at the same location, the station numbers established by Dames and Moore are used for the EVS and Ott Water Engineers (1983) data. Only limited baseline water quality monitoring was conducted in tributaries to Middle Fork Red Dog Creek.

Water quality monitoring stations referenced in this report are Ikalukrok Creek at Station 8 and Station 73, Mainstem Red Dog Creek at Station 10, Middle Fork Red Dog Creek at Stations 20 and 140, Shelly Creek , Connie Creek, Sulfur Creek, Rachael Creek, and North Fork Red Dog Creek.

Wastewater Dischargers

The Red Dog Mine is currently the only industrial development in the Wulik River drainage that discharges to waters of the state.

Problem Definition

Studies to date have shown that Middle Fork Red Dog Creek has not supported fish or other aquatic populations. The absence of aquatic communities is because of natural mineralization, naturally occurring high concentrations of metals, and low pH. Intermittent flows and poor water quality in tributaries to Middle Fork Red Dog Creek probably limit aquatic life. Fish use in tributary streams also is limited by lack of overwintering habitat and inability to access these tributaries through the naturally degraded water quality of Middle Fork Red Dog Creek.

The water treatment system at the Red Dog Mine uses calcium hydroxide to remove sulfide metals. The resulting effluent is high in total dissolved solids in the form of calcium sulfate. Treating seepage water from the ore body has resulted in water in both Middle Fork and Mainstem Red Dog Creek that is lower in Cd, Cu, Pb, and Zn but higher in pH, total dissolved solids and sulfate than under natural, undisturbed conditions.

Approach to Use Attainability

The Wulik River and its tributaries currently are classified under 18 AAC 70.050 as protected for all uses. Red Dog Creek historically has had periodic high concentrations of metals. Fish kills were reported in Mainstem Red Dog Creek and in Ikalukrok Creek at the confluence with Red Dog Creek before development of the Red Dog Mine (EVS

and Ott Water Engineers 1983). Baseline sampling found no evidence of fish use of Middle Fork Red Dog Creek, South Fork Red Dog Creek (now the tailing dam), or any tributaries to Middle Fork Red Dog Creek.

Extensive sampling by the Alaska Department of Fish and Game has not shown fish to occur in Middle Fork Red Dog Creek, upstream of North Fork Red Dog Creek (Weber Scannell and Ott 1995). The Alaska Department of Fish and Game does not believe that Middle Fork Red Dog Creek contains water of sufficient quality to support fish (Weber Scannell and Ott 1995).

The objective of this study was to sample Mainstem Red Dog Creek, Middle Fork Red Dog Creek, and tributary streams downstream of and adjacent to the Red Dog Mine for macro- and microinvertebrates, periphyton, and macrophytes. Ikalukrok Creek below Red Dog Creek (at Station 8) and North Fork Red Dog Creek (the reference stream) also were sampled. This survey provides information on relative abundance and relative diversity of aquatic taxa to fulfill the aquatic life analysis of a use attainability analysis for reclassifying Middle Fork Red Dog Creek and other appropriate tributaries. Information on the taxonomic groups present in Mainstem Red Dog Creek and Ikalukrok Creek can be used to develop site-specific criteria for total dissolved solids and sulfate.

Data Analysis

Hydrology

Red Dog Creek from its source to Ikalukrok Creek, tributaries to Middle Fork Red Dog Creek, and portions of Ikalukrok Creek freeze in late October; by mid-winter there is no flowing surface water. Isolated pools may form in Ikalukrok Creek; this water usually has low (<1 mg/L) dissolved oxygen and high metals and dissolved solids concentrations. Fish could not survive in these conditions. North Fork Red Dog Creek may contain some spring water input, but probably does not contain any flowing water suitable for overwintering fish. The winter distribution of fish appears to be limited to Ikalukrok Creek downstream of the confluence with Dudd Creek and in the Wulik River.

When breakup occurs (usually in late May), Arctic graying migrate upstream in Ikalukrok Creek to Mainstem Red Dog Creek and into North Fork Red Dog Creek.

Stream Flow Evaluation

Water Quality Evaluation, Baseline Conditions

The following is a summary of the water quality conditions measured in the study streams before development of the Red Dog Mine. Included is a discussion of the number of occasions metals concentrations exceeded amounts reported toxic to salmonid fish. Refer to Appendix 1 for a summary of 1979-1983 hardness, total dissolved solids (TDS), sulfate, pH, and temperature data; Appendix 2 for a summary of 1979-1983 dissolved oxygen, conductivity, flow, and alkalinity data; and Appendix 3 for a summary

of 1979-1983 metals data. Appendix 11 contains all available baseline water quality and metals data.

Metals concentrations reported for the water quality sampling stations were compared with concentrations reported to cause acute or chronic toxicity on species of salmonid fish and with concentrations currently listed by US EPA as the Maximum Allowable Concentration (Table 1). The acute and chronic concentrations and the references for each concentration are listed below.

The following criteria were used to select values for chronic toxicity from published literature: at least 50% mortality of salmonid fish, tests conducted in moderately hard to hard water from 100-350 mg $CaCO_3$/L, and test conducted over at least 96 hours. Chronic toxic values for zinc were reported as 2 to 4 mg/L; in comparing toxic values with stream water samples we used the lower value of 2 mg/L.

Table 1. Chronic/acute and Maximum Allowable Concentrations of Metals.

Metal	Chronic/Acute Toxicity adult salmonid fish mg/L	Maximum Allowable Conc. aquatic life mg/L	Reference
Aluminum	0.1		Ontario Minis. of the Environ. (1984)
Cadmium	0.027	0.0039	Alabaster and Lloyd 1982 US EPA 1992
Copper	0.28	0.018	Alabaster and Lloyd 1982 US EPA 1992
Lead	0.19	0.082	USEPA 1985 US EPA 1992
Zinc	2	0.12	Alabaster and Lloyd 1982 US EPA 1992

Ikalukrok Creek: Station 8

Baseline data showed Ikalukrok Creek at Station 8 contained moderately hard water with circumneutral pH. During winter (measured in March), water is high in total dissolved solids and hardness; this is a result of ionic exclusion during ice formation. Data collected during the winter are not included in this report because they are not considered to represent conditions other than ionic exclusion from ice formation. Low conductivity in late May was due to snow melt.

Water occasionally contained elevated concentrations of aluminum, cadmium, and zinc (Table 2). The maximum reported concentrations were 0.17 mg Al/L, 0.04 mg Cd/L, and 4.2 mg Zn/L.

Table 2. Ikalukrok Creek (Station 8), percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	30		10
Cadmium	11	67	18
Copper	0	10	10
Lead	0	0	18
Zinc	17	78	18

Mainstem Red Dog Creek, Station 10

Baseline data showed Mainstem Red Dog Creek at Station 10 contained moderately hard water with neutral to acidic pH. During winter (measured in March), water was high in total dissolved solids, sulfate, and hardness; this was a result of ice formation.

Concentrations of Zn were elevated above the reported chronic/acute toxic concentrations of 2 mg/L for salmonid fish and often contained elevated concentrations of Al and Cd (Table 3). Concentrations of Pb were not elevated: the maximum concentration was 0.1 mg/L and median concentration was 0.08 mg/L (the Limit of Detection). The chronic/acute level for Zn (from Alabaster and Lloyd 1982, Table 1) is conservative; higher values also were reported. Baseline studies (Dames and Moore 1983) reported that Arctic graying migrated through Mainstem Red Dog Creek to North Fork Red Dog Creek during spring high flows when metals concentrations were lower.

Table 3. Mainstem Red Dog Creek (Station 10), percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	37		38
Cadmium	44	LOD[1] too high	43
Copper	0	0	15
Lead	0	0	43
Zinc	100	100	43

[1]LOD = Limit of Detection

Middle Fork Red Dog Creek, Station 20

Baseline data showed water in Middle Fork Red Dog Creek contained elevated concentrations of aluminum, cadmium, and zinc, and frequently elevated concentrations of Pb. The maximum reported concentrations were 0.91 mg Al/L, 0.14 mg Cd/L, 0.36 mg Pb/L, and 17 mg Zn/L. The number of times water samples exceeded chronic/acute toxicity concentrations (Table 4) suggests that this water is not suitable to support fish.

Table 4. Middle Fork Red Dog Creek (Station 20), percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	57		28
Cadmium	97	100	34
Copper	insufficient data		4
Lead	24	56	34
Zinc	100	100	34

Middle Fork Red Dog Creek, Station 140

Baseline data showed water in Middle Fork Red Dog Creek at Station 140 frequently contained elevated concentrations of aluminum, cadmium, lead, and zinc. The maximum

reported concentrations were 2.31 mg Al/L, 0.21 mg Cd/L, 1.11 mg Pb/L, and 28.5 mg Zn/L. Median concentrations were 0.73 mg Al/L, 0.12 mg Cd/L, 0.33 mg Pb/L, and 15.7 mg Zn/L. The number of times water samples exceeded chronic/acute toxicity concentrations (Table 5) and the extremely high metals concentrations suggest that this water is not suitable to support fish.

Table 5. Middle Fork Red Dog Creek (Station 140), percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	100		20
Cadmium	100	100	20
Copper	No data available		0
Lead	80	95	20
Zinc	100	100	20

Shelly Creek

There were no baseline data collected on hardness, TDS, flow, dissolved oxygen, or other water quality factors in Shelly Creek. Samples for metals concentrations were limited to one sample in 1981 and four in 1982 (Appendix 11). Concentrations of both Cd and Zn exceeded Maximum Allowable Concentrations in all of the samples collected, Pb was not elevated. The maximum concentration of Cd was 0.028 mg/L, of Pb 0.08 mg/L, and Zn 2.3 mg/L.

Table 6. Shelly Creek, percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	no data available		0
Cadmium	20	100	5
Copper	No data available		0
Lead	0	0	5
Zinc	20	100	5

Connie Creek

Limited water quality and metals data (Appendix 11 and Table 7) collected in Connie Creek during baseline studies showed this creek to have moderately good water quality. However, Cd concentrations were above but close to the Maximum Allowable Concentration, and ranged from 0.002 to 0.021 mg/l.

Table 7. Connie Creek, percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	No data available		0
Cadmium	0	83	6
Copper	No data available		0
Lead	0	0	6
Zinc	17	83	6

Sulfur Creek

Limited water quality data collected by Dames and Moore (1981) portray Sulfur Creek as having elevated concentrations of Pb and Zn (average of three samples = 0.128 mg Pb/L and 0.754 mg Zn/L) and slightly elevated concentrations of Cd (average of three samples = 0.007 mg/L) (Table 8, Appendix 11). Flow ranged from 0.07 to 1.2 cfs, dissolved

oxygen concentrations were near saturation, and pH was slightly acidic. The highest zinc concentration measured (of 3 samples) was 1.167 mg/L.

Table 8. Sulfur Creek, percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	No data available		
Cadmium	0	100	3
Copper	No data available		
Lead	33	33	3
Zinc	0	100	3

Rachael Creek

Water sampling in Rachael Creek was limited to four samples in 1982 (Appendix 11 and Table 9). The water was described by Dames and Moore (1983) as clear, of low turbidity, and high dissolved oxygen concentrations. Cd and Zn concentrations were low, ranging from 0.002 to 0.008 mg Cd/L and 0.079 to 0.142 mg Zn/L. No baseline data on Al concentrations were found.

Table 9. Rachael Creek, percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	No data available		
Cadmium	0	25	4
Copper	No data available		
Lead	0	0	4
Zinc	0	25	4

Hilltop Creek

No historic data were available for Hilltop Creek.

North Fork Red Dog Creek

North Fork Red Dog Creek was described by Dames and Moore (1983) as being of high water quality and supporting a diverse community of flora and fauna. The creek is a clear water stream with high dissolved oxygen concentrations during summer and low levels of total suspended solids, total dissolved solids, and settleable solids. Alkalinity was higher than in any of the other creeks monitored. Dames and Moore measured concentrations of Cu, Pb, Ag, and Zn in the sediments. They reported concentrations considerably lower than Middle Fork or Mainstem Red Dog Creek. During summer, Al concentrations are moderately high (Table 10).

Table 10. North Fork Red Dog Creek, percent of water samples exceeding chronic/acute levels, 1979-1983.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Number of Samples
Aluminum	36		25
Cadmium	0	LOD too high	29
Copper		0	5
Lead	0	0	29
Zinc	0	7	29

LOD = Limit of Detection. Unless samples are at least 5 times the LOD, the values are considered to be qualitative.

Water Quality Evaluation, after development of the Red Dog Mine.

The following is a summary of the water quality conditions measured in the study streams from 1991 to summer 1995. This time period begins with completion of the mine seepage water collection system in 1991. Collection and treatment of mine seepage water had the most profound effect on water quality of Red Dog Creek. Water quality of the mine effluent was further improved by installation of the sand filters in 1994 and improvements in the water treatment plant. Included is a discussion of the number of times metals concentrations exceeded amounts reported toxic to salmonid fish (Reference

toxic amounts listed on Table 1) and identification of the metals believed to be exerting the most toxicity during the time period from 1991 through 1995. Refer to Appendix 4 for a summary of 1991-1995 water quality data, including hardness, TDS, sulfate, pH, temperature, dissolved oxygen, conductivity, and flow, and Appendix 5 for a summary of 1991-1995 metals data. Appendix 12 contains all of the baseline water quality and metals data.

Ikalukrok Creek: Station 8

Ikalukrok Creek at Station 8 has moderately hard water with circumneutral pH (Appendix 4). During periods of discharge from the mine effluent, water hardness reached a maximum concentration of 666 mg/L and TDS a maximum concentration of 906 mg/L. The treated mine effluent appears to moderate the lowest pH values. In 1992, the minimum pH was 5.7 and in 1994 and 1995 the minimum values were 7.2 and 7.1. Flow data from Station 8 were limited to two measurements.

During open water periods, temperatures ranged from a low of 0°C to 13.6°C (measured in 1992). Maximum water temperatures in 1995 during periods of maximum discharge from the Red Dog Mine do not appear to alter downstream temperature regimes (Appendices 4 and 12). Maximum and median temperatures in 1995 are not higher than in years 1991-1993 when discharge volumes were low or zero.

Water occasionally contained slightly elevated concentrations of aluminum, cadmium, and zinc (Appendices 5 and 12 and Table 11). Metals concentrations measured in 1995 were generally lower than in 1991 through 1993, when there was minimal discharge. Al concentrations were higher in 1995; however, these concentrations are related to high rainfall and increased erosion in the headwaters of Middle Fork Red Dog Creek and do not correspond to concentrations found in the mine effluent.

Table 11. Ikalukrok Creek, after mining. Percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	26		92
Cadmium	1	7	96
Copper	0	0	58
Lead	0	4	96
Zinc	6/0*	100	96

*6% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, none of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Mainstem Red Dog Creek, Station 10

Mainstem Red Dog Creek contains moderately hard water. Both hardness and TDS are elevated during periods of maximum discharge from the mine. Concentrations of TDS reached a maximum of 1100 mg/L in 1994 and 1070 mg/L in 1995 (Appendix 4 and Appendix 12). Median TDS concentrations in 1995 also were higher than in 1991 and 1992, when discharge was minimal. Periods of high discharge during open water months also correspond to higher pH values: median pH values were 7.7 in 1994 and 7.6 in 1995, compared with median values of 7.0 in 1991 and 7.4 in 1992. Stream flow (based on 6 measurements in 1993) ranged from 32.7 cfs to 400 cfs.

Metals concentrations at Station 10 were elevated in Al, Cd, and Zn (Table 12 and Appendices 5 and 12).

Table 12. Mainstem Red Dog Creek, after mine development. Percent of water samples exceeding chronic/acute criteria.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	16		85
Cadmium	33	LOD too high	95
Copper	0	0	60
Lead	2	4	94
Zinc	55/19*	100	94

*55% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 19% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

LOD = Limit of Detection. Unless samples are at least 5 times the LOD, the values are considered to be qualitative.

Middle Fork Red Dog Creek, Station 20

Hardness, TDS, and sulfate concentrations in Middle Fork Red Dog Creek below the mine effluent are elevated by the effluent (Appendix 4). In 1995, the maximum hardness was 1170 mg/L, maximum TDS was 2190 mg/L, and maximum sulfate was 1500 mg/L. The highest measured pH of 9.0 was in 1994. The median pH for 1994 and 1995 is slightly higher than in 1992 but not higher than median values for 1991 and 1993.

Water temperatures during the open flow periods range from 0°C to 19.4°C. Temperature does not appear to be elevated by discharge (Appendix 4).

Metals concentrations, except for Al, have shown a steady decline between 1991 and 1995 (Appendix 5). When compared to levels reported in the literature (Table 1) for chronic/acute toxicity, water at Station 20 is toxic for Cd and Zn most of the time, and toxic for Al 25% of the time and Pb 36% of the time (Table 13). High Al concentrations occurred in fall 1995 after abnormally high rainfall. Elevated Al was not found in 1991-1994. (Refer to Appendices 5 and 12 for comparisons of metals concentrations for each year.)

The concentrations of Cd and Zn are sufficiently elevated to prevent fish from successfully spawning and rearing in this creek, and to limit primary and macroinvertebrate production.

Table 13. Middle Fork Red Dog Creek, below mine effluent. Percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	25		99
Cadmium	76	90	118
Copper	0	1	76
Lead	9	36	118
Zinc	93/61*	98	118

*93% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 61% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Middle Fork Red Dog Creek, Station 140

Station 140 is located in a channel constructed to bypass Red Dog Creek around the active ore body, above the mine discharge. Although construction of the bypass channel has decreased metals concentrations in Red Dog Creek (compared with concentrations measured before mining), the water flows through naturally mineralized areas and remains high in metals, especially Cd, Pb, and Zn (Appendices 5 and 12).

Water Quality at Station 140 is acidic with pH levels as low as 5.2.

Water samples collected between 1992 and 1995 exceed the reported chronic/acute toxicity limits for Cd in 75% of the samples, for Pb in 85% of the samples, and for Zn in 86% of the samples (Table 14). Given the high metals concentrations, it is unlikely that this waterway would support fish, aquatic invertebrates, or aquatic plants.

Table 14. Middle Fork Red Dog Creek, Station 140. Percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	20		70
Cadmium	75	100	101
Copper	0	0	72
Lead	42	85	101
Zinc	86/68*	100	101

*86% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 68% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Shelly Creek

Few water samples were collected in Shelly Creek (Appendix 12). Shelly Creek has moderately hard water (Appendix 12) and in 1995, water contained concentrations of Al and Cd that were elevated above the reported chronic/acute toxicity levels (79% samples for Al and 36% of samples for Cd) (Table 15). Seventy nine percent of the water samples contained concentrations of Cd that were above the Maximum Allowable Concentration and 93% of the samples exceeded the Maximum Allowable Concentration for Zn. Concentrations of Fe ranged from 0.19 to 1.22 mg Fe/L.

Water in Shelly Creek is naturally high in metals. It is likely that high concentrations of Al, Cd, Fe, and Zn limit the aquatic life use of this creek.

Table 15. Shelly Creek. Percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	79		14
Cadmium	36	79	14
Copper	0	31	13
Lead	7	14	14
Zinc	43/14*	93	14

*43% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 14% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Connie Creek

Few water samples were collected in Connie Creek (Appendix 12). Connie Creek has moderately hard water and in 1995, metals concentrations were generally lower than reported chronic/acute toxicity levels for Cd, Cu, Pb, and Zn (Table 16).

Connie Creek contains the best water quality of any of the tributaries to Middle Fork Red Dog Creek. If fish were not excluded from this tributary by the poor water quality in Middle Fork Red Dog Creek, it is possible they could inhabit this creek.

Table 16. Connie Creek, percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	33		12
Cadmium	8	25	12
Copper	0	8	12
Lead	17	17	12
Zinc	8/8*	50	12

*8% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 8% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Sulfur Creek

Sulfur Creek is a small, intermittent tributary with an estimated summer flow of less than 3 cfs. The creek contains small step pools. Flows are too low to allow fish to swim upstream between step pools. Sulfur Creek typically stops flowing in mid-summer. In 1995, flows stopped in late July.

Only two water samples were collected in Sulfur Creek (Appendix 12), both in 1995. Sulfur Creek has moderately hard water (133 and 140 mg/L) and in 1995, water contained concentrations of Cd, Pb, and Zn that were elevated above the Maximum Allowable Concentrations (Table 17).

High metals concentrations and the poor water quality in Middle Fork Red Dog Creek, along with the small size of Sulfur Creek, its steep step pools, and intermittent flows, probably exclude fish from using this tributary.

Table 17. Sulfur Creek, percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	17		6
Cadmium	0	37	6
Copper	0	0	6
Lead	33	67	6
Zinc	0/0*	100	6

*0% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 0% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Rachael Creek

Rachael Creek has moderately hard water and in 1995, water contained very high concentrations of Al (from 1.17 to 1.81 mg/L) and Cu (from 0.04 to 0.06 mg/L) and low pH (from 4.7 to 5.9) (Appendix 12). According to the Canadian Water Quality Guidelines (CWQG), at pH below 6.5, Al is extremely toxic to aquatic life. The CWQG suggests a maximum Al concentration of 0.005 mg/L to protect aquatic life when the pH is less than 6.5. The median concentration of Al measured in Rachael Creek during 1995 was 340 times the toxic level and the maximum concentration measured in 1995 was more than 650 times the toxic level; pH was below the State Water Quality Criteria for protection of aquatic life. The combination of high concentrations of Al and low pH would exclude most, if not all, aquatic species from Rachael Creek. Concentrations of Cu and Zn also were elevated above the Maximum Allowable Concentrations in 100% of the samples (Table 18).

Table 18. Rachael Creek, percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	100		10
Cadmium	0	0	11
Copper	0	100	11
Lead	0	0	11
Zinc	0/0*	100	11

*0% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 0% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Hilltop Creek

Hilltop Creek is a small tributary to Red Dog Creek that flows from the southeast edge of the currently developed deposit. Flows in the creek are low and may be intermittent. Metals concentrations are high (Table 19 and Appendix 12); water in this tributary contains some of the highest metals concentrations found in any tributaries to Red Dog Creek. Cominco Alaska Inc. sampled three sections of Hilltop Creek in 1995: the headwaters, the middle section, and the lower section near Red Dog Creek. Metals were not as high at the headwaters near the mine pit as in the middle section (Appendix 12).

This creek was not sampled for fish, aquatic invertebrates, or aquatic plants during this study. High concentrations of Al (average 5.97 mg/L, range 0.26 - 9.59 mg/L), Cd (average 6.43 mg/L, range 3.2 to 7.8 mg/L), Pb (average 3.4 mg/L, range 0.39 to 4.22 mg/L) and zinc (average 1197 mg/L, range 147 to 1580 mg/L) combined with low pH (range 4.2 to 6.1) would exclude aquatic communities from this creek.

Table 19. Hilltop Creek, percent of water samples exceeding chronic/acute levels.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	100		11
Cadmium	100	100	11
Copper	no data available		
Lead	100	100	11
Zinc	100	100	10

*100% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 100% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

North Fork Red Dog Creek

Only 14 samples were collected from Station 12 during 1995 and 2 in 1992 (Appendix 12). Most of the metals samples were below the limit of detection; 1 sample in 1995 had Cd and Zn concentrations above the reported chronic/acute toxic levels (Table 20). This sample also had concentrations above the Maximum Allowable Concentration for Cd, Pb, and Zn. Except for the one water sample with slightly elevated metals concentrations, the water in North Fork Red Dog Creek is of high quality for aquatic life.

Table 20. North Fork Red Dog Creek, percent of water samples exceeding chronic/acute criteria.

Metal	% Samples exceeding chronic/acute toxicity to adult salmonid fish	% Samples exceeding Maximum Allowable Concentration	Total number of samples
Aluminum	0		10
Cadmium	6	6	16
Copper	0	0	16
Lead	0	6	16
Zinc	6/0*	6	16

*6% of the samples exceeded the reported chronic toxic level of 2 mg Zn/L, 0% of the samples exceeded the higher reported chronic toxic level of 4 mg Zn/L.

Conclusions

Mainstem Red Dog Creek

Although water quality periodically exceeds toxic limits and Maximum Allowable Concentrations, exceedences are not sufficient to exclude fish and other aquatic species. Water quality has been improved from background by the mine sump collection system and, probably, by high effluent discharges.

Middle Fork Red Dog Creek

Concentrations of metals, especially Cd and Zn, are sufficiently high to preclude use by fish, aquatic plants, and aquatic invertebrates.

Sulfur Creek

Fish use of Sulfur Creek is limited by poor water quality in Middle Fork Red Dog Creek as well as the small size, low and intermittent flows, and step pool configurations found in Sulfur Creek. Water quality is poor.

Rachael Creek

High concentrations of Al and low pH would eliminate most, if not all, aquatic species from this tributary.

Shelly Creek

Water in Shelly Creek is degraded by elevated concentrations of Al, Cd, Cu, and Zn. It is likely that poor water quality combined with low flows and high gradient limit use of this waterway by fish and other species of aquatic life.

Connie Creek

Poor water quality in Middle Fork Red Dog Creek limits upstream movement of fish. Connie Creek supports a community of aquatic invertebrates and algae.

Hilltop Creek

Extremely poor water quality due to elevated concentrations of Al, Cd, Pb, and Zn would eliminate most classes of organisms from Hilltop Creek.

North Fork Red Dog Creek

Water quality in this tributary is excellent and rarely exceeds limits reported to cause acute or chronic toxicity to aquatic species.

Biological Evaluations

Benthic Macroinvertebrates: Baseline Studies

Aquatic invertebrate communities were sampled by EVS and Ott Water Engineers (1983) and Dames and Moore (1983) as part of the baseline studies conducted for Red Dog Creek. Taxonomy for Oligichaeta and Chironomidae has been revised substantially since these reports were completed. Therefore, in the present report Chironomidae and Oligichaeta from baseline data are not identified below family level for Chironomidae or class for Oligichaeta.

Ikalukrok Creek, Station 73

Aquatic invertebrate samples were collected in Ikalukrok Creek at Station 73, about 5 km (3 miles) downstream from Station 8 (Table 21, Appendix 6, EVS and Ott Water Engineers 1983). There are no significant inflows of water to Ikalukrok Creek between Stations 8 and 73; therefore, water quality conditions are similar and the invertebrate data are believed to represent populations in Ikalukrok Creek at Station 8.

Among the creeks influenced by mineralization from Red Dog Creek, Ikalukrok Creek contained the greatest abundance of aquatic invertebrates. Taxonomic richness was similar to communities in Mainstem Red Dog Creek and Middle Fork Red Dog Creek.

Mainstem Red Dog Creek, Station 10

Few invertebrates were collected in Mainstem Red Dog Creek (Table 21, Appendix 6). There was an average of 3.1 invertebrates collected during each sampling time, with only 5.5 taxonomic groups represented.

Middle Fork Red Dog Creek, Station 20 and Station 140

Dames and Moore (1981) describe the macroinvertebrate communities in Middle Fork Red Dog Creek:

> There is little or no macroscopic life in the Main Fork Red Dog Creek from Station 43 below where the first major drainage from the ore body enters the creek to Station 20 above the confluence of the North Fork. Tributaries entering this reach from the ore body significantly degrade the water quality and the suitability of the aquatic habitat. Other tributaries entering this reach support rich and diverse invertebrate life but are of insufficient volume to dilute the stream to the point where long-term residency is possible.

EVS and Ott Water Engineers collected about the same number of invertebrates from Station 21 (an average of 15 per sample time) and Station 140 (an average of 13.9 per sample time) (Table 21, Appendix 6). Taxonomic richness also was similar at the two stations: EVS and Ott Water Engineers reported an average of 5 taxonomic groups from Station 21 and 4.7 taxonomic groups from Station 140. At both stations the majority of invertebrates were Plecoptera.

Shelly Creek, Connie Creek, Sulfur Creek, and Rachael Creek, Hilltop Creek

No baseline data on aquatic invertebrate populations are available for any of these tributaries.

North Fork Red Dog Creek

North Fork Red Dog Creek contained both the greatest abundance and the highest taxonomic richness of any of the sites sampled during baseline studies. In the limited sampling done by EVS and Ott Water Engineers (Table 21 and Appendix 6), 8 different taxonomic groups were found. Ephemeroptera and Plecoptera dominated the aquatic invertebrate community. Dames and Moore (1983) reported similar populations of aquatic invertebrates in their baseline studies (Appendix 6).

Table 21. Aquatic invertebrates collected during baseline studies by EVS (1983).

Creek	Invertebrate Abundance average #/sample	Invertebrate Abundance maximum #/sample	Taxonomic Richness average #/sample	Taxonomic Richness maximum #/sample
Ikalukrok C. (Sta. 73)	16.3	41.8	5.4	7
Mainstem Red Dog Creek	4.8	1.4	5	6
Middle Fork Red Dog Creek				
Station 21	15	24.7	5	5
Station 140	13.9	33.1	4.7	5
North Fork Red Dog Creek	63.5	100.2	7	8

No data were found for Shelly, Connie, Sulfur, or Rachael Creek
Data from EVS and Ott Water Engineers (1983)

Macroinvertebrates: Current Study

Aquatic invertebrate communities were sampled in 1995 to detect any changes in either abundance or taxonomic richness that may have occurred since development of the Red Dog Mine. Communities were sampled once in July. Because different methods were used to collect invertebrates and because invertebrate taxonomy has changed since the baseline sampling, only general comparisons between pre- and post mining are made.

Methods

Five semi-quantitative samples were collected at each sample site with a "D" net in July 1995. Samples were washed through a plankton bucket into whirl-pack bags, preserved in 70% ETOH, and labeled.

Samples were sorted from rocks and organic debris, identified to lowest practical taxonomic level, and counted. All invertebrate samples were permanently preserved in homeopathic vials with neoprene stoppers and stored at Alaska Department of Fish and Game, Fairbanks. Hilltop Creek was not sampled.

Results and Discussion

Results of the invertebrate sampling are summarized in Table 22. Data from each sample on numbers of invertebrates by family are presented in Appendix 7.

Table 22. Aquatic invertebrate communities, 1995.

Creek	Invertebrate Abundance		Taxonomic Richness	
	average #/sample	maximum #/sample	average #/sample	maximum #/sample
Ikalukrok Creek				
Station 8	7.4	24	1.4	4
Mainstem Red Dog Creek				
Station 10	4	13	1	2
Station 11	0.4	1	0.4	1
Middle Fork Red Dog Creek				
Station 140	0.2	1	0.2	1
Station 20	1	3	0.6	1
Tributary Streams				
Sulfur Creek	36.6	74	1.8	3
Shelly Creek	4.2	7	1.6	2
Connie Creek	40.6	47	2.6	3
Rachael Creek	0.2	1	0.2	1
North Fork Red Dog Creek	26	40	5.4	7

Ikalukrok Creek

Station 8

Samples collected in Ikalukrok Creek had an average of 7.4 invertebrates and 1.4 taxa per sample, with a maximum of 24 invertebrates and a total of 4 taxa (Table 22, Appendix 7). Invertebrates were primarily Nematodes (from 60% to 100% of the total). Only one Plecoptera and no Ephemeroptera or Trichoptera were found.

Mainstem Red Dog Creek

Station 10

An average of 4 invertebrates and 1 taxon were collected in Mainstem Red Dog Creek at Station 10. Three invertebrate families were represented: Nematoda, Diptera: Tipulidae, and Diptera: Chironomidae. Nearly 100% of the invertebrates were Nematoda.

Station 11

Invertebrate communities in Mainstem Red Dog Creek at Station 11 were even more depauperate than at Station 10. Only 1 taxon was found: Diptera: Chironomidae; the average number of invertebrates per sample was less than 1 because 60% of the samples had no invertebrates.

Middle Fork Red Dog Creek

Station 20

Only five Nematoda were found in the aquatic invertebrate samples collected at Station 20. The lack of taxonomic richness and invertebrate abundance suggests that this section of Red Dog Creek does not support a viable invertebrate community.

Station 140.

Only one Chironomidae larvae was found in the five aquatic invertebrate samples collected at Station 140; it could not be determined if this one invertebrate drifted from upstream areas or was produced locally. The lack of taxonomic richness and invertebrate abundance suggests that this section of Red Dog Creek does not support a viable invertebrate community and that invertebrate production is low to non-existent.

Shelly Creek

Few invertebrates were found in Shelly Creek (Appendix 7). The aquatic benthic community included a small leach (Hirudinea), Nematoda, the Dipteran Chironomidae, and the Plecoptera: Nemouridae. The average number of invertebrates per sample was 4.2 and the maximum number was 7.

Connie Creek

Connie Creek supports an abundant, however not diverse, invertebrate community. Invertebrate abundance was similar to that found in the North Fork Red Dog Creek; however, the community had lower taxonomic richness than found in the North Fork Red Dog Creek. In order of abundance, taxa found were Diptera: Chironomidae, Ephemeroptera: Heptagenidae, Diptera: Tipulidae, and Plectoptera: Nemouridae.

Sulfur Creek

Sulfur Creek supports a fairly abundant invertebrate community with low taxonomic richness. In order of abundance, the invertebrate groups found were Nematoda and Chironomidae. Exuvia from Plecoptera: Nemouridae were found; they did not appear to be pre-emergent.

Rachael Creek

The invertebrate community in Rachael Creek was virtually non-existent: only two Chironomidae adults were found. It is unlikely these insects were produced in Rachael Creek.

North Fork Red Dog Creek

North Fork Red Dog Creek had an invertebrate community that was both diverse and abundant. Ten different taxonomic groups were found; more than at any other site. Tipulidae, Trichoptera, and Ephemeroptera were too immature to identify beyond family (or order for Trichoptera). Chironomidae were primarily case-builders, probably primarily Orthocladinae. Identification of Chironomidae larvae was beyond the scope of this project.

Conclusions

Invertebrate communities, as demonstrated by both taxonomic richness (more than 2 orders represented) and abundance (more than 1 invertebrate per sample) were documented in the following streams:

North Fork Red Dog Creek
Sulfur Creek
Connie Creek

When compared to baseline studies, aquatic invertebrate densities were lower in Station 73 in 1995 than in Station 73 or Station 8 during baseline studies (Table 23). EVS reported more invertebrates from Station 21 during baseline (average of 15 organisms per approximately 0.1 m^2 sample) than during post mining sampling at Station 20 in 1995 (average of 1 organism per approximately 0.1 m^2 sample). Ikalukrok Creek upstream of Red Dog Creek was sampled by Dames and Moore during baseline studies. At that time, this site had the highest invertebrate density measured anywhere in the drainage: there was an average of 245 organisms per approximately 0.1 m^2 sample).

Table 23. Average invertebrate density reported by Dames and Moore (1983), EVS (1983) and ADF&G (1995) at various sampling locations in the Wulik River drainage.

Station	average number of organisms/sample
Dames and Moore Baseline Data	
Station 10	3
Station 8	71
Station 9	245
EVS Baseline Data	
Station 73	16.3
Middle Fork Red Dog Creek	3.1
Station 21	15.0
Station 140	13.9
North Fork Red Dog Creek	63.5
ADF&G	
Station 8	7.4
Station 10	4
Station 11	0.4
Station 20	1
Station 140	0.2
Sulfur Creek	36.6
Shelly Creek	4.2
Connie Creek	40.6
Rachael Creek	0.6
North Fork Red Dog Creek	26

Microinvertebrates

Baseline Studies

No data were found on microinvertebrate communities during baseline studies.

Current Study

Streams in the Red Dog area were sampled in July 1995 for the presence of microinvertebrate communities. This component of the aquatic community was examined to determine its importance in each stream.

Methods

Five rocks were collected from each sample site and packed in individual plastic, sealed bags. Rocks were examined within 6 hours of collection with a dissection microscope at 10 to 60 x. Scrapings of the rocks were mounted on a microscope slide with water and examined with a compound microscope. Photographs were taken of the organisms.

Results and Discussion

Ikalukrok Creek

Station 8

Examination of all surfaces of five rocks from Station 8 showed few microinvertebrates and no visible algae. One small (<1 mm Chironomidae) and one small (<1 mm) mite were found. No other microinvertebrates were found on the rocks.

Mainstem Red Dog Creek

Station 10

No plant or invertebrate life was observed on any of the rocks, with the exception of one empty Simulidae pupal case.

Station 11

One of the five rocks supported sub-microscopic Simulidae larvae, nothing was observed on the other four rocks.

Middle Fork Red Dog Creek

Station 20

A small (<1 mm) Chironomidae larvae was found on one of the rocks. No microinvertebrates were found on any of the other rocks, nor was algae, moss, or blue-green bacteria visible with microscopic examination.

Station 140

Five rocks were examined, no plants or invertebrates were observed.

Shelly Creek

Rocks from Shelly Creek were covered with a thick mineral precipitate; no signs of plant or animal life were detected with microscopic examination.

Connie Creek

Rocks from Connie Creek supported from 20 to 100 sub-microscopic Chironomidae. No other invertebrates were observed on the rocks. Abundant mosses were observed along the stream margin; no invertebrates were observed in the mosses (at 50 to 250 x).

Sulfur Creek

Rocks from Sulfur Creek contained no visible aquatic vegetation. Two small invertebrates were observed; they appeared to be tiny aquatic leeches.

Rachael Creek

Rocks were coated with a thick precipitate that probably was aluminum; no invertebrates or plants were observed.

North Fork Red Dog Creek

Each rock was covered with diatoms and blue-green bacteria, probably Nostoc. Chironomidae larvae were associated with the blue-green bacteria. Rocks had from 25 to hundreds of Chironomidae. Also observed on the rocks were filamentous green algae, pupal cases from Simulidae, sub-microscopic Ephemeroptera and Plecoptera nymphs, and Trichoptera larvae. Clusters of unidentified insect eggs were found on some of the rocks.

Conclusions

Microscopic and sub-microscopic communities were found on rocks from the following streams:

Ikalukrok Creek (only a sparse community)
Connie Creek
North Fork Red Dog Creek

Periphyton: Baseline Studies

EVS and Ott Water Engineers (1983) conducted limited sampling of periphyton communities in Middle Fork Red Dog Creek by measuring concentrations of chlorophyll-a. Their methods were similar to those used by ADF&G in this study. EVS and Ott Water Engineers (1983) reported concentrations of chlorophyll-a ranging from 0.01 to 0.10 mg/cm^2 in flowing water upstream of the South Fork Red Dog Creek and chlorophyll-a concentrations ranging from 0.04 to 0.20 mg/cm^2 in seeps adjacent to

Middle Fork Red Dog Creek. Periphyton was not sampled in Red Dog Creek downstream of the South Fork or in Ikalukrok Creek.

Periphyton: Current Study

Methods

Five rocks were collected at each sample site within a riffle section. A 5 cm x 5 cm square of high density foam was placed on the rock. Using a small tooth brush, all material around the foam square was removed and rinsed away with clean water. The foam was removed from the rock and the rock was brushed with a clean tooth brush and rinsed onto a 0.45 *u*m glass fiber filter, held by a magnetic filter holder connected to a hand vacuum pump. Excess water was pumped through the filter, and approximately 1 ml saturated $MgCO_3$ was added to the filter to prevent acidification. The dry filter was wrapped in a large filter (to absorb any additional water, labeled, and placed in a zip-lock bag and packed over desiccant. Filters were frozen in a light-proof container with desiccant.

Filters were cut into small pieces and placed in an extraction tube with 10 ml of 90% buffered acetone. Extraction tubes were covered with aluminum foil and were held in a dark refrigerator for 24 hours. After extraction, samples were read on a Shimadzu UV-1601 Spectrophotometer and a Turner Model 10 Fluorometer. Trichromatic equations (according to Standard Methods, APHA 1992) were used to convert spectrophotometric optical densities to total chlorophyll-a. The Turner Fluorometer was calibrated with US EPA standards according to Standard Methods. A calibration curve was developed, using known standards, standard dilutions, and chlorophyll-a concentrations determined with a spectrophotometer. Hilltop Creek was not sampled.

Results and Discussion

Periphyton communities (i.e., detecting chlorophyll-a in at least 3 of the 5 samples) were documented in North Fork Red Dog Creek, Sulfur Creek, Shelly Creek, and Connie Creek (Appendix 8). Station 11 contained one sample with measurable amounts of chlorophyll-a, and Ikalukrok Creek contained two samples with measurable amounts of chlorophyll-a.

Conclusions

Based on samples examined for the presence of chlorophyll-a (a measure of periphyton standing crop), periphyton communities were documented in the following sites:

North Fork Red Dog Creek	Sulfur Creek
Connie Creek	Shelly Creek

Limited algal productivity was indicated in Ikalukrok Creek and Mainstem Red Dog Creek.

Macrophytes: Baseline Studies

No previous studies were found that documented the presence of aquatic macrophytes in Ikalukrok Creek or Red Dog Creek and its tributaries.

Macrophytes: Current Study

Streams in the Red Dog area were examined and photographed in July 1995 for the presence of macrophytic plants. Aquatic plants may be an important component of an aquatic community and an indicator of good water quality. Hilltop Creek was not sampled.

Methods

Our intention was to collect any visible macrophyte algae along the stream and place it in a labeled plastic bag for later identification. Because few macrophytes were observed and those were generally limited to mosses, we noted their presence only. The following is a description of macrophyte communities observed at each sample site.

Results and Discussion

Ikalukrok Creek

Station 8

The edges of the stream bank at Station 8 in Ikalukrok Creek were gravel, with no aquatic plants along the stream margins. Mosses grew in seeps adjacent to the stream, but there were no aquatic plants found in the stream.

Mainstem Red Dog Creek

Station 10

The edges of the stream bank at Station 10, Mainstem Red Dog Creek contained wide gravel bars and shrub vegetation. No aquatic plants were found in the stream.

Station 11

The Mainstem Red Dog Creek at Station 11, just below the confluence with the North Fork, contained wide gravel bars and the banks supported shrub vegetation. No aquatic plants were found in the stream.

Middle Fork Red Dog Creek

Station 20

The edges of the stream bank at Station 20 in Middle Fork Red Dog Creek were gravel, with few grasses and shrubs. No aquatic plants were found in the stream.

Station 140

This section of the Middle Fork of Red Dog Creek is a man-made channel with steep, graveled sides. No vegetation has established along the stream margins. There were no aquatic plants found in the water.

Shelly Creek

The banks of Shelly Creek were covered with shrub willows. No aquatic plants were evident on the stream bottom; however, mosses grew abundantly along the stream margins.

Connie Creek

The edges of Connie Creek were primarily gravel, with shrubs growing on the stream banks. A few mosses were observed on the stream bottom.

Sulfur Creek

The banks of Sulfur Creek contained grasses and sedges. No aquatic plants were found in this darkly stained creek.

Rachael Creek

The stream banks along Rachael Creek were covered with grasses, sedges, and other terrestrial plants. No aquatic plants were evident in the stream.

North Fork Red Dog Creek

North Fork Red Dog Creek contained abundant aquatic mosses and filamentous algae on the stream bed. The edges of the creek were filled with various aquatic plants. The mosses and filamentous algae in the stream appeared to provide an important substrate for aquatic invertebrates.

Conclusions

Aquatic macrophytes were an important part of the aquatic ecosystem in North Fork Red Dog Creek, and to a lesser extent, in Connie Creek and Shelly Creek. They were not found in the other sites. We believe that high metals concentrations in Middle Fork Red Dog Creek contributed to the absence of aquatic macrophytes in downstream areas.

Fish: Baseline Studies

Baseline studies conducted by Dames and Moore (1983) reported fish use in Ikalukrok Creek, Mainstem Red Dog Creek, and North Fork Red Dog Creek (Table 24). Fish species present in the Wulik River are listed to illustrate the importance of this river for fish. Common and scientific names of fish are listed in Appendix 9.

Table 24. Fish species collected during baseline studies.

Water body	Use (fish species)	Notes
Ikalukrok Creek	Migration (AG) Spawning (AG, ChumS) Rearing (AG, DV, SSc)	few present
Mainstem Red Dog Creek	Migration (AG)	migration limited to spring high flows
Middle Fork Red Dog Creek	no fish found	
North Fork Red Dog Creek	Migration (AG) Spawning (AG) Rearing (AG)	
Wulik River	Arctic grayling slimy sculpin chum salmon Dolly Varden humpback whitefish round whitefish least cisco Bering cisco Alaska blackfish pink salmon sockeye salmon coho salmon chinook salmon ninespine stickleback	

DV = Dolly Varden, AG = Arctic grayling, SSc = slimy sculpin, ChumS = chum salmon
Shelly, Rachael, Connie, and Sulfur Creeks were not sampled.

Natural Fish Kills

EVS and Ott Water Engineers (1983) observed natural fish kills in 1982 while collecting baseline data for the Wulik River drainage. Arctic grayling moralities ranged from underyearling juveniles (20 to 40.9 mm) to sub-adults (75 to 220 mm); Dolly Varden mortalities were juveniles (53 to 113 mm). Thirty six dead Dolly Varden and 171 dead Arctic grayling were found in Red Dog Creek between Station 12 and the mouth in July and August 1982. One juvenile Dolly Varden and one juvenile Arctic grayling were found dead in Ikalukrok Creek above the confluence of Red Dog Creek. EVS and Ott Water Engineers reported that fish found dead in Red Dog Creek had considerable amounts of brown precipitate and mucus on their gills and occasionally had hemorrhaged gills and opaque eyes.

Fish: Current Study

Methods

ADF&G flew aerial surveys using fixed-wing aircraft in fall 1979 through 1995, with the exception of 1983, 1985, 1986, and 1990. The fall surveys covered the Wulik River from its mouth near the village of Kivalina to a point approximately five river miles above its confluence with Ikalukrok Creek.

ADF&G trapped Dolly Varden and other fish species (e.g., Arctic grayling, slimy sculpin) in Ikalukrok Creek, North Fork Red Dog Creek, and Mainstem Red Dog Creek from 1991 through 1995. Sampling was done with minnow traps baited with salmon roe contained in perforated plastic containers. Minnow traps fished from about 20 to 80 hours each sample period.

ADF&G conducted visual stream surveys for Arctic grayling and other fish in North Fork Red Dog Creek, Mainstem Red Dog Creek, and Middle Fork Red Dog Creek from 1991 through 1995 and in Shelly, Sulfur, Connie, and Rachael Creeks in 1995. Arctic grayling were sampled by angling in North Fork Red Dog Creek, Mainstem Red Dog Creek, and Ikalukrok Creek.

Results and Discussion

The number of overwintering Dolly Varden in the Wulik River ranged from 30,853 in 1984 to a high of 144,138 fish in 1993 (Appendix 10, Weber Scannell and Ott 1995). Surveys showed the Wulik River to be one of the most important drainages for overwintering Dolly Varden in northwest Alaska.

Fish were found to inhabit Ikalukrok Creek, Mainstem Red Dog Creek, and North Fork Red Dog Creek. Slimy sculpin were not found in Mainstem Red Dog Creek or North Fork Red Dog Creek before 1995. They are believed to migrate into these creeks in spring after breakup, then use the waterways for summer rearing. Most likely, they migrate downstream in fall, before freeze-up. The uses of streams by fish after development of the Red Dog mine are listed in Table 25. The data on catch per unit effort and actual numbers of fish are given in Weber Scannell and Ott (1995).

Table 25. Post-mining use of Wulik River drainage streams by fish.

Stream	Use (Fish Species)	
Ikalukrok Creek	Migration (AG, DV, SSc)	
Station 8	Rearing (AG, DV, SSc)	
Ikalukrok Creek[1]	Migration (AG)	
upstream of Red Dog Creek	Rearing (AG)	
Mainstem Red Dog Creek	Migration (AG, DV, SSc)	
Station 10	Rearing (AG, DV, SSc)	
Station 11	Migration (AG, DV, SSc)	
	Rearing (AG, DV, SSc)	
Middle Fork Red Dog Creek		
Station 20	no fish found	
Station 140	no fish found	
Shelly Creek	no fish found	
Connie Creek	no fish found	
Sulfur Creek	no fish found	
Rachael Creek	no fish found	
North Fork	Migration (AG, DV, SSc)	
Red Dog Creek	Spawning (AG)	
	Rearing (AG, DV, SSc)	
Wulik River[2]	Arctic grayling	pink salmon
	slimy sculpin	sockeye salmon
	chum salmon	coho salmon
	Dolly Varden	chinook salmon
	humpback whitefish	ninespine stickleback
	round whitefish	burbot
	least cisco	
	Bering cisco	
	Alaska blackfish	

DV = Dolly Varden, AG = Arctic grayling, SSc = slimy sculpin.

[1]Incomplete surveys have been conducted in Ikalukrok Creek above Red Dog Creek. Species other than Arctic grayling may be using this portion of the creek.

[2]Fish use was not documented in the Wulik River.

Point Source Evaluation

Comparisons of water quality and metals concentrations data before and after development of the Red Dog Mine (Table 26) indicate the following changes related to the point source discharge from the mine and to diversion and collection of the mine seepage water. It is not possible to separate the effects of effluent from mine seepage collection. Refer to summaries of water quality data presented in Appendices 1 through 5 and to the complete listing of water quality and metals data from sampling stations in Appendices 11 and 12, and water quality and metals data from mine effluent in 1995 in Appendix 13.

In summer 1995 the wastewater treatment plant discharged maximum amounts of treated water. The volume of mine discharge during 1995 is representative of the amount of discharge requested by Cominco Alaska Inc. in the NPDES permit.

Table 26. Comparisons of water quality and metals before and after mine development.

Analyte or Factor	Ikalukrok Creek	Mainstem Red Dog Creek	Middle Fork Red Dog Creek
Temperature	NMC[1]	NMC	NMC
pH	>[1]	>	>
Flow	>	>	>
Hardness	>	>	>
TSS	NMC	NMC	NMC
Dissolved Oxygen	NMC	NMC	NMC
Turbidity	NMC	NMC	NMC
Conductivity	>	>	>
TDS	>	>	>
Sulfate	>	>	>
Al	not related[2]	not related	not related
Cd	<[1]	<	<
Cu	<	<	<
Pb	<	<	<
Zn	<	<	<

[1]NMC = no measurable change, < = decrease, > = increase over background conditions.
[2] Concentrations of Al appear to be related to high rainfall and increased erosion.

Non-Point Source Evaluation: Whole Effluent Toxicity

Whole effluent toxicity (WET) tests were conducted on water taken from Middle Fork Red Dog Creek at Station 140 during summer 1995 (Parametrix 1995 a, b, c, d, e, and f) and from Ikalukrok Creek at Station 9 above Red Dog Creek (Parametrix 1995f). WET tests were conducted at other stations that are influenced by the mine discharge effluent. Because it is not possible to separate effects between natural mineralization and mine effluent, those test results are not presented.

Tests on water taken from Station 140 (Table 27) showed significant toxicity for both *Ceriodaphnia dubia and Pimephales promelas.* The no observed effects concentration (NOEC) was <1% Station 140 water mixed with 99% laboratory water. The concentration of Station 140 water resulting in 50% mortality was <1%.

Table 27. Whole Effluent Toxicity at Station 140.

		Ceriodaphnia dubia		*Pimephales promelas*	
Date Water Collected		survival	reproduction	survival	growth mg
June 11-14 1995	NOEC[1]	1%	<1%	1%	1%
	LOEC[2]	6%	1%	6%	>1%
	LC50[3]	2%		5%	
June 19,21,23 1995	NOEC	1%	1%	1%	1%
	LOEC	6%	1%	6%	>1%
	LC50	2%		3%	
July 5,7,10 1995	NOEC	<1%	<1%	1%	1%
	LOEC	1%	1%	6%	>1%
	LC50	<1%		2%	
July 17,19,21	NOEC	<1%		1%	1%
	LOEC	1%		6%	>1%
	LC50	<1%		2%	

[1]NOEC = No Observed Effects Concentration.
[2]LOEC = Lowest Concentrations at which adverse effects were observed
[3]LC50 = Concentration at which 50% of the test population died.

Station 9, Ikalukrok Creek above Red Dog Creek

Whole effluent toxicity tests conducted on water from Ikalukrok Creek at Station 9 (above Red Dog Creek) did not show significant toxicity for *Ceriodaphnia dubia* or *Pimephales promelas* survival in August 1995 (Table 28). The NOEC for *C. dubia* survival was 100%. Tests did show significant detrimental effects of Station 9 water on *C. dubia* reproduction, with a NOEC of 1% Station 9 water.

Whole effluent toxicity tests using Station 9 water collected in September 1995 showed somewhat higher toxicity for *C. dubia* than in August, the NOEC was 73% and the LC50 was 84%. Survival and growth of *P. promelas* remained at 100% in September samples.

Table 28. Whole Effluent Toxicity at Ikalukrok Creek, Station 9.

		Ceriodaphnia dubia		*Pimephales promelas*	
Date Water Collected		survival	reproduction	survival	growth mg
August 6 1995	NOEC[1]	100%	1%	100%	100%
	LOEC[2]	>100%	<1%	>100%	>100%
	LC50[3]	>100%	N/A	>100%	N/A
Sept. 9 1995	NOEC	73%		100%	100%
	LOEC	100%		>100	>100%
	LC50	84%		>100	

[1]NOEC = No Observed Effects Concentration.
[2]LOEC = Lowest Concentrations at which adverse effects were observed
[3]LC50 = Concentration at which 50% of the test population died.

Conclusions and Recommendations

Information from baseline studies and from post-mining studies were used to determine the ability of each waterway to support a viable aquatic community (Table 29 for fish, Table 30 for invertebrates, Table 31 for periphyton). Aquatic communities include any combination of fish, aquatic macroinvertebrates, aquatic microinvertebrates, periphyton, and macrophytes. Incidental occurrence of a few organisms is not considered to constitute a community.

Table 29. Summary of fish use of streams in the upper Wulik River drainage.

Stream	Pre-mining	Post-mining	Attainable
Ikalukrok Creek	Yes	Yes	Yes
Mainstem Red Dog Creek	Yes	Yes	Yes
Middle Fork Red Dog Creek	No	No	No
Sulfur Creek	No	No	No
Shelly Creek	? (No)	No	No
Connie Creek	? (No)	No	No
Rachael Creek	? (No)	No	No
Hilltop Creek	?(No)	No	No
North Fork Red Dog Creek	Yes	Yes	Yes

? = no data were available.

Table 30. Summary of aquatic micro and macroinvertebrate use of streams in the upper Wulik River drainage.

Stream	Pre-mining	Post-mining	Attainable
Ikalukrok Creek	Yes	Low	Yes
Mainstem Red Dog Creek	Low	Low	Yes
Middle Fork Red Dog Creek	No	No	No
Sulfur Creek	?	No	No
Shelly Creek	?	Very Low	No
Connie Creek	?	Yes	Yes
Rachael Creek	?	No	No
Hilltop Creek	?	No	No
North Fork Red Dog Creek	Yes	Yes	Yes

? = no data were available.

Table 31. Summary of macrophyte and periphyton use of streams in the upper Wulik River drainage.

Stream	Pre-mining	Post-mining	Attainable
Ikalukrok Creek	Low	Low	Limited
Mainstem Red Dog	Low	Low	Limited
Middle Fork Red Dog	No	No	No
Sulfur Creek	?	Yes	Limited
Shelly Creek	?	Low	Limited
Connie Creek	?	Yes	Yes
Rachael Creek	?	No	No
Hilltop Creek	?(No)	No	No
North Fork Red Dog Creek	Yes	Yes	Yes

? = no data were available.

Based upon information presented in this Use Attainability Analysis, the Alaska Department of Fish and Game recommends retaining the stream classification for Aquatic Life in the following streams:

Connie Creek
Ikalukrok Creek
North Fork Red Dog Creek
Mainstem Red Dog Creek

The Alaska Department of Fish and Game recommends elimination of the stream classification for Aquatic Life in the following waterbodies:

Middle Fork Red Dog
Shelly Creek
Hilltop Creek
Sulfur Creek
Rachael Creek

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Appendix 1. Summary of water quality data, 1979-1983.

Station		Hardness mg/L	TDS mg/L	Sulfate mg/L	pH	Temperature °C
Station 20	median	93		108	6.6	5.0
	maximum	145		149	6.9	14.3
	minimum	58.5		66	5.7	0.0
	count	16		3	5	5
Station 30	median	92.1	216	174	5.85	6.3
Station 30	maximum	201	287	324	6.5	12.8
Station 30	minimum	67.5	131	95	5.3	0.0
Station 30	count	12	4	5	8	7
Station 12	median	96.15	187	87.5	7.5	6.3
North Fork	maximum	217	210	98	7.8	8.7
	minimum	39	183	50	6.0	0.0
	count	16	3	3	8	7
Station 140						
	median	89			6.4	
	maximum	155			6.7	
	minimum	68			5.8	
	count	10			10	
Station 09	median	116	143	60	7.5	4.1
Station 09	maximum	290	284	76	7.9	14.7
Station 09	minimum	34	115	30		-0.1
Station 09	count	24	4	3	9	8

TDS = total dissolved solids

Appendix 2. Summary of water quality data, 1979-1983.

Station		Dissolved Oxygen mg/L	Conductivity *u*mho/cm	Flow cfs	Alkalinity mg/L
Station 140	median				
Station 140	maximum	13.2	230		13
Station 140	minimum	10.4	140		2.2
Station 140	count	5	8		10
Station 73	median				68.4
Station 73	maximum	13.4	220		87.8
Station 73	minimum	10.2	110		47.4
Station 73	count	48	50		15
Station 30	median	11.3	276	8.55	4.95
Station 30	maximum	14.2	650	27	16
Station 30	minimum	10.4	63	1.3	1
Station 30	count	8	7	8	8
Station 20	median	11.6	265	13.5	23
Station 20	maximum	14.2	525	76	44
Station 20	minimum	9.7	28	1.6	1.7
Station 20	count	5	5	18	5
Station 12	median	7.7	352	19	90.5
Station 12	maximum	7.9	591	92	115.4
Station 12	minimum	7.2	44	12	48.8
Station 12	count	14	7	15	15
Station 10	median	10.9	328	32.0	70
Station 10	maximum	13.5	1090	126.0	245
Station 10	minimum	0.3	154	3.2	5.2
Station 10	count	9.0	8	25	9
Station 08	median	11.6	289	102.5	75
Station 08	maximum	13.7	940	310.0	388
Station 08	minimum	2.3	179	15.0	12
Station 08	count	9	8	14	10.

Appendix 2, continued.

Station		D.O. mg/L	Conduct. umho/cm	Flow cfs	Alkalinity mg/L
Station 12	median	11.25	352	20	99
Station 12	maximum	14.4	591	92	138
Station 12	minimum	9.5	44	8.1	8.4
Station 12	count	8	7	19	8
Station 09	median	11.7	282.5	132	73.5
Station 09	maximum	13.9	480	1260	176
Station 09	minimum	0.2			16
Station 09	count	9	8	31	26

Appendix 3. Summary metals data, 1979-1983.

Station		Al mg/L	Cd mg/L	Cu mg/L	Pb mg/L	Zn mg/L
Station 140	median	0.73	0.12		0.33	15.70
Station 140	maximum	2.31	0.21		1.11	28.50
Station 140	minimum	0.15	0.07		<0.08	9.06
Station 140	count	20	20		20	20
Station 73	median		0.0115		0.029	0.98
Station 73	maximum		<0.025		<0.08	1.8
Station 73	minimum		<0.006		0.0003	0.349
Station 73	count		12		12	12
Station 30	median	0.665	0.1335	0.013	0.274	15.85
Station 30	maximum	2.31	0.94	0.028	1.11	49.8
Station 30	minimum	0.15	0.071	0.007	0.0026	9.06
Station 30	count	24	32	4	32	32
Station 20	median	0.325	0.078	0.009	0.11	9.865
Station 20	maximum	0.91	0.14	0.025	0.36	16.5
Station 20	minimum	0.05	<0.02	<0.005	0.0015	2.63
Station 20	count	28	34	4	34	34
Station 12	median	<0.15	0.03	<0.01	<0.08	0.02
Station 12	maximum	0.55	0.03	<0.01	<0.08	0.37
Station 12	minimum	<0.02	<0.0002	<0.002	<0.004	0.01
Station 12	count	25	29	5	29	29
Station 10	median	<0.15	0.03	<0.001	<0.08	3.70
Station 10	maximum	1.19	0.10	<0.02	0.10	13.00
Station 10	minimum	<0.02	<0.002	<0.002	<0.001	0.57
Station 10	count	38	43	15	43	43
Station 08	median	0.04	<0.01	<0.001	<0.004	0.74
Station 08	maximum	0.17	0.04	<0.02	0.028	4.20
Station 08	minimum	<0.02	<0.001	<0.001	<0.001	0.17
Station 08	count	10.00	18	10	18	18

Appendix 3, continued.

Station		Al mg/L	Cd mg/L	Cu mg/L	Pb mg/L	Zn mg/L
Station 12	median	<0.15	<0.025	<0.005	<0.08	0.023
Station 12	maximum	0.55	<0.025	0.013	<0.08	0.37
Station 12	minimum	<0.02	<0.0002	<0.002	<0.0001	0.005
Station 12	count	25	29	5	29	29
Station 09	median	0.045	0.002	0.0045	0.0012	0.0255
Station 09	maximum	0.23	0.025	0.012	<0.08	2.3
Station 09	minimum	<0.02	<0.0002	<0.001	<0.0001	0.006
Station 09	count	10	24	10	24	24

Appendix 4. Summary of Water Quality Data, 1991-1995.

Ikalukrok Creek, Station 8.

Hardness, total dissolved solids, and pH.

Year		Hardness mg/L	TDS mg/L	pH
1991	median	179	261	7.1
	maximum	270	406	7.5
	minimum	143	174	6.8
	count	11	11	11
1992	median	237	312	7.44
	maximum	798	1040	8.2
	minimum	53.1	64	5.7
	count	29	29	29
1993	median	131	181	7.7
	maximum	191	229	8.2
	minimum	55.9	68	6.7
	count	12	17	17
1994	median	132.5	159.5	7.7
	maximum	498	658	8.2
	minimum	43.2	57	7.2
	count	22	22	22
1995	median	156	209	7.7
	maximum	666	906	7.9
	minimum	82.5	118	7.1
	count	12	15	14

Appendix 4, continued.

Station 8. Temperature, dissolved oxygen, conductivity, and flow.

Date		Temperature °C	Dissolved Oxygen mg/L	Conductivity *u*mho/cm	Flow cfs
1991	median	5.8	12.8	348	
	maximum	11.5	13.6	576	
	minimum	-0.2	10.3	215	
	count	11	10	8	
1992	median	7.6	9.2	465	
	maximum	13.6	13.2	135	
	minimum	-0.5	4	11	
	count	29	25	22	
1993	median	6.7	11.15	268	189.9
	maximum	15	20	420	248.3
	minimum	2	8.1	50	131.5
	count	17	12	14	2
1994	median	4	11.55	248	
	maximum	8.4	13.2	790	
	minimum	0	7.5	143	
	count	22	22	20	
1995	median	5.8	13	330	
	maximum	10.6	14.5	442	
	minimum	1	12.7	261	
	count	14	5	6	

Appendix 4, continued.

Mainstem Red Dog Creek, Station 10

Year		Hardness mg/L	Total Dissolved Solids mg/L	pH
1991	median	244	349	7.0
	maximum	563	831	7.5
	minimum	179	207	6.7
	count	12	12	12
1992	median	369	519	7.4
	maximum	1540	1850	8.1
	minimum	52.7	67	6.12
	count	30	30	30
1993	median		214.5	7.55
	maximum		369	8.2
	minimum		50	6.6
	count		18	18
1994	median	177	228	7.7
	maximum	1100	1610	7.9
	minimum	99.3	127	7.2
	count	18	18	18
1995	median	580	824	7.6
	maximum	1070	1610	7.8
	minimum	247	171	7.1
	count	9	19	14

Appendix 4, continued.

Mainstem Red Dog Creek, Station 10

Date		Temperature °C	Dissolved Oxygen mg/L	Conductivity umho/cm	Flow cfs
1991	median	6.1	11.8	481	
	maximum	14.1	14.0	665	
	minimum	-0.2	9.5	270	
	count	11	11	8	
1992	median	5.35	9.8	680	
	maximum	13.9	13.4	2090	
	minimum	-0.5	4.9	114	
	count	30	28	27	
1993	median	7			182.6
	maximum	17			400
	minimum	1			32.7
	count	18			6
1994	no samples were collected.				
1995	median	9.5		1029	
	maximum	13		1790	
	minimum	3		97	
	count	14		14	

Appendix 4, continued.

Middle Fork Red Dog Creek, Station 20.
Hardness, total dissolved solids, sulfate, and pH.

Year		Hardness mg/L	TDS mg/L	Sulfate mg/L	pH
1991	median	354	568		7
	maximum	763	1310		7.6
	minimum	210	346		6
	count	13	13		13
1992	median	561	810		6.8
	maximum	1560	2230		8
	minimum	28	50		6.1
	count	32	32		32
1993	median	53.5	198		7.1
	maximum	74	961		7.7
	minimum	32.9	57		6.3
	count	2	19		18
1994	median	319	509	300	7
	maximum	1580	2440	1500	9
	minimum	71.5	97	55	6
	count	18	18	18	17
1995	median	597	1680	1000	7.3
	maximum	1170	2190	1500	7.8
	minimum	138	135	57	6.6
	count	5	28	10	25

Appendix 4, continued.

Middle Fork Red Dog Creek, Station 10.
Temperature, dissolved oxygen, conductivity, and flow.

Year		Temperature. °C	Dissolved Oxygen mg/L	Conductivity *u*mho/cm	Flow cfs
1991	median	5.5	11.9	1.3	577
	maximum	16.1	16	6.1	1570
	minimum	-0.2	8.8	0.4	440
	count	12	12	13	11
1992	median	6.7	9	0.435	0.96
	maximum	19.4	13.4	11	2.56
	minimum	0	1.8	0.12	0.08
	count	32	29	30	32
1993	median	5.5	12.3	3.35	
	maximum	13	12.5	3.7	
	minimum	0	12.1	3	
	count	18	2	2	
1994	median	4			
	maximum	13			
	minimum	0			
	count	17			
1995	median	12		1580.5	7.6
	maximum	15.2		2390	28.9
	minimum	7		94	26.7
	count	24		26	9

Appendix 4, continued.

Middle Fork Red Dog Creek, Station 140.
Hardness, total dissolved solids, and pH.

Date		Hardness mg/L	TDS mg/L	pH
1991	median	155	345	7
	maximum	267	717	8.2
	minimum	108	210	5.2
	count	19	13	52
1992	median	127.5	204	6.5
	maximum	242	456	8.2
	minimum	25.2	16.6	5.7
	count	36	36	36
1993	no samples were collected.			
1994	no samples were collected.			
1995	median	412.5		
	maximum	624		
	minimum	105		
	count	32		

Appendix 4, concluded.

Station 140. Temperature, dissolved oxygen, conductivity, and flow.

Date		Temperature °C	Dissolved Oxygen mg/L	Conductivity *u*mho/cm	Flow cfs
1991	median	4.3	11.5	305	
	maximum	11.6	15	490	
	minimum	-0.2	7.7	178	
	count	13	13	10	
1992	median	8.25	7.5	274	
	maximum	15.4	12.5	58	
	minimum	-0.1	3.3	27	
	count	36	33	28	
1994	median			680	
	maximum			70	
	minimum			63	
	count			7	
1995	median				4.65
	maximum				24.2
	minimum				2.1
	count				20

Appendix 5. Summary of Metals Data, 1991-1995.

Ikalukrok Creek, Station 8 and 73.

Year		Al mg/L	Cd mg/L	Cu mg/L	Pb mg/L	Zn mg/L
1991	median	<0.05	0.012	<0.01	0.008	1.62
	maximum	<0.05	0.040	<0.01	0.023	3.61
	minimum	<0.05	0.007	<0.01	<0.001	1.07
	count	12	12	12	12	12
1992	median	<0.05	0.007	<0.01	<0.002	0.865
	maximum	0.73	0.024	<0.01	0.094	3.120
	minimum	<0.05	<0.003	<0.01	<0.002	0.305
	count	28	28	28	28	28
1993	median	<0.05	<0.003		<0.002	0.203
	maximum	0.28	<0.003		0.009	0.389
	minimum	<0.05	<0.003		<0.002	0.143
	count	17	17		17	17
1994	median	0.085	0.003		0.006	0.282
	maximum	1.02	0.02		0.078	2.62
	minimum	0.05	0.003		0.002	0.098
	count	23	23		23	23
1995	median	0.145	0.00483	0.00322	0.00565	0.619
	maximum	1.06	0.0198	0.01	0.106	2.01
	minimum	0.05	0.00069	0.0016	0.00058	0.138
	count	13	17	17	17	17

Appendix 5, continued.

Mainstem Red Dog Creek, Station 10

Date		Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L
1991	median	<0.05	0.036	<0.01	0.02	0.026	5.85
	maximum	<0.05	0.047	<0.01	0.06	0.028	6.54
	minimum	<0.05	0.010	<0.01	0.02	0.010	1.58
	count	12	12	12	12	12	12
1992	median	<0.05	0.02	<0.01	0.045	0.007	2.515
	maximum	0.892	0.06	<0.01	2.98	0.386	5.92
	minimum	<0.05	<0.003	<0.01	0.02	<0.002	0.699
	count	30	30	30	30	29	30
1993	median	<0.05	0.008			0.014	0.939
	maximum	0.69	0.013			0.136	1.31
	minimum	<0.05	<0.003			0.004	0.463
	count	18	18			18	17
1994	median	0.108	0.014			0.023	1.59
	maximum	0.403	0.031			0.07	3.38
	minimum	<0.05	0.006			0.004	0.533
	count	17	18			18	18
1995	median	0.05	0.02	0.0034	0.083	0.0187	2.55
	maximum	0.105	0.237	0.0047	0.237	0.0393	3.67
	minimum	0.05	0.012	0.0014	0.057	0.0131	1.39
	count	9	18	18	8	18	18

Appendix 5, continued.

Middle Fork Red Dog Creek, Station 20.

Year		Al mg/L	Cd mg/L	Cu mg/L	Pb mg/L	Zn mg/L
1991	median	<0.05	0.13	<0.01	0.161	21.75
	maximum	0.48	0.19	<0.01	0.295	32.40
	minimum	<0.05	0.06	<0.01	0.044	8.28
	count	12	12	12	12	12
1992	median	<0.05	0.045	<0.01	0.0405	6.38
	maximum	0.226	0.147	0.012	0.23	18.7
	minimum	<0.05	0.013	<0.01	0.015	1.6
	count	30	30	30	30	30
1993	median	<0.05	0.026		0.049	3.29
	maximum	0.38	0.032		0.348	3.83
	minimum	<0.05	0.013		0.016	1.64
	count	17	17		17	17
1994	median	0.086	0.029		0.095	3.57
	maximum	1.25	0.52		0.345	11.3
	minimum	0.05	0.016		0.01	2.1
	count	23	23		23	23
1995	median	0.091	0.0428	0.00589	0.046	4.91
	maximum	0.197	0.0559	0.109	0.142	8.06
	minimum	0.05	<0.00005	0.00023	0.00039	0.0008
	count	9	28	28	28	28

Appendix 5, continued.

Middle Fork Red Dog Creek, Station 140

Year		Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L
1991	median	0.1	0.08	0.04	0.215	0.108	13.8
	maximum	0.44	0.758	0.05	2.9	0.856	157
	minimum	0.05	0.003	0.01	0.04	0.01	1.4
	count	56	56	56	54	56	56
1992	median	0.05	0.054	0.01	0.023	0.181	9.99
	maximum	1.61	0.216	0.07	3.69	1.94	138
	minimum	0.05	0.012	0.01	0.02	0.046	1.47
	count	36	36	36	36	36	36
1993	median	0.08	0.02	0.01	0.58	0.10	1.93
	maximum	0.46	0.15	0.02	1.68	0.58	16.30
	minimum	0.05	0.01	0.01	0.17	0.05	1.10
	count	20	20	3	3	20	20
1994	median	0.103	0.035	0.058	0.101	0.207	4.11
	maximum	1.47	0.15	0.058	0.101	0.542	29.5
	minimum	0.05	0.012	0.058	0.101	0.126	1.57
	count	13	13	1	1	13	13
1995	median	0.196	0.1045	0.0128	0.236	0.1815	22.1
	maximum	0.196	0.262	0.0197	0.236	0.345	33.6
	minimum	0.196	0.0317	0.0056	0.236	0.131	4.78
	count	1	32	32	1	32	32

Appendix 5, continued.

Shelly Creek, 1995

	Hardness mg/L	Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L	pH
median	62	0.271	0.0137	0.0140	0.403	0.0496	1.62	6.8
maximum	116	0.549	0.0447	0.0235	1.220	0.6040	5.10	7.3
minimum	33	0.077	0.0006	0.0016	0.190	0.0052	0.09	6.4
count	5	14	14	13	13	14	14	6

Connie Creek, 1995

	Hardness mg/L	Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L	pH
median	79	0.09	0.00	<0.005	0.09	0.01	0.12	6.85
maximum	148	0.37	0.19	0.06	1.22	0.27	36.80	7.40
minimum	51	0.05	0.00	<0.005	0.05	<0.002	<0.01	6.60
count	5	12	12	12	11	12	12	6

Rachael Creek, 1995

	Hard mg/L	Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L	pH
median	256	1.70	0.00300	0.0610	2.80	0.0008	0.707	5.45
maximum	491	3.27	0.00381	0.0840	4.28	0.0480	0.838	5.90
minimum	164	1.17	0.00214	0.0427	0.25	0.0003	0.202	4.70
count	5	10	11	11	9	11	11	4

Appendix 5, continued.

Sulfur Creek, 1995

	Hardness mg/L	Al mg/L	Cd mg/L	Cu mg/L	Fe mg/L	Pb mg/L	Zn mg/L	pH
median	132	0.05	0.0070	0.0064	0.058	0.0913	0.971	7.0
maximum	140	5.97	0.0118	0.0200	20.100	2.1200	1.900	7.4
minimum	87	0.05	0.0030	0.0012	0.036	0.0658	0.399	6.5
count	4	6	6	6	5	6	6	4

Hilltop Creek

Date	Al mg/L	Cd mg/L	Fe mg/L	Pb mg/L	Zn mg/L	pH
Middle of Hilltop						
7/31/95	17.10	10.1	20.6	2.64	2130	3.55
8/1/95	27.60	10.5	22	2.33	2080	3.5
Mouth of Hilltop						
7/31/95	7.87	6.2	3.45	4.69	1510	4.25
8/1/95	12.20	6.9	4.11	4.55	1600	4.1
Headwaters of Hilltop						
7/31/95	15.40	3.78	85.5	1.63	530	2.71
8/1/95	12.20	6.9	4.11	4.55	1600	4.1
Hilltop Monitoring						
8/16/95	9.39	7.8	3.68	4.12	1580	4.2
8/21/95	8.19	7.6	1.96	4.22	1550	4.8
8/25/95	9.59	7	3.88	3.90	147	4.2
8/29/95	8.47	5	2.39	3.78	1430	4.6
9/3/95	7.75	6.7	2.17	3.49	1460	5
9/6/95	4.09	6.5	0.37	3.39	1260	
9/13/95	3.65	7	0.21	0.39	1380	5.7
9/21/95	2.97	6.9	0.11	3.94	1250	5.7
9/28/95	8.29	6.8	0.8	3.09	1250	5
10/6/95	3.05	6.2	0.16	3.35	1150	5.8
10/17/95	0.26	3.2	0.03	3.75	710	6.1

Appendix 6. Invertebrates found in Wulik River Drainage Before Mining.

Baseline Studies Conducted by EVS (1983).

	Oligichaeta		Chironomidae		Plecoptera		Ephemeroptera	
Station	Taxa	N	Taxa	N	Taxa	N	Taxa	N
Ikalukrok Creek								
Station 73	3	2.5	9	6.5	2	3.2	1	2.3
(sampled at	3	0.2	9	1.2	1	0.2	1	0.1
4 locations)	2	7.9	11	14.1	2	12.3	1	5.5
July	1	0.7	10	4.2	2	1.5	1	1.2
August	3	2	9	3	2	3.8	3	1.9
	2	0.2	6	1.5	2	1.7	2	1.0
	2	10.3	7	22.1	2	6.5	3	2.9
	3	1.2	7	14.6	1	0.7	2	0.6
Station 9								
July	2	0.4	12	6.4	2	2.2	1	0.4
Mainstem Red Dog Creek								
Station 10								
July	1	<0.1	9	3.9	2	0.3	1	0.5
August	1	<0.1	5	0.7	2	0.2	2	0.4
Middle Fork Red Dog Creek								
Station 21								
July	2	0.8	6	2.4	2	0.9	1	1.1
August	2	4.8	9	2.8	2	9.8	1	7.3
Station 140								
July	1	1.5	8	1.4	2	0.1	1	0.4
August	0	0	6	2	2	0.3	1	3
August	2	12	10	5.5	0	9.3	3	6.3
North Fork Red Dog Creek								
July	3	10.3	11	50.3	2	15.6	2	24.0
August	3	9.2	13	6.1	3	4	3	7.5

Appendix 6, continued.

Baseline Studies Conducted by Dames and Moore (1983).

Station	Non-Insect Invertebrates	Chironomidae	Plecoptera	Ephemeroptera	Total
Station 10	1	1	0	1	3
Station 8	11	76	14	55	156
Station 8	1	22	2	11	36
Station 8	2	14	2	4	22
Station 9	17	52	71	105	245

Appendix 7. Invertebrate data, 1995.

		Ikalukrok Creek, Station 8						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		1	24	1	11	0	7.4	24
Total number of taxa		1	1	1	4	0	1.4	4
	Acarina							
	Nematoda	1	24	1	6			
	Tipulidae							
Diptera	Chironomidae larvae				3			
	Chironomidae pupae		1 exuvia					
	Simulidae							
Ephemeroptera	Heptagenidae				1			
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae				1			
	Capniidae							
Trichoptera								
		Connie Creek						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		42	38	37	39	47	40.6	47
Total number of taxa		3	1	3	3	3	2.6	3
	Acarina							
	Nematoda							
	Tipulidae			1		1		
Diptera	Chironomidae larvae	35	37	33	37	44		
	Chironomidae pupae	2	1	2		1		
	Simulidae				1	1		
Ephemeroptera	Heptagenidae	4		1	1			
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae	1 + 1exuvia						
	Capniidae							
Trichoptera								

Appendix 7, continued.

		Sulfur Creek						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		74	12	57	20	20	36.6	74
Total number of taxa		2	2	2	1	1	1.6	2
	Acarina							
	Nematoda	70	7	56	20	20		
	Tipulidae							
Diptera	Chironomidae larvae	3	5	1				
	Chironomidae pupae	1						
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae	1 exuvia		exuvia				
	Capniidae							
Trichoptera								
		Rachael Creek					average	maximum
Sample number		1	2	3	4	5		
Total number of organisms		1	1	1	0	0	0.6	1
Total number of taxa		1	1	1	0	0	0.6	1
	Acarina							
	Nematoda							
	Tipulidae							
Diptera	Chironomidae larvae							
	Chironomidae pupae		1 adul	1 adult				
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae	1		1 exuvia				
	Capniidae							
Trichoptera								

Appendix 7, continued.

		Red Dog Creek, Station 11						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		0	1	0	1	0	0.4	1
Total number of taxa		0	1	0	1	0	0.4	1
	Acarina							
	Nematoda							
	Tipulidae							
Diptera	Chironomidae larvae				1			
	Chironomidae pupae		1pupa					
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae							
	Capniidae							
Trichoptera								
		North Fork Red Dog Creek						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		14	40	24	26	26	26	40
Total number of taxa		6	5	7	6	3	5.4	7
	Acarina	1	3	1		2		
	Nematoda	3						
	Tipulidae	1		1				
Diptera	Chironomidae larvae	1	30	12	4	12		
	Chironomidae pupae		2	2	2	2		
	Simulidae	2		1p	1p			
Ephemeroptera	Heptagenidae	6	3	4	14	10		
	Baetidae		2	2	2			
	Siphloneuridae				1			
Plecoptera	Nemouridae							
	Capniidae		1		2			
Trichoptera				1				

Appendix 7, continued.

		Red Dog Creek, Station 140						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		0	1	0	0	0	0.2	1
Total number of taxa		0	0	0	0	0	0	0
	Acarina							
	Nematoda							
	Tipulidae							
Diptera	Chironomidae larvae		1					
	Chironomidae pupae							
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae	1 exuvia						
	Capniidae							
Trichoptera								
		Red Dog Creek, Station 20						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		1	1	3	0	0	1	3
Total number of taxa		1	1	1	0	0	0.6	1
	Acarina							
	Nematoda	1	1	3				
	Tipulidae							
Diptera	Chironomidae larvae							
	Chironomidae pupae							
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae							
	Capniidae							
Trichoptera								

Appendix 7, concluded.

		Red Dog Creek, Station 10						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		2	5	13	0	0	4	13
Total number of taxa		1	3	1	0	0	1	3
	Acarina							
	Nematoda	2	3	12				
	Tipulidae		1 Tipula					
Diptera	Chironomidae larvae			1				
	Chironomidae pupae		1					
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae		1 exuvia					
	Capniidae							
Trichoptera								
		Shelley Creek						
Sample number		1	2	3	4	5	average	maximum
Total number of organisms		4	3	4	7	3	4.2	7
Total number of taxa		1	1	2	2	1	1.4	2
	Acarina							
	Nematoda	4			5	3		
	Tipulidae							
Diptera	Chironomidae larvae		2	2	2			
	Chironomidae pupae	1 exuvia		1a				
	Simulidae							
Ephemeroptera	Heptagenidae							
	Baetidae							
	Siphloneuridae							
Plecoptera	Nemouridae		1	1	2 exuvia			
	Capniidae							
Trichoptera								

Appendix 8. Estimates of Chlorophyll-a, 1995.

Periphyton samples were collected and analyzed by ADF&G according to methods presented in the text.

Creek	Station Number	ug/cm^2 chlorophyll-a
Ikalukrok Creek	Station 8	0.155
Ikalukrok Creek	Station 8	<LOD
Ikalukrok Creek	Station 8	<LOD
Ikalukrok Creek	Station 8	<LOD
Ikalukrok Creek	Station 8	0.215
Mainstem Red Dog Creek	Station 10	<LOD
Mainstem Red Dog Creek	Station 10	<LOD
Mainstem Red Dog Creek	Station 10	<LOD
Mainstem Red Dog Creek	Station 10	<LOD
Mainstem Red Dog Creek	Station 10	<LOD
Mainstem Red Dog Creek	Station 11	<LOD
Mainstem Red Dog Creek	Station 11	<LOD
Mainstem Red Dog Creek	Station 11	0.567
Mainstem Red Dog Creek	Station 11	<LOD
Mainstem Red Dog Creek	Station 11	<LOD
Middle Fork Red Dog Creek	Station 20	<LOD
Middle Fork Red Dog Creek	Station 20	<LOD
Middle Fork Red Dog Creek	Station 20	<LOD
Middle Fork Red Dog Creek	Station 20	<LOD
Middle Fork Red Dog Creek	Station 20	<LOD
Middle Fork Red Dog Creek	Station 140	<LOD
Middle Fork Red Dog Creek	Station 140	<LOD
Middle Fork Red Dog Creek	Station 140	<LOD
Middle Fork Red Dog Creek	Station 140	0.11
Middle Fork Red Dog Creek	Station 140	<LOD
Sulfur Creek		0.56
Sulfur Creek		0.49
Sulfur Creek		0.62
Sulfur Creek		0.80
Sulfur Creek		0.32

Appendix 8, concluded.

Creek	Station Number	ug/cm^2 chlorophyll-a
Shelly Creek		0.041
Shelly Creek		0.136
Shelly Creek		0.064
Shelly Creek		0.078
Shelly Creek		<LOD
Connie Creek		0.12
Connie Creek		0.11
Connie Creek		0.13
Connie Creek		0.14
Connie Creek		0.07
Rachael Creek		<LOD
Rachael Creek		<LOD
Rachael Creek		<LOD
Rachael Creek		<LOD
Rachael Creek		<LOD
North Fork Red Dog Creek	Station 12	0.896
North Fork Red Dog Creek	Station 12	1.273
North Fork Red Dog Creek	Station 12	0.558
North Fork Red Dog Creek	Station 12	0.337
North Fork Red Dog Creek	Station 12	0.273

Appendix 9. Common and Scientific Names of Fish from Wulik River Drainage

Arctic grayling	*Thymallus arcticus*
slimy sculpin	*Cottus cognatus*
Dolly Varden	*Salvelinus malma*
humpback whitefish	*Coregonus pidschian*
round whitefish	*Prosopium cylindraceum*
least cisco	*Coregonus sardinella*
Bering cisco	*Coregonus laurettae*
Alaska blackfish	*Dallia pectoralis*
chum salmon	*Oncorhynchus keta*
pink salmon	*O. gorbuscha*
sockeye salmon	*O. nerka*
coho salmon	*O. kisutch*
chinook salmon	*O. tshawytscha*
ninespine stickleback	*Pungitius pungitius*

Appendix 10. Overwintering Adult Dolly Varden in the Wulik River.

Fish were aerial surveyed by ADF&G before freeze up. Data on fish surveys are presented in Weber Scannell and Ott (1995). All surveys were conducted by A. DeCicco, ADF&G.

Year	Wulik River upstream of Ikalukrok Creek	Wulik River downstream of Ikalukrok Creek	Total Fish	Percent of Fish downstream of Ikalukrok Creek
1979	3,305	51,725	55,030	94
1980	12,486	101,067	113,553	89
1981	4,125	97,136	101,261	96
1982	2,300	63,197	65,497	97
1984	370	30,483	30,853	99
1987	893	60,397	61,290	99
1988	1500	78,644	80,144	98
1989	2,110	54,274	56,384	96
1991	7,930	119,055	126,985	94
1992	750	134,385	135,135	99
1993	7,650	136,488	144,138	95
1994	415	66,337	66,752	99

Appendix 11. Water quality and metals data, 1979-1983.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Wulik River									
Station 02	6/19/81	D&M	113	147					800.0
Station 02	7/16/81	D&M	118	166		7.7	11.7	237	1700.0
Station 02	8/14/81	D&M	103	174		7.4	12.0		2100.0
Station 02	9/6/81	D&M	183			7.6	11.5	291	650.0
Station 02	3/17/82	D&M	200			6.7	9.9	320	
Station 02	6/1/82	D&M				7.1	12.9	111	2700.0
Station 02	7/9/82	D&M				7.8	10.3	219	800.0
Station 02	8/10/82	D&M				8.0	11.2	264	500.0
Station 02	9/12/82	D&M				7.9	12.7	275	600.0
Station 02	10/16/82	D&M				7.9	13.9	230	190.0
Ikalukrok Creek at Dudd Creek									
Station 07	6/18/81	D&M	96	128					
Station 07	9/7/81	D&M	179			7.5	11.3	300	110.0
Station 07	7/9/82	D&M				7.7	9.3	216	175.0
Station 07	8/11/82	D&M				7.8	11.8	268	118.0
Station 07	9/12/82	D&M				7.9	12.8	293	135.0
Station 07	10/17/82	D&M				7.7	12.6	320	45.0
Ikalukrok Creek									
Station 73	3/19/82	D&M				7.9	0.6	1050	
Station 73	7/6/82	EVS							
Station 73	7/6/82	EVS							
Station 73	7/10/82	D&M				7.5	9.6	189	1550.0
Station 73	7/23/82	EVS							
Station 73	7/23/82	EVS							
Station 73	7/31/82	EVS							
Station 73	7/31/82	EVS							
Station 73	8/11/82	D&M				7.7	11.4	264	108.0
Station 73	8/14/82	EVS							
Station 73	8/14/82	EVS							
Station 73	9/13/82	D&M				7.1	13.2	282	100.0
Station 73	10/19/82	D&M				7.7	12.4	230	28.0
Ikalukrok Creek below Red Dog Creek									
Station 08	8/11/81	D&M	146	174		6.9	11.2		140.0
Station 08	9/4/81	D&M	167			7.7	11.0	292	110.0
Station 08	3/21/82	D&M	720	635		7.3	2.3	940	

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 08	5/30/82	D&M	28			6.1	13.7	233	300.0
Station 08	7/8/82	D&M	96		62	7.5	10.0	200	162.0
Station 08	7/8/82	D&M			36				
Station 08	8/12/82	D&M	155			7.6	11.6	499	105.0
Station 08	9/13/82	D&M			72	7.6	13.5	286	100.0
Station 08	9/13/82	D&M	145						100.0
Station 08	10/19/82	D&M	194		114	7.3	11.8	440	15.0
Station 08	10/19/82	D&M							
Station 08	5/28/83	P&N							280.0
Station 08	6/15/83	P&N							89.0
Station 08	6/15/83	P&N							
Station 08	7/10/83	P&N							75.0
Station 08	8/3/83	P&N							80.0
Station 08	9/3/83	P&N							80.0
Station 08	7/18/81	D&M	79	124		7.1	12.1	179	310.0
Ikalukrok Creek above Red Dog Creek									
Station 09	6/17/81	D&M	90	115					110.0
Station 09	7/16/81	D&M	93	123		7.5	11.7	192	230.0
Station 09	8/11/81	D&M	142	163		7.2	11.3		98.0
Station 09	9/4/81	D&M	163			7.5	11.7	285	82.0
Station 09	3/19/82	D&M	290	284		7.1	0.2	430	
Station 09	5/30/82	D&M	34			6.0	13.9	243	170.0
Station 09	7/6/82	EVS	85						245.0
Station 09	7/6/82	EVS	85						245.0
Station 09	7/8/82				30	7.8	9.8	188	132.0
Station 09	7/8/82	EVS	92						132.0
Station 09	7/14/82	EVS							100.0
Station 09	7/21/82	EVS	123						70.0
Station 09	7/22/82	EVS	127						100.0
Station 09	7/23/82	EVS	121						190.0
Station 09	7/23/82	EVS	121						190.0
Station 09	7/24/82	EVS	109						250.0
Station 09	7/26/82	EVS	87						1260.0
Station 09	7/29/82	EVS	105						360.0
Station 09	7/31/82	EVS	106						460.0
Station 09	7/31/82	EVS							
Station 09	8/1/82	EVS	111						365.0
Station 09	8/7/82	EVS	133						135.0
Station 09	8/12/82	D&M				7.8	11.5	480	78.0

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 09	8/12/82	EVS	123						100.0
Station 09	8/12/82	CL	152						78.0
Station 09	8/14/82	EVS	110						770.0
Station 09	8/14/82	EVS							
Station 09	9/13/82	D&M	143		60	7.9	13.5	280	73.0
Station 09	10/19/82	D&M	176		76	7.8	12.9	370	11.0
Station 09	5/28/83	P&N							200.0
Station 09	6/15/83	P&N							67.0
Station 09	7/10/83	P&N							50.0
Station 09	8/3/83	P&N							60.0
Station 09	9/3/83	P&N							60.0
Mainstem Red Dog Creek									
Station 10	6/17/81	D&M	86	159	69.6	6.6			32.0
Station 10	7/17/81	D&M	99	175	66.6	6.5	11.7	233	76.0
Station 10	8/11/81	D&M	156	198	46.0	6.6	10.7		35.0
Station 10	9/4/81	D&M	184	232	87.0	6.4	10.9	341	28.0
Station 10	3/19/82	D&M				6.7	0.3	1090	
Station 10	3/21/82	D&M		876	440.0				
Station 10	5/30/82	D&M	21	24	7.9	6.1	13.5	154	123.0
Station 10	5/30/82	D&M		9	8.8				
Station 10	7/6/82	EVS	93						50.0
Station 10	7/6/82	EVS							
Station 10	7/8/82	D&M	107	158	68.0	7.0	9.2	236	30.0
Station 10	7/8/82	D&M							
Station 10	7/14/82	EVS							25.0
Station 10	7/14/82	EVS							
Station 10	7/21/82	EVS	147						20.0
Station 10	7/21/82	EVS							
Station 10	7/22/82	EVS	137						22.0
Station 10	7/22/82	EVS							
Station 10	7/23/82	EVS	155						26.0
Station 10	7/23/82	EVS							
Station 10	7/23/82	EVS							
Station 10	7/23/82	EVS	140						27.0
Station 10	7/24/82	EVS	151						32.0
Station 10	7/24/82	EVS							
Station 10	7/26/82	EVS							126.0
Station 10	7/29/82	EVS	119						58.0
Station 10	7/29/82	EVS							

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 10	7/30/82	EVS	117						66.0
Station 10	7/30/82	EVS							
Station 10	7/31/82	EVS	98						108.0
Station 10	7/31/82	EVS							
Station 10	8/1/82	EVS	107						80.0
Station 10	8/1/82	EVS							
Station 10	8/7/82	EVS	127						36.0
Station 10	8/12/82	D&M		207	75.0	7.3	11.5	492	27.0
Station 10	8/12/82	EVS	142						32.0
Station 10	8/12/82	EVS							
Station 10	8/14/82	EVS	107						80.0
Station 10	8/14/82	EVS							
Station 10	9/13/82	D&M	144	210	102.0	7.3	13.0	315	27.0
Station 10	9/13/82	D&M							
Station 10	10/19/82	D&M		286	124.0	7.0	10.6	450	3.2
Station 10	10/19/82	D&M	227						3.2
Middle Fork Red Dog Creek				(upstream of North Fork Red D					
Station 20	6/15/78	W&O							
Station 20	5/31/82					5.7	14.2	28	55.0
Station 20	7/6/82	EVS	59						
Station 20	7/6/82	EVS							
Station 20	7/8/82	D&M	64		66	6.6	9.7	181	14.0
Station 20	7/8/82	D&M							
Station 20	7/14/82	EVS							15.0
Station 20	7/14/82	EVS							
Station 20	7/21/82	EVS	109						8.0
Station 20	7/23/82	EVS	110						10.0
Station 20	7/23/82	EVS	103						11.0
Station 20	7/23/82	EVS							
Station 20	7/23/82	EVS							
Station 20	7/24/82	EVS	105						13.0
Station 20	7/24/82	EVS							
Station 20	7/26/82	EVS	107						54.0
Station 20	7/29/82	EVS	81						20.0
Station 20	7/29/82	EVS							
Station 20	7/30/82	EVS	75						22.0
Station 20	7/30/82	EVS							
Station 20	7/31/82	EVS	70						36.0
Station 20	7/31/82	EVS							

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 20	8/1/82	EVS	75						29.0
Station 20	8/1/82	EVS							
Station 20	8/7/82	EVS	90						11.0
Station 20	8/12/82	D&M				6.9	11.0	525	12.0
Station 20	8/12/82	D&M							
Station 20	8/12/82	EVS	93						11.0
Station 20	8/12/82	EVS							
Station 20	8/14/82	EVS	93						76.0
Station 20	8/14/82	EVS							
Station 20	9/13/82	D&M	96		108	6.6	12.1	265	12.0
Station 20	9/13/82	D&M							
Station 20	10/19/82	D&M	145		149	6.8	11.6	390	1.6
Station 20	10/19/82	D&M							
Middle Fork Red Dog Creek									
Station 30	6/17/81	D&M		131					
Station 30	7/17/81	D&M		170		5.9	11.4	237	27.0
Station 30	8/12/81	D&M	129	262	120	5.8	11.6		8.2
Station 30	9/5/81	D&M		287	174	5.8	13.3	374	6.1
Station 30	5/31/82	D&M				5.3	14.2	63	22.0
Station 30	7/6/82	EVS	68						
Station 30	7/6/82	EVS							
Station 30	7/8/82	D&M			95	6.5	10.4	220	8.9
Station 30	7/8/82	D&M							
Station 30	7/23/82	EVS	134						
Station 30	7/23/82	EVS							
Station 30	7/23/82	EVS	134						
Station 30	7/23/82	EVS							
Station 30	7/24/82	EVS	155						
Station 30	7/24/82	EVS							
Station 30	7/26/82	EVS							
Station 30	7/26/82	EVS	85						
Station 30	7/29/82	EVS	84						
Station 30	7/29/82	EVS							
Station 30	7/30/82	EVS	94						
Station 30	7/30/82	EVS							
Station 30	7/31/82	EVS	88						
Station 30	7/31/82	EVS							
Station 30	8/1/82	EVS	77						
Station 30	8/1/82	EVS							

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 30	8/13/82	D&M				6.2	11.1	276	14.0
Station 30	8/13/82	D&M							
Station 30	8/14/82	EVS	90						
Station 30	8/14/82	EVS							
Station 30	9/13/82	D&M			196	6.5	11.2	383	5.6
Station 30	9/13/82	D&M							
Station 30	10/19/82	D&M	201		324	5.8	11.2	650	1.3
Station 30	10/19/82	D&M							
Middle Fork Red Dog Creek									
Station 140	7/6/82	EVS	68			6.7			
Station 140	7/6/82	EVS							
Station 140	7/23/82	EVS	134			6.1			
Station 140	7/23/82	EVS							
Station 140	7/23/82	EVS	134			5.9			
Station 140	7/23/82	EVS							
Station 140	7/24/82	EVS	155			5.8			
Station 140	7/24/82	EVS							
Station 140	7/26/82	EVS	85			6.1			
Station 140	7/26/82	EVS							
Station 140	7/29/82	EVS	84			6.6			
Station 140	7/29/82	EVS							
Station 140	7/30/82	EVS	94			6.5			
Station 140	7/30/82	EVS							
Station 140	7/31/82	EVS	88			6.7			
Station 140	7/31/82	EVS							
Station 140	8/1/82	EVS	77			6.5			
Station 140	8/1/82	EVS							
Station 140	8/14/82	EVS	90			6.3			
Station 140	8/14/82	EVS							
North Fork Red Dog Creek									
Station 12	6/17/81	D&M		187					
Station 12	7/17/81	D&M		183		7.0	11.9	275	54.0
Station 12	8/12/81	D&M	94	210		7.0	11.2		34.0
Station 12	9/4/81	D&M				7.7	10.9	373	17.0
Station 12	5/31/82	D&M	39			6.0	14.4	44	66.0
Station 12	7/7/82	D&M			50.0	7.5	11.3	255	20.0
Station 12	7/23/82	EVS	188						16.0

Appendix 11, continued.

Water Quality Data, before mining.									
Station	DATE	Source	hard.	TDS	SO4	pH	D.O.	Cond.	Flow
			mg/L	mg/L			mg/L		cfs
Station 12	7/23/82	EVS							
Station 12	7/23/82	EVS	180						16.0
Station 12	7/23/82	EVS							
Station 12	7/24/82	EVS	180						18.0
Station 12	7/24/82	EVS							
Station 12	7/26/82	EVS	70						74.0
Station 12	7/29/82	EVS	98						34.0
Station 12	7/29/82	EVS							
Station 12	7/30/82	EVS	49						54.0
Station 12	7/30/82	EVS							
Station 12	7/31/82	EVS	58						76.0
Station 12	7/31/82	EVS							
Station 12	8/1/82	EVS	65						53.0
Station 12	8/1/82	EVS							
Station 12	8/7/82	EVS	94						19.0
Station 12	8/12/82	D&M	201			7.8	11.2	591	15.0
Station 12	8/12/82	EVS	155						16.0
Station 12	8/12/82	EVS							
Station 12	8/14/82	EVS	85						92.0
Station 12	8/14/82	EVS							
Station 12	9/13/82	D&M	179		87.5	7.8	12.6	352	14.0
Station 12	10/19/82	D&M	217		98.0	7.5	9.5	450	8.1

Appendix 11, continued.

Metals Concentrations before Mine Development													
Station	DATE	Source	Report*		Al		Cd		Cu		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L
Wulik River													
Station 02	6/19/81	D&M	D				0.002			<	0.000		0.02
Station 02	7/16/81	D&M	D				0.004				0.000		0.00
Station 02	8/14/81	D&M	D			<	0.002				0.000		0.00
Station 02	9/6/81	D&M	D				0.008				0.012		0.13
Station 02	3/17/82	D&M	D				0.006				0.001		0.02
Station 02	6/1/82	D&M	T				0.000				0.001		0.00
Station 02	7/9/82	D&M	T				0.009				0.001		0.01
Station 02	8/10/82	D&M	T				0.002				0.001		0.01
Station 02	9/12/82	D&M	T				0.002				0.001		0.01
Station 02	10/16/82	D&M	T				0.002				0.001		0.01
Ikalukrok Creek at Dudd Creek													
Station 07	6/18/81	D&M	D				0.007				0.001		0.34
Station 07	9/7/81	D&M	D				0.012				0.004		0.29
Station 07	7/9/82	D&M	T				0.010				0.001		0.21
Station 07	8/11/82	D&M	T				0.004				0.001		0.34
Station 07	9/12/82	D&M	T				0.008				0.001		0.48
Station 07	10/17/82	D&M	T			<	0.002				0.001		0.28
Ikalukrok Creek													
Station 73	3/19/82	D&M	D				0.004				0.009		3.00
Station 73	7/6/82	EVS	T				0.006				0.017		0.86
Station 73	7/6/82	EVS	D				0.006				0.007		0.71
Station 73	7/10/82	D&M	T				0.012				0.000		0.35
Station 73	7/23/82	EVS	T			<	0.025			<	0.080		1.18
Station 73	7/23/82	EVS	D			<	0.025			<	0.080		1.10
Station 73	7/31/82	EVS	T			<	0.025			<	0.080		1.44
Station 73	7/31/82	EVS	D				0.025			<	0.080		1.42
Station 73	8/11/82	D&M	T				0.007				0.001		0.68
Station 73	8/14/82	EVS	T				0.012				0.045		1.80
Station 73	8/14/82	EVS	D				0.011				0.041		1.74
Station 73	9/13/82	D&M	T				0.011				0.002		0.86
Station 73	10/19/82	D&M	T				0.006				0.001		0.70
D = dissolved metals, T = total metals, TR = total recoverable metals.													

Appendix 11, continued.

Metals Concentrations before Mine Development													
Station	DATE	Source	Report*		Al		Cd		Cu		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L
Ikalukrok Creek below Red Dog Creek													
Station 08	8/11/81	D&M	D				0.007				0.000		0.77
Station 08	9/4/81	D&M	D				0.008				0.010		0.76
Station 08	3/21/82	D&M	D				0.034				0.001		0.48
Station 08	5/30/82	D&M	T		0.02		0.001	<	0.002		0.009		0.17
Station 08	7/8/82	D&M	T		0.02		0.016	<	0.002		0.002		0.71
Station 08	7/8/82	D&M	D				0.014				0.001		0.72
Station 08	8/12/82	D&M	T		0.14		0.025		0.022		0.004		1.66
Station 08	9/13/82	D&M	D.				0.019				0.001		2.25
Station 08	9/13/82	D&M	T		0.17		0.020		0.005		0.028		1.74
Station 08	10/19/82	D&M	T		0.02		0.038		0.003		0.002		4.20
Station 08	10/19/82	D&M	D				0.034				0.002		4.10
Station 08	5/28/83	P&N	T		0.14		0.004		0.003		0.006		0.38
Station 08	6/15/83	P&N	D				0.002				0.005		0.41
Station 08	6/15/83	P&N	T		0.03		0.004		0.005		0.014		0.44
Station 08	7/10/83	P&N	T		0.03		0.007		0.002		0.002		0.30
Station 08	8/3/83	P&N	T		0.04		0.004		0.001		0.010		0.26
Station 08	9/3/83	P&N	T		0.08		0.014		0.005		0.026		0.94
Station 08	7/18/81	D&M	D				0.010				0.013		0.97
Ikalukrok Creek above Red Dog Creek													
Station 09	6/17/81	D&M	D			<	0.002				0.002		0.095
Station 09	7/16/81	D&M	D				0.004			<	0.000		0.014
Station 09	8/11/81	D&M	D				0.005			<	0.000		0.018
Station 09	9/4/81	D&M	D				0.007				0.001		0.006
Station 09	3/19/82	D&M	D				0.002				0.001		0.143
Station 09	5/30/82	D&M	T		0.02	<	0.000		0.002		0.001		0.026
Station 09	7/6/82	EVS	T				0.001				0.004		2.300
Station 09	7/6/82	EVS	D			<	0.001				0.001	<	0.015
Station 09	7/8/82												
Station 09	7/8/82	EVS	T		0.02		0.003		0.004	<	0.000		0.013
Station 09	7/14/82	EVS											
Station 09	7/21/82	EVS											
Station 09	7/22/82	EVS											
Station 09	7/23/82	EVS	T			<	0.025			<	0.080		0.023
Station 09	7/23/82	EVS	D			<	0.025			<	0.080		0.029
Station 09	7/24/82	EVS											
Station 09	7/26/82	EVS											
Station 09	7/29/82	EVS											
Station 09	7/31/82	EVS	T			<	0.025			<	0.080		0.028

Appendix 11, continued.

Metals Concentrations before Mine Development													
Station	DATE	Source	Report*		Al		Cd		Cu		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L
Station 09	7/31/82	EVS	D			<	0.025			<	0.080		0.023
Station 09	8/1/82	EVS											
Station 09	8/7/82	EVS											
Station 09	8/12/82	D&M	D				0.020				0.002		1.660
Station 09	8/12/82	EVS											
Station 09	8/12/82	CL	T		0.13		0.002		0.008		0.000		0.023
Station 09	8/14/82	EVS	T			<	0.001				0.008		0.075
Station 09	8/14/82	EVS	D			<	0.001			<	0.080		0.054
Station 09	9/13/82	D&M	T		0.23		0.002		0.004	<	0.000		0.025
Station 09	10/19/82	D&M	T		0.02		0.002		0.009		0.001		0.032
Station 09	5/28/83	P&N	T		0.06		0.000		0.012		0.002		0.032
Station 09	6/15/83	P&N	T		0.03		0.001		0.002		0.001		0.031
Station 09	7/10/83	P&N	T		0.03	<	0.001		0.005		0.000		0.017
Station 09	8/3/83	P&N	T		0.08	<	0.001		0.001		0.001		0.012
Station 09	9/3/83	P&N	T		0.06		0.006		0.008		0.002		0.020
Mainstem Red Dog Creek													
Station 10	6/17/81	D&M	D				0.022		0.004		0.001		3.90
Station 10	7/17/81	D&M	D				0.025		0.005		0.007		3.44
Station 10	8/11/81	D&M	D				0.026		0.005		0.001		3.47
Station 10	9/4/81	D&M	D				0.038		0.004		0.001		4.03
Station 10	3/19/82	D&M	T	<	0.02		0.095		0.009		0.004		13.00
Station 10	3/21/82	D&M	D	<	0.02		0.098		0.002		0.001		9.20
Station 10	5/30/82	D&M	T				0.002		0.005		0.028		0.66
Station 10	5/30/82	D&M	D	<	0.02		0.002		0.003		0.012		0.57
Station 10	7/6/82	EVS	T		1.19		0.026				0.065		3.00
Station 10	7/6/82	EVS	D		0.05		0.025				0.065		2.65
Station 10	7/8/82	D&M	T	<	0.02		0.024	<	0.002		0.008		3.32
Station 10	7/8/82	D&M	D	<	0.02		0.023	<	0.002		0.002		3.23
Station 10	7/14/82	EVS	T		0.37		0.029			<	0.080		3.71
Station 10	7/14/82	EVS	D	<	0.15		0.027			<	0.080		3.70
Station 10	7/21/82	EVS	T	<	0.15		0.031			<	0.080		4.18
Station 10	7/21/82	EVS	D.	<	0.15		0.032			<	0.080		4.11
Station 10	7/22/82	EVS	T		0.50		0.035			<	0.080		4.68
Station 10	7/22/82	EVS	D		0.62		0.035			<	0.080		4.50
Station 10	7/23/82	EVS	T	<	0.15		0.034			<	0.080		4.28
Station 10	7/23/82	EVS	D	<	0.15		0.034			<	0.080		4.04
Station 10	7/23/82	EVS	D	<	0.15		0.040			<	0.080		4.54
Station 10	7/23/82	EVS	T		0.54		0.038			<	0.080		4.80
Station 10	7/24/82	EVS	T		0.19		0.035			<	0.080		4.73

Appendix 11, continued.

Metals Concentrations before Mine Development											
Station	DATE	Source	Report*		Al		Cd	Cu		Pb	Zn
					mg/L		mg/L	mg/L		mg/L	mg/L
Station 10	7/24/82	EVS	D	<	0.15		0.036		<	0.080	4.76
Station 10	7/26/82	EVS	D		0.38	<	0.025		<	0.080	2.45
Station 10	7/29/82	EVS	T		0.42		0.028		<	0.080	3.68
Station 10	7/29/82	EVS	D	<	0.15		0.027		<	0.080	3.50
Station 10	7/30/82	EVS	T		0.63	<	0.025			0.100	2.87
Station 10	7/30/82	EVS	D		0.48	<	0.025		<	0.080	2.59
Station 10	7/31/82	EVS	T		0.64	<	0.025		<	0.080	2.81
Station 10	7/31/82	EVS	D	<	0.15	<	0.025		<	0.080	2.73
Station 10	8/1/82	EVS	T		0.55		0.026		<	0.080	3.29
Station 10	8/1/82	EVS	D	<	0.15		0.026		<	0.080	3.29
Station 10	8/7/82	EVS	T		0.32		0.036		<	0.080	4.29
Station 10	8/12/82	D&M	D		0.05		0.034	0.019		0.002	4.23
Station 10	8/12/82	EVS	T	<	0.15		0.041		<	0.080	5.06
Station 10	8/12/82	EVS	D	<	0.15	<	0.025		<	0.080	2.06
Station 10	8/14/82	EVS	T		0.61		0.020			0.060	2.67
Station 10	8/14/82	EVS	D		0.18		0.017			0.056	2.50
Station 10	9/13/82	D&M	T		1.01		0.038	0.002		0.083	3.81
Station 10	9/13/82	D&M	D		0.21		0.034	0.002		0.002	3.46
Station 10	10/19/82	D&M	D	<	0.02		0.041	0.007		0.001	4.30
Station 10	10/19/82	D&M	T		0.04		0.044	0.016		0.002	4.58
Middle Fork Red Dog Creek											
Station 20	6/15/78	W&O	T				0.020			0.084	2.63
Station 20	5/31/82										
Station 20	7/6/82	EVS	T		0.91		0.055			0.130	8.33
Station 20	7/6/82	EVS	D		0.08		0.050			0.053	7.54
Station 20	7/8/82	D&M	T		0.07		0.078	0.010		0.074	9.40
Station 20	7/8/82	D&M	D				0.077			0.007	8.90
Station 20	7/14/82	EVS	T		0.67		0.099			0.150	15.00
Station 20	7/14/82	EVS	D		0.23		0.110			0.110	13.70
Station 20	7/21/82	EVS	D	<	0.15		0.110		<	0.080	16.20
Station 20	7/23/82	EVS	T		0.83		0.110			0.360	15.60
Station 20	7/23/82	EVS	D	<	0.15		0.100		<	0.080	15.10
Station 20	7/23/82	EVS	T		0.86		0.099			0.350	13.40
Station 20	7/23/82	EVS	D	<	0.15		0.095		<	0.080	12.70
Station 20	7/24/82	EVS	T		0.86		0.094			0.360	13.40
Station 20	7/24/82	EVS	D	<	0.15		0.092			0.099	12.90
Station 20	7/26/82	EVS	D		0.24		0.046			0.093	5.88
Station 20	7/29/82	EVS	T		0.68		0.078			0.200	10.40
Station 20	7/29/82	EVS	D	<	0.15		0.078		<	0.080	10.20

Appendix 11, continued.

Metals Concentrations before Mine Development													
Station	DATE	Source	Report*		Al		Cd		Cu		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L
Station 20	7/30/82	EVS	T		0.63		0.064				0.290		8.36
Station 20	7/30/82	EVS	D		0.16		0.062				0.110		8.34
Station 20	7/31/82	EVS	T		0.41		0.060				0.180		8.12
Station 20	7/31/82	EVS	D	<	0.15		0.059			<	0.080		8.00
Station 20	8/1/82	EVS	T		0.48		0.068				0.170		8.79
Station 20	8/1/82	EVS	D	<	0.15		0.069			<	0.080		8.67
Station 20	8/7/82	EVS	T		0.62		0.120				0.220		14.50
Station 20	8/12/82	D&M	T				0.119		0.025		0.266		13.70
Station 20	8/12/82	D&M	T				0.064				0.188		7.25
Station 20	8/12/82	EVS	T		0.54		0.120				0.310		15.20
Station 20	8/12/82	EVS	D		0.51		0.057				0.180		7.51
Station 20	8/14/82	EVS	T		0.59		0.043				0.170		5.93
Station 20	8/14/82	EVS	D		0.21		0.047				0.140		5.90
Station 20	9/13/82	D&M	T		0.52		0.107		0.008		0.097		9.91
Station 20	9/13/82	D&M	D				0.104				0.002		9.82
Station 20	10/19/82	D&M	T		0.05		0.140		0.005		0.021		16.50
Station 20	10/19/82	D&M	D				0.137				0.017		16.40
Middle Fork Red Dog Creek													
Station 30	6/17/81	D&M	D				0.088				0.005		12.40
Station 30	7/17/81	D&M	D				0.110				0.248		12.60
Station 30	8/12/81	D&M	D				0.184				0.009		23.60
Station 30	9/5/81	D&M	D				0.182		0.007		0.003		12.90
Station 30	5/31/82	D&M											
Station 30	7/6/82	EVS	T		1.60		0.091				0.240		13.40
Station 30	7/6/82	EVS	D		0.44		0.084				0.230		12.40
Station 30	7/8/82	D&M	T		0.30		0.115		0..0130		0.257		15.90
Station 30	7/8/82	D&M	D				0.114				0.169		15.50
Station 30	7/23/82	EVS	T		2.31		0.210				1.110		28.50
Station 30	7/23/82	EVS	D		1.50		0.190				0.870		27.40
Station 30	7/23/82	EVS	T		1.27		0.190				0.650		26.70
Station 30	7/23/82	EVS	D		0.31		0.190				0.640		26.10
Station 30	7/24/82	EVS	T		1.34		0.180				0.990		25.80
Station 30	7/24/82	EVS	D		0.94		0.940				0.880		24.30
Station 30	7/26/82	EVS	T		0.17		0.078				0.110		10.50
Station 30	7/26/82	EVS	D	<	0.15		0.075			<	0.080		10.40
Station 30	7/29/82	EVS	T		1.02		0.140				0.350		18.60
Station 30	7/29/82	EVS	D		0.60		0.140				0.350		17.90
Station 30	7/30/82	EVS	T		0.64		0.120				0.400		16.70
Station 30	7/30/82	EVS	D		0.50		0.130				0.190		16.60

Appendix 11, continued.

Metals Concentrations before Mine Development													
Station	DATE	Source	Report*		Al		Cd		Cu			Pb	Zn
					mg/L		mg/L		mg/L			mg/L	mg/L
Station 30	7/31/82	EVS	T		0.76		0.110					0.320	14.20
Station 30	7/31/82	EVS	D		0.53		0.110					0.340	14.00
Station 30	8/1/82	EVS	T		0.69		0.110					0.310	14.80
Station 30	8/1/82	EVS	D		0.48		0.110					0.310	14.60
Station 30	8/13/82	D&M	T		0.40		0.141		0.028			0.253	15.80
Station 30	8/13/82	D&M	D				0.137					0.007	15.10
Station 30	8/14/82	EVS	T		0.95		0.075					0.270	9.12
Station 30	8/14/82	EVS	D		0.24		0.071					0.190	9.06
Station 30	9/13/82	D&M	T		1.25		0.213		0.019			0.278	22.40
Station 30	9/13/82	D&M	D				0.210					0.014	22.20
Station 30	10/19/82	D&M	T		0.72		0.481		0.007			0.462	49.80
Station 30	10/19/82	D&M	D				0.445					0.412	49.20
Middle Fork Red Dog Creek													
Station 140	7/6/82	EVS	T		1.60		0.091					0.240	13.40
Station 140	7/6/82	EVS	D		0.44		0.084					0.230	12.40
Station 140	7/23/82	EVS	T		2.31		0.210					1.110	28.50
Station 140	7/23/82	EVS	D		1.50		0.190					0.870	27.40
Station 140	7/23/82	EVS	T		1.27		0.190					0.650	26.70
Station 140	7/23/82	EVS	D		0.81		0.190					0.640	26.10
Station 140	7/24/82	EVS	T		1.34		0.180					0.990	25.80
Station 140	7/24/82	EVS	D		0.94		0.170					0.880	24.30
Station 140	7/26/82	EVS	T		0.17		0.078					0.110	10.50
Station 140	7/26/82	EVS	D	<	0.15		0.075				<	0.080	10.40
Station 140	7/29/82	EVS	T		1.02		0.140					0.350	18.60
Station 140	7/29/82	EVS	D		0.60		0.140					0.350	17.90
Station 140	7/30/82	EVS	T		0.64		0.120					0.400	16.70
Station 140	7/30/82	EVS	D		0.50		0.130					0.190	16.60
Station 140	7/31/82	EVS	T		0.76		0.110					0.320	14.20
Station 140	7/31/82	EVS	D		0.53		0.110					0.340	14.00
Station 140	8/1/82	EVS	T		0.69		0.110					0.310	14.80
Station 140	8/1/82	EVS	D		0.48		0.110					0.310	14.60
Station 140	8/14/82	EVS	T		0.95		0.075					0.270	9.12
Station 140	8/14/82	EVS	D		0.24		0.071					0.190	9.06
North Fork Red Dog Creek													
Station 12	6/17/81	D&M	D				0.005				<	0.000	0.02
Station 12	7/17/81	D&M	D				0.003				<	0.000	0.04
Station 12	8/12/81	D&M	D				0.009				<	0.000	0.05
Station 12	9/4/81	D&M	D				0.002					0.000	0.01

Appendix 11, continued.

Metals Concentrations before Mine Development												
Station	DATE	Source	Report*		Al		Cd		Cu		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L
Station 12	5/31/82	D&M	T	<	0.02	<	0.000		0.003		0.001		0.08
Station 12	7/7/82	D&M	T	<	0.02		0.002		0.002		0.001		0.01
Station 12	7/23/82	EVS	T		0.21	<	0.025			<	0.080		0.07
Station 12	7/23/82	EVS	D	<	0.15	<	0.025			<	0.080		0.02
Station 12	7/23/82	EVS	T		0.35	<	0.025			<	0.080		0.37
Station 12	7/23/82	EVS	D	<	0.15	<	0.025			<	0.080		0.15
Station 12	7/24/82	EVS	T		0.29	<	0.025			<	0.080		0.05
Station 12	7/24/82	EVS	D	<	0.15	<	0.025			<	0.080	<	0.02
Station 12	7/26/82	EVS	D	<	0.15	<	0.025			<	0.080		0.05
Station 12	7/29/82	EVS	T		0.32	<	0.025			<	0.080		0.02
Station 12	7/29/82	EVS	D	<	0.15	<	0.025			<	0.080	<	0.02
Station 12	7/30/82	EVS	T		0.55	<	0.025			<	0.080		0.02
Station 12	7/30/82	EVS	D		0.16	<	0.025			<	0.080	<	0.02
Station 12	7/31/82	EVS	T		0.26	<	0.025			<	0.080	<	0.02
Station 12	7/31/82	EVS	D	<	0.15	<	0.025			<	0.080		0.02
Station 12	8/1/82	EVS	T	<	0.15	<	0.025			<	0.080		0.02
Station 12	8/1/82	EVS	D	<	0.15	<	0.025			<	0.080	<	0.02
Station 12	8/7/82	EVS	T		0.41	<	0.025			<	0.080	<	0.02
Station 12	8/12/82	D&M	T		0.13	<	0.002		0.013		0.002		0.02
Station 12	8/12/82	EVS	T	<	0.15	<	0.025			<	0.080		0.13
Station 12	8/12/82	EVS	D	<	0.15	<	0.025			<	0.080		0.03
Station 12	8/14/82	EVS	T		0.34	<	0.001			<	0.008		0.11
Station 12	8/14/82	EVS	D	<	0.15	<	0.001			<	0.001		0.06
Station 12	9/13/82	D&M	T		0.31		0.002		0.005		0.001		0.01
Station 12	10/19/82	D&M	T	<	0.02		0.002		0.006		0.001		0.02

Appendix 11, continued.

DATE	REF.		Report		Cd		Pb		Zn
					mg/L		mg/L		mg/L
Sulfur Creek, Station 34									
7/15/81	D&M		D		0.008		0.0719		0.188
8/11/81	D&M		D		0.005		0.2650		0.970
9/4/82	D&M		D		0.007		0.0481		1.167
Shelly Creek, Station 38									
9/4/81	D&M		D		0.013		0.0037		0.694
7/7/82	D&M		T		0.019		0.0220		0.613
8/13/82	D&M		T		0.006		0.0099		0.340
9/13/82	D&M		T		0.021		0.0256		0.910
10/20/82	D&M		T		0.028		0.0801		2.310
Connie Creek, Station 40									
9/4/81	D&M		D.		0.013		0.0041		0.222
3/23/82	D&M		D		0.002		0.0021		0.002
7/7/82	D&M		T		0.012		0.0181		0.201
8/13/82	D&M		T		0.011		0.0213		0.761
9/13/82	D&M		T		0.005		0.0158		0.756
10/20/82	D&M		T		0.021		0.0267		2.420
Rachael Creek, Station 47									
7/7/82	D&M		T		0.008		0.0006		0.061
8/13/82	D&M		T		0.002		0.0034		0.079
9/13/82	D&M		T		0.002		0.0005		0.142
10/20/82	D&M		T		0.002		0.0010		0.100
Middle Fork Red Dog Creek, Station 45									
6/15/81	D&M		D		0.011		0.0010		1.700
8/11/81	D&M		D		0.008		0.0032		0.284
9/4/81	D&M		D		0.006		0.0010		0.213
7/6/82	EVS		T	<	0.001		0.0020		0.053
7/6/82	EVS		D	<	0.001		0.0020		0.039
7/7/82	D&M		T		0.010		0.0006		0.045
7/23/82	EVS		T	<	0.025	<	0.0800		0.370
7/23/82	EVS		D	<	0.025	<	0.0800		0.089
7/23/82	EVS		T	<	0.025	<	0.0800		0.069
7/23/82	EVS		D	<	0.025	<	0.0800		0.036
7/24/82	EVS		T	<	0.025	<	0.0800		0.051

Appendix 11, concluded.

DATE	REF.		Report		Cd		Pb		Zn
					mg/L		mg/L		mg/L
Middle Fork Red Dog Creek, Station 45, continued									
7/24/82	EVS		D	<	0.025	<	0.0800		0.049
7/26/82	EVS		D	<	0.025	<	0.0800		0.120
7/29/82	EVS		T	<	0.025	<	0.0800		0.088
7/29/82	EVS		D	<	0.025	<	0.0800		0.058
7/30/82	EVS		T	<	0.025	<	0.0800		0.088
7/30/82	EVS		D	<	0.025	<	0.0800		0.055
7/31/82	EVS		T	<	0.025	<	0.0800		0.078
7/31/82	EVS		D	<	0.025	<	0.0800		0.055
8/1/82	EVS		T	<	0.025	<	0.0800		0.086
8/1/82	EVS		D	<	0.025	<	0.0800		0.066
8/13/82	D&M		T		0.004		0.0008		0.028
8/14/82	EVS		T	<	0.001		0.0040		0.200
8/14/82	EVS		D	<	0.001	<	0.0010		0.150
9/13/82	D&M		T		0.002		0.0009		0.075
10/20/82	D&M		T		0.002		0.0004		0.034
9/4/81	D&M		D		0.021		0.0152		0.682

Appendix 12. Water quality and metals data, 1991-1995.

Ikalukrok Creek: Station 8 and Station 73													
Water Quality													
Station	Date	Reference	Hard	TDS	SO4		TSS	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
			mg/L	mg/L	mg/L		mg/L		°C	mg/L	NTU		
Station 08	8/3/91	Cominco	143	174		<	5	6.8	11.2	10.6	0.6	576	
Station 08	8/8/91	Cominco	252	384		<	5	7.0	6.6	11.1	0.9	320	
Station 08	8/9/91	Cominco	269	406			5	7.0	5.7	12.9	1.3	497	
Station 08	8/13/91	Cominco	179	257			6	7.5	10.0	13.6	1.4		
Station 08	8/16/91	Cominco	164	299		<	5	7.4	11.5	10.3			
Station 08	8/19/91	Cominco	200	280		<	5	7.1	10.7	12.8			
Station 08	8/24/91	Cominco	270	369		<	5	7.4	5.8	13.1	0.4	310	
Station 08	8/27/91	Cominco	174	221		<	5	7.2	5.1	13.2	0.7	215	
Station 08	8/29/91	Cominco	179	232		<	5	7.0	4.3	12.0	1.3	215	
Station 08	10/2/91	Cominco	174	261		<	5	7.1	2	13	0.4	440	
Station 08	10/5/91	Cominco	181	251		<	5	7.3	-0.2	15**	0.7	376	
Station 08	5/27/92	Cominco	277	429		<	5	5.7	2.6	4	0.9	0.844	
Station 08	6/10/92	Cominco	53.1	64			26	7.4	0.2	7.9	2.9	0.110	
Station 08	6/16/92	Cominco	54.3	73			56	6.2	2.4	10.6	20	0.118	
Station 08	6/24/92	Cominco	77	95		<	5	7.5	7.6	16.2**	2.7	0.163	
Station 08	7/2/92	Cominco	107	134		<	5	7.2	9.6	8.9	1.30	0.202	
Station 08	7/2/92	Cominco	107	134		<	5	7.2	9.6	8.9			1.30
Station 08	7/8/92	Cominco	126	165		<	5	7.4	12.3	10.2	0.45	0.268	
Station 08	7/8/92	Cominco	126	165		<	5	7.4	12.3	10.2			0.45
Station 08	7/15/92	Cominco	168	209		<	5	7.4	8.7	8.3	0.34	0.351	
Station 08	7/15/92	Cominco	168	209		<	5	7.4	8.7	8.3			0.34
Station 08	7/18/92	Cominco	154	201		<	5	7.9	11.2	7.6	0.47	0.331	
Station 08	7/18/92	Cominco	154	201		<	5	7.9	11.2	7.6			0.47
Station 08	7/22/92	Cominco	224	311		<	5	7.8	9.3	8.6	0.35	0.440	
Station 08	7/22/92	Cominco	224	311		<	5	7.8	9.3	8.6			0.35
Station 08	7/25/92	Cominco	241	337		<	5	7.2	11.2	12.1	---	0.485	
Station 08	7/25/92	Cominco	241	337		<	5	7.2	11.2	12.1			---
Station 08	7/29/92	Cominco	392	548		<	5	7.4	13.6	9.2			0.60
Station 08	7/29/92	Cominco	392	548		<	5	7.4	13.6	9.2	0.60	0.783	
Station 08	9/2/92	Cominco	162	201		<	5	7.0	5.2	13.2	0.53	0.330	
Station 08	9/5/92	Cominco	237	312		<	5	8.2	4.7	7.3	0.35	0.446	
Station 08	9/9/92	Cominco	333	431		<	5	7.6	1.4	6.5	0.27	0.555	
Station 08	9/12/92	Cominco	273	376		<	5	8.2	0.6		0.3	0.584	
Station 08	9/16/92	Cominco	344	461		<	5	8.2	0.3		0.5	0.667	
Station 08	9/22/92	Cominco	389	540		<	5	8.1	0	12.8	0.25	0.630	
Station 08	9/26/92	Cominco	356	500		<	5	7.5	0	14.8**	0.46	0.330	
Station 08	9/30/92	Cominco	476	699		<	5	7.6	0	10.8	0.3	0.980	
Station 08	10/3/92	Cominco	798	1040		<	5	7.5	-0.5	12.0	0.24	1.350	
Station 08	10/10/92	Cominco	472	623		<	5	7.7	0	11.5	0.38	0.890	
Station 08	10/15/92	Cominco	262	328		<	5	7.4	0.1	10.4	0.33	0.510	
Station 73	6/3/93	Cominco	55.9	68			18	7.4	3	20	9.2	50	
Station 73	6/10/93	Cominco	78.3	101		<	5	7.7	7	16	16	127	
Station 73	6/20/93	Cominco	92.5	98		<	5	7.8	11	8.4	0.9	178	
Station 73	6/24/93	Cominco	126	161		<	5	7.1	11	9.6	0.8	250	

Appendix 12, continued.

Ikalukrok Creek: Station 8 and Station 73													
Water Quality													
Station	Date	Reference	Hard	TDS	SO4		TSS	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
			mg/L	mg/L	mg/L		mg/L		°C	mg/L	NTU		
Station 73	6/29/93	Cominco	135	144		<	5	6.7	10	9.5	0.5	267	
Station 73	7/9/93	Cominco	101	125			8	7.5	6	13.4	2	223	
Station 73	7/18/93	Cominco	127	176		<	5	7.7	15	11.8	0.4	270	
Station 73	7/24/93	Cominco	159	182		<	5	8.2	13.5	10.2	0.2	295	
Station 73	8/1/93	Cominco		187		<	5	7.8	6.7	11.2	0.56	420	
Station 73	8/12/93	Cominco		181		<	5	7.4	5		0.24	285	
Station 73	8/21/93	Cominco		171		<	5	8.1	11		0.64	262	
Station 73	8/28/93	Cominco		229		<	5	8	7				
Station 73	9/4/93	Cominco	191	205		<	5	7.9	4				
Station 73	9/8/93	Cominco	168	200		<	5	8	4				
Station 73	9/12/93	Cominco	172	213		<	5	7.7	5.5	11.1	0.38	366	131.5
Station 73	9/20/93	Cominco		188		<	5	7.4	4.5	12.5	0.3	327	248.3
Station 73	10/10/93	Cominco	183	204		<	5	7.8	2	8.1	1.1	361	
Station 73	5/18/94	Cominco	43.2	57	19		16	7.4	2	12.3	5.4		1083
Station 73	5/22/94	Cominco	54.3	72	21		22	7.4	1	12.8	8.7		1145
Station 73	6/2/94	Cominco	98.6	136	50	<	5	7.7	4	12.4	1.1	286	218
Station 73	6/9/94	Cominco	83.2	96	34	<	5	7.2	7.3	11.5	1.5	177	571
Station 73	6/22/94	Cominco	148	181	68	<	5	8.2	6.5	9.1	0.5	143	106
Station 73	6/26/94	Cominco	131	153	53	<	5	7.9	8.4	9.5	0.7	247	135
Station 73	6/28/94	Cominco	135	168	59	<	5	8.1	2.9	7.5	0.9	280	120
Station 73	7/3/94	Cominco	117	133	40	<	5	8	3.9	9.5	1.1	220	179
Station 73	7/13/94	Cominco	111	143	40	<	5	7.2	4	10.4	3	197	575
Station 73	7/19/94	Cominco	116	142	34	<	5	7.9	7.9	9.4	0.8	222	348
Station 73	7/27/94	Cominco	223	144	42	<	5	7.9	7.7	9.9	1.3	241	361
Station 73	8/5/94	Cominco	134	166	58	<	5	7.8	7.4	9.9	9.9	210	
Station 73	8/11/94	Cominco	98.1	109	27		41	7.7	4.3	12.2	15	197	
Station 73	8/15/94	Cominco	103	123	41		17	7.6	2.5	12.2	0.6	209	
Station 73	8/23/94	Cominco	121	166	57		6	7.4	4	12.4	4.3	253	
Station 73	9/1/94	Cominco	175	252	110		8	7.7	4	11.8	2.4	250	
Station 73	9/9/94	Cominco	216	307	140	<	5	7.7	4	11.1	2.3	431	
Station 73	9/13/94	Cominco	274	377	200	<	5	7.6	3.9	8.6	2.6	518	
Station 73	9/22/94	Cominco	304	386	190	<	5	7.7	1	11.6	1.5	548	
Station 73	9/25/94	Cominco	430	557	180	<	5	7.7	1	12.6	1	642	
Station 73	10/2/94	Cominco	498	658	400	<	5	7.7	1	13.2	1	690	
Station 73	10/17/94	Cominco	391	627	290	<	5	7.6	0	12.8	0.8	790	
Station 08	5/20/95	Cominco	121	159	93			7.2	2				
Station 08	5/25/95	Cominco	82.5	122	60			7.1	3				
Station 08	5/30/95	Cominco	100	130	64			7.3					
Station 73	6/3/95	Cominco	120	157	79		7	7.6	4		2.2	261	
Station 73	6/4/95	Cominco	183	260	130		5	7.2	1	12.7	2.7	372	
Station 73	6/11/95	Cominco		164	96	<	5		3	13	1.85	267	
Station 73	6/13/95	Cominco		254		<	5						
Station 73	6/18/95	Cominco		190		<	5	7.7	4	14.5	2.48	289	

Appendix 12, continued.

Ikalukrok Creek: Station 8 and Station 73													
Water Quality													
Station	Date	Reference	Hard	TDS	SO4		TSS	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
			mg/L	mg/L	mg/L		mg/L		°C	mg/L	NTU		
Station 73	6/25/95	Cominco	196	264				7.9	5.5	14.5	1.18	420	
Station 73	6/27/95	Cominco						7.8	6.1	12.9	1.21	442	
Station 73	6/29/95	Cominco											
Station 8	7/2/95	Cominco	99.2	118	42	<	5	7.8	7				
Station 8	7/10/95	Cominco	292	414	250			7.7	7				
Station 8	7/16/95	Cominco	129	681	400			7.7	10				
Station 8	8/6/95	Cominco	666	906	590			7.7	9.6				
Station 8	8/16/95	Cominco	184	209	100			7.9	8.7				
Station 8	8/22/95	Cominco	609	877	560			7.9	10.6				

Appendix 12, continued.

Ikalukrok Creek: Station 8 and Station 73																	
Station	Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn
					mg/L		mg/L		mg/L		mg/L		mg/L		mg/L
Station 08	8/3/91	Cominco	TR	<	0.05		0.011	<	0.01	<	0.020		0.009		1.900
Station 08	8/8/91	Cominco	TR	<	0.05		0.022	<	0.01		0.04		0.015		3.610
Station 08	8/9/91	Cominco	TR	<	0.05		0.018	<	0.01		0.02		0.011		2.700
Station 08	8/13/91	Cominco	TR	<	0.05		0.040	<	0.01		0.04		0.006		1.420
Station 08	8/16/91	Cominco	TR	<	0.05		0.007	<	0.01		0.08	<	0.002		1.070
Station 08	8/19/91	Cominco	TR	<	0.05		0.012	<	0.01		0.06		0.001		1.540
Station 08	8/24/91	Cominco	TR	<	0.05		0.014	<	0.01		0.04		0.009		1.920
Station 08	8/27/91	Cominco	TR	<	0.05		0.010	<	0.01		0.09		0.008		1.610
Station 08	8/29/91	Cominco	TR	<	0.05		0.009	<	0.01		0.06		0.005		1.630
Station 08	10/2/91	Cominco	TR	<	0.05		0.012	<	0.01		0.06		0.007		1.570
Station 08	10/5/91	Cominco	TR	<	0.05		0.018	<	0.01		0.09		0.023		2.850
Station 08	5/27/92	Cominco	TR	<	0.05		0.018	<	0.01		0.06		0.088		2.660
Station 08	6/10/92	Cominco	TR		0.45	<	0.003	<	0.01		1.04		0.005		1.100
Station 08	6/16/92	Cominco	TR		0.73		0.006	<	0.01		2.38		0.094		0.721
Station 08	6/24/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.164		0.006		0.305
Station 08	7/2/92	Cominco	TR	<	0.05		0.005	<	0.01		0.079		0.003		0.484
Station 08	7/2/92	Cominco	TR	<	0.05		0.005	<	0.01		0.079		0.003		0.484
Station 08	7/8/92	Cominco	TR	<	0.05		0.004	<	0.01		0.023	<	0.002		0.370
Station 08	7/8/92	Cominco	TR	<	0.05		0.004	<	0.01		0.023	<	0.002		0.370
Station 08	7/15/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.049	<	0.002		0.362
Station 08	7/15/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.049	<	0.002		0.362
Station 08	7/18/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.047	<	0.002		0.344
Station 08	7/18/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.047	<	0.002		0.344
Station 08	7/22/92	Cominco	TR		0.07		0.008	<	0.01		0.118	<	0.002		0.903
Station 08	7/22/92	Cominco	TR		0.07		0.008	<	0.01		0.118		0.002		0.903
Station 08	7/25/92	Cominco	TR		0.06		0.009	<	0.01		0.046	<	0.002		0.826
Station 08	7/25/92	Cominco	TR		0.06		0.009	<	0.01		0.046	<	0.002		0.826
Station 08	7/29/92	Cominco	TR	<	0.05		0.022	<	0.01		0.064	<	0.002		1.950
Station 08	7/29/92	Cominco	TR	<	0.05		0.022	<	0.01		0.064	<	0.002		1.950
Station 08	9/2/92	Cominco	TR	<	0.05		0.006	<	0.01		0.06		0.012		0.771
Station 08	9/5/92	Cominco	TR	<	0.05		0.007	<	0.01		0.06		0.007		0.914
Station 08	9/9/92	Cominco	TR	<	0.05		0.01		0.011		0.05		0.006		1.310
Station 08	9/12/92	Cominco	TR	<	0.05		0.007	<	0.01		0.07	<	0.002		1.010
Station 08	9/16/92	Cominco	TR	<	0.05		0.011	<	0.01		0.10		0.003		1.240
Station 08	9/22/92	Cominco	TR	<	0.05		0.01	<	0.01		0.10	<	0.002		1.390
Station 08	9/26/92	Cominco	TR	<	0.05		0.011	<	0.01		0.06	<	0.002		1.440
Station 08	9/30/92	Cominco	TR	<	0.05		0.019	<	0.01		0.06	<	0.002		2.230
Station 08	10/3/92	Cominco	TR	<	0.05		0.024	<	0.01		0.069		0.002		3.120
Station 08	10/10/92	Cominco	TR	<	0.05		0.014	<	0.01		0.05	<	0.002		1.900
Station 08	10/15/92	Cominco	TR	<	0.05		0.005	<	0.01		0.046		0.003		0.790
Station 73	6/3/93	Cominco	TR		0.28	<	0.003						0.009		0.164
Station 73	6/10/93	Cominco	TR		0.06	<	0.003						0.004		0.16
Station 73	6/20/93	Cominco	TR	<	0.05	<	0.003						0.003		0.143
Station 73	6/24/93	Cominco	TR		0.05	<	0.003					<	0.002		0.389

Appendix 12, continued.

Ikalukrok Creek: Station 8 and Station 73

Station	Date	Reference	matrix	Al	Cd	Cu	Fe	Pb	Zn
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Station 73	6/29/93	Cominco	TR	< 0.05	< 0.003			< 0.002	0.233
Station 73	7/9/93	Cominco	TR	0.1	< 0.003		0.179	0.004	0.151
Station 73	7/18/93	Cominco	TR	< 0.05	< 0.003		0.052	0.002	0.15
Station 73	7/24/93	Cominco	TR	< 0.05	< 0.003		< 0.02	< 0.002	0.156
Station 73	8/1/93	Cominco	TR	< 0.05	< 0.003			0.003	0.154
Station 73	8/12/93	Cominco	TR	< 0.05	< 0.003			< 0.002	0.216
Station 73	8/21/93	Cominco	TR	< 0.05	< 0.003			0.004	0.169
Station 73	8/28/93	Cominco	TR	< 0.05	< 0.003			< 0.002	0.239
Station 73	9/4/93	Cominco	TR	< 0.05	< 0.003		0.054	< 0.002	0.23
Station 73	9/8/93	Cominco	TR	< 0.05	< 0.003		0.06	< 0.002	0.203
Station 73	9/12/93	Cominco	TR	< 0.05	< 0.003		0.056	0.003	0.279
Station 73	9/20/93	Cominco	TR	< 0.05	< 0.003		0.081	0.003	0.208
Station 73	10/10/93	Cominco	TR	< 0.05	< 0.003		0.096	< 0.002	0.282
Station 73	5/18/94	Cominco	TR	0.427	0.004		0.954	0.05	0.416
Station 73	5/22/94	Cominco	TR	0.423	< 0.003		0.978	0.022	0.275
Station 73	6/2/94	Cominco	TR	0.056	0.004		0.138	0.003	0.212
Station 73	6/9/94	Cominco	TR	0.059	< 0.003		0.148	0.004	0.153
Station 73	6/22/94	Cominco	TR	< 0.05	< 0.003		0.049	< 0.002	0.206
Station 73	6/26/94	Cominco	TR	< 0.05	< 0.003		0.035	< 0.002	0.168
Station 73	6/28/94	Cominco	TR	< 0.05	< 0.003		0.073	0.05	0.183
Station 73	7/3/94	Cominco	TR	< 0.05	< 0.003		0.099	0.022	0.134
Station 73	7/13/94	Cominco	TR	0.094	0.004		0.263	0.01	0.467
Station 73	7/19/94	Cominco	TR	< 0.05	< 0.003		0.085	< 0.002	0.135
Station 73	7/27/94	Cominco	TR	< 0.05	0.005		0.225	0.006	0.338
Station 73	8/5/94	Cominco	TR	0.058	< 0.003		0.107	0.005	0.232
Station 73	8/11/94	Cominco	TR	1.02	< 0.003		1.5	0.033	0.282
Station 73	8/15/94	Cominco	TR	0.563	< 0.003		0.872	0.017	0.31
Station 73	8/23/94	Cominco	TR	0.334	0.01		0.86	0.016	1.19
Station 73	9/1/94	Cominco	TR	0.343	0.006		0.812	0.016	0.672
Station 73	9/9/94	Cominco	TR	0.354	0.007	< 0.01	0.617	0.008	0.841
Station 73	9/13/94	Cominco	TR	0.295	0.007		0.643	0.006	0.788
Station 73	9/22/94	Cominco	TR	0.3	0.004		0.359	< 0.002	0.432
Station 73	9/25/94	Cominco	TR	0.153	0.007		0.303	< 0.002	0.791
Station 73	10/2/94	Cominco	TR	0.134	0.007		0.387	0.003	0.865
Station 73	10/17/94	Cominco	TR	< 0.05	0.006		0.098	< 0.002	0.577
Station 08	5/20/95	Cominco	TR	0.967	0.01	< 0.01		0.095	1.71
Station 08	5/25/95	Cominco	TR	1.06	0.009	< 0.01		0.106	1.29
Station 08	5/30/95	Cominco	TR	0.299	0.008	< 0.01		0.03	1.11
Station 73	6/3/95	Cominco	TR	0.208	0.00332	0.00442	0.661	0.0081	0.434
Station 73	6/4/95	Cominco	TR	0.19	0.00483	0.0045	0.67	0.00565	0.619
Station 73	6/11/95	Cominco	TR	0.145	0.00303	0.00322		0.00267	0.39
Station 73	6/13/95	Cominco	TR		0.00398	0.0029		0.00487	0.537
Station 73	6/18/95	Cominco	TR		0.00379	0.0034		0.00555	0.46

Appendix 12, continued.

Ikalukrok Creek: Station 8 and Station 73

Station	Date	Reference	matrix		Al	Cd	Cu	Fe	Pb	Zn
					mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Station 73	6/25/95	Cominco	TR		0.112	0.00433	0.0029	0.286	0.00367	0.593
Station 73	6/27/95	Cominco	TR			0.0055	0.004		0.00377	0.648
Station 73	6/29/95	Cominco	TR			0.00377	0.003		0.00354	0.509
Station 8	7/2/95	Cominco	TR		0.152	0.00078	0.0024		0.00135	0.138
Station 8	7/10/95	Cominco	TR		0.105	0.0125	0.0035		0.0115	1.73
Station 8	7/16/95	Cominco	TR	<	0.05	0.0152	0.0031		0.00881	1.56
Station 8	8/6/95	Cominco	TR	<	0.057	0.0185	0.0021		0.00718	1.95
Station 8	8/16/95	Cominco	TR		0.145	0.00069	0.003		0.00058	0.14
Station 8	8/22/95	Cominco	TR		0.067	0.0198	0.0016		0.00831	2.01

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek										
Water Quality										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
8/3/91	Cominco	179	237		6.7	12.7	10.9	0.5	665	
8/8/91	Cominco	347	546		6.9	7.0	10.7	1.7	420	
8/9/91	Cominco	398	621		7.1	6.1	11.8	0.7	575	
8/13/91	Cominco	344	552		7.1	11.7	9.9	1.3		
8/16/91	Cominco	269	352		6.8	14.1	9.5			
8/19/91	Cominco	190	610		7.0	13.4	12.2			
8/24/91	Cominco	563	831		7.1	6.0	11.5	0.5	600	
8/26/91	Cominco				7.0	4.2	13.0	1.0	285	
8/27/91	Cominco	242	346							
8/29/91	Cominco	233	329		6.8	3.0	12.8	3.5	270	
10/2/91	Cominco	221	207		7.0	2	14	0.2	542	
10/5/91	Cominco	181	235		7.3	-0.2	14	0.6	389	
10/8/91	Cominco	245	331		7.5			0.5		
5/27/92	Cominco	227	331		6.2	1.9	4.9	1.5	0.547	
6/10/92	Cominco	64.7	91		7.4	0	9.8	3.4	0.136	
6/16/92	Cominco	52.7	67		6.1	2	10.2	20	0.114	
6/24/92	Cominco	97.4	123		7.6	7.9	13.4	3.7	0.202	
7/2/92	Cominco	130	173		7.2	10.5	9.0	2.50	0.244	
7/8/92	Cominco	162	205		7.3	12.4	9.9			0.84
7/15/92	Cominco	293	431		7.4	9.7	6.8	0.27	0.635	
7/18/92	Cominco	219	302		8.0	12.3	7.1	0.36	0.470	
7/22/92	Cominco	394	564		7.8	10.3	8.0			0.17
7/25/92	Cominco	472	675		7.9	11.9	10.9			---
7/29/92	Cominco	619	937		7.1	13.9	8.7	0.21	1.150	
8/1/92	Cominco	709	1060		7.5	13.2	11.0	0.2	1.220	
8/5/92	Cominco	828	1230		7.4	12.4	8.7	0.2	1.420	
8/8/92	Cominco	742	994		7.7	10.1	9.2	0.5	1.200	
8/12/92	Cominco	240	346		7.9	5.4	7.3	0.5	0.483	
8/15/92	Cominco	329	438		7.0	4.4	7.8	0.3	0.512	
8/17/92	Cominco	342	195		7.4	6.7	9.8	0.4	0.651	
8/22/92	Cominco	199	232		8.0	6.5	9.7	1.9	0.369	
8/29/92	Cominco	344	505		7.6	8.2	7.7	0.3	0.680	
9/2/92	Cominco	192	237		7.0	5.3	12.5	0.65	0.304	
9/5/92	Cominco	331	447		8.1	5	11.3	0.45	0.624	
9/9/92	Cominco	446	618		7.5	1.3	8.4	0.39	0.767	
9/12/92	Cominco	489	689		8.1	1.1		0.3	0.914	
9/16/92	Cominco	749	1100		8.0	0.1		0.44	1.330	
9/22/92	Cominco	761	1140		7.8	0	12	0.22	1.400	
9/26/92	Cominco	713	1070		7.2	0	12.3	0.46	1.001	

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek										
Water Quality										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
9/30/92	Cominco	893	1311		7.3	0	10.4	0.25	1.460	
10/3/92	Cominco	1540	1850		7.2	-0.5	10.3	0.37	2.090	
10/10/92	Cominco	900	1290		7.4	0	11	0.76	1.470	
10/15/92	Cominco	421	533		7.4	0.1	11.6	0.22	0.736	
5/28/93	Cominco		50		7.2	1	11.2	3.4	77	400
6/5/93	Cominco		74		7.6	6				
6/13/93	Cominco		103		7.2	7				
6/19/93	Cominco		120		8.2	12				
6/24/93	Cominco		242		6.8	10				
6/29/93	Cominco		369		7.2	12				
7/10/93	Cominco		177		7	10				
7/14/93	Cominco		202		7.9	13				
7/21/93	Cominco		227		7.9	17				
8/6/93	Cominco		176		7.3	5				
8/14/93	Cominco		269		6.9	7				
8/20/93	Cominco		256		7.9	7				
8/29/93	Cominco		330		7.9	7				
9/2/93	Cominco		365		7.8	3				32.7
9/10/93	Cominco		233		7.7	3				80.2
9/14/93	Cominco		157		7.5	5.5				285
9/25/93	Cominco		244		7.8	1				40.6
6/11/94	Cominco	101	131	58	7.8	5				
6/15/94	Cominco	136	166	84	7.8	7.8				
6/25/94	Cominco	150	190	85	7.9	10.1				
6/30/94	Cominco	191	253	120	7.9	3.8				135.1
7/13/94	Cominco	132	168	59	7.5	5				95.8
7/22/94	Cominco	157	195	72	7.8	7.5				42.8
7/24/94	Cominco	99.3	127	43	7.7	7.5				240
8/3/94	Cominco	163	203	93	7.7	6.3				
8/9/94	Cominco	233	320	140	7.7	8.6				
8/21/94	Cominco	119	168	63	7.3	4				
8/23/94	Cominco	131	182	64	7.3	4				
9/1/94	Cominco	307	447	240	7.6	4				143
9/8/94	Cominco	416	583	320	7.7	4				120
9/11/94	Cominco	454	659	400	7.6	4				97
9/18/94	Cominco	773	1100	680	7.8	3				55
9/25/94	Cominco	1100	1510	1600	7.6	1				36
10/2/94	Cominco	1060	1520	800	7.7	1				

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek										
Water Quality										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
10/14/94	Cominco	1040	1610	1000	7.2	0				
6/3/95	Cominco	247	171	210	7.2	3.0		2	507	
6/8/95	Cominco	336	459		7.1	3.0		3	97	
6/11/95	Cominco		525	350	7.5	8.0		1	638	
6/13/95	Cominco		688					1		
6/18/95	Cominco		588		7.6	6.4		1	666	
6/25/95	Cominco		745		7.6	8		0	958	
6/27/95	Cominco		824		7.6	8			1029	
6/29/95	Cominco	580	885	550						
6/29/95	Cominco		824							
7/2/95	Cominco	443	664	410	7.7	10			812	
7/10/95	Cominco	406	610	400						
7/12/95	Cominco		830	650						
7/16/95	Cominco	675	1060		7.8	10			1206	
7/23/95	Cominco		1240		7.6	10.9			1499	
8/2/95	Cominco		1610		7.5	13			1775	
8/6/95	Cominco	965	1470	1000	7.6	10.5			1719	
8/16/95	Cominco	1070	1510	940	7.7	12.8			1790	
8/20/95	Cominco	975	1380	970	7.7	9.5			1769	
8/27/95	Cominco		1400		7.8	10.5			656	

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek																
Metals Concentrations																
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn		
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		
8/3/91	Cominco	TR	<	0.05		0.034	<	0.01	<	0.020		0.027		5.740		
8/8/91	Cominco	TR	<	0.05		0.039	<	0.01	<	0.020		0.026		6.080		
8/9/91	Cominco	TR	<	0.05		0.040	<	0.01	<	0.020		0.026		6.360		
8/13/91	Cominco	TR	<	0.05		0.040	<	0.01	<	0.020		0.026		5.800		
8/16/91	Cominco	TR	<	0.05		0.035	<	0.01	<	0.020		0.014		5.090		
8/19/91	Cominco	TR	<	0.05		0.047	<	0.01	<	0.020		0.028		6.540		
8/24/91	Cominco	TR	<	0.05		0.042	<	0.01	<	0.020		0.028		6.210		
8/26/91	Cominco	TR														
8/27/91	Cominco	TR	<	0.05		0.035	<	0.01		0.02		0.026		5.890		
8/29/91	Cominco	TR	<	0.05		0.036	<	0.01	<	0.020		0.022		6.050		
10/2/91	Cominco	TR	<	0.05		0.028	<	0.01		0.03		0.015		3.890		
10/5/91	Cominco	TR	<	0.05		0.010	<	0.01		0.06		0.013		1.580		
10/8/91	Cominco	TR	<	0.05		0.024	<	0.01		0.03		0.010		3.460		
5/27/92	Cominco	TR	<	0.05		0.017	<	0.01		0.074		0.386		2.380		
6/10/92	Cominco	TR		0.15	<	0.003	<	0.01		0.581		0.028		0.699		
6/16/92	Cominco	TR		0.89		0.008	<	0.01		2.98		0.108		0.822		
6/24/92	Cominco	TR		0.07		0.006	<	0.01		0.271		0.015		0.884		
7/2/92	Cominco	TR		0.09		0.009	<	0.01		0.199		0.007		1.210		
7/8/92	Cominco	TR	<	0.05		0.010	<	0.01	<	0.020		0.002		1.060		
7/15/92	Cominco	TR	<	0.05		0.020	<	0.01	<	0.020	<	0.002		2.450		
7/18/92	Cominco	TR	<	0.05		0.013	<	0.01	<	0.020	<	0.002		1.350		
7/22/92	Cominco	TR	<	0.05		0.028	<	0.01		0.032	<	0.002		3.110		
7/25/92	Cominco	TR	<	0.05		0.032	<	0.01		0.023	<	0.002		3.130		
7/29/92	Cominco	TR	<	0.05		0.045	<	0.01		0.031	<	0.002		4.290		
8/1/92	Cominco	TR	<	0.05		0.047	<	0.01		0.048		0.004		4.770		
8/5/92	Cominco	TR	<	0.05		0.060	<	0.01		0.047		0.004		5.920		
8/8/92	Cominco	TR	<	0.05		0.050	<	0.01		0.040		0.004		5.130		
8/12/92	Cominco	TR	<	0.05		0.019	<	0.01		0.064		0.009		2.270		
8/15/92	Cominco	TR	<	0.05		0.020	<	0.01		0.056		0.007		2.580		
8/17/92	Cominco	TR	<	0.05		0.014	<	0.01		0.037		0.022		1.760		
8/22/92	Cominco	TR		0.10		0.010	<	0.01		0.289		0.084		1.420		
8/29/92	Cominco	TR	<	0.05		0.016	<	0.01		0.032		0.017		2.000		
9/2/92	Cominco	TR	<	0.05		0.012	<	0.01		0.05		0.026		1.710		
9/5/92	Cominco	TR	<	0.05		0.016	<	0.01		0.03		0.016		1.890		
9/9/92	Cominco	TR	<	0.05		0.015	<	0.01		0.04		0.012		2.070		
9/12/92	Cominco	TR	<	0.05		0.023	<	0.01		0.04		0.008		2.580		
9/16/92	Cominco	TR	<	0.05		0.034	<	0.01		0.06		0.010		4.060		
9/22/92	Cominco	TR	<	0.05		0.037	<	0.01		0.05	<	0.002		4.380		
9/26/92	Cominco	TR	<	0.05		0.037	<	0.01		0.04				4.650		

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek																				
Metals Concentrations																				
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn						
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L						
9/30/92	Cominco	TR	<	0.05		0.049	<	0.01		0.04		0.004		5.830						
10/3/92	Cominco	TR	<	0.05		0.047	<	0.01		0.055		0.005		5.840						
10/10/92	Cominco	TR	<	0.05		0.043	<	0.01		0.054	<	0.002		5.050						
10/15/92	Cominco	TR	<	0.05		0.023	<	0.01		0.039		0.005		2.660						
5/28/93	Cominco	TR		0.31		0.004						0.034								
6/5/93	Cominco	TR		0.24	<	0.003						0.027		0.463						
6/13/93	Cominco	TR		0.14		0.005						0.017		0.61						
6/19/93	Cominco	TR	<	0.05		0.003						0.016		0.618						
6/24/93	Cominco	TR		0.05		0.008						0.009		1.06						
6/29/93	Cominco	TR	<	0.05		0.013						0.008		1.31						
7/10/93	Cominco	TR		0.06		0.006						0.021		0.939						
7/14/93	Cominco	TR	<	0.05		0.009						0.016		0.896						
7/21/93	Cominco	TR	<	0.05		0.007						0.004		0.719						
8/6/93	Cominco	TR		0.09		0.010						0.027		1.1						
8/14/93	Cominco	TR	<	0.05		0.007						0.004		1.02						
8/20/93	Cominco	TR	<	0.05		0.008						0.010		1.02						
8/29/93	Cominco	TR	<	0.05		0.008						0.007		1.02						
9/2/93	Cominco	TR	<	0.05		0.010						0.006		1.09						
9/10/93	Cominco	TR		0.061		0.009						0.012		1.05						
9/14/93	Cominco	TR		0.69		0.008						0.136		0.919						
9/25/93	Cominco	TR	<	0.05		0.007						0.010		0.791						
6/11/94	Cominco	TR		0.108		0.006						0.028		0.533						
6/15/94	Cominco	TR		0.066		0.006						0.014		0.669						
6/25/94	Cominco	TR	<	0.05		0.007						0.009		0.779						
6/30/94	Cominco	TR				0.011						0.01		0.958						
7/13/94	Cominco	TR		0.175		0.009						0.026		1.11						
7/22/94	Cominco	TR	<	0.05		0.008						0.01		0.746						
7/24/94	Cominco	TR		0.21		0.012						0.07		1.14						
8/3/94	Cominco	TR		0.232		0.008						0.045		1.11						
8/9/94	Cominco	TR		0.064		0.009						0.02		1.05						
8/21/94	Cominco	TR		0.403		0.026						0.045		2.99						
8/23/94	Cominco	TR		0.263		0.016						0.03		2.04						
9/1/94	Cominco	TR		0.259		0.019						0.058		2.16						
9/8/94	Cominco	TR		0.298		0.025						0.045		3.38						
9/11/94	Cominco	TR		0.19		0.026						0.026		3.17						
9/18/94	Cominco	TR		0.067		0.026						0.012		2.78						
9/25/94	Cominco	TR		0.05		0.031						0.005		3.05						
10/2/94	Cominco	TR	<	0.05		0.023						0.008		2.42						

Appendix 12, continued.

Station 10, Mainstem Red Dog Creek												
Metals Concentrations												
Date	Reference	matrix		Al	Cd		Cu	Fe		Pb		Zn
				mg/L	mg/L		mg/L	mg/L		mg/L		mg/L
10/14/94	Cominco	TR	<	0.05	0.029					0.004		2.55
6/3/95	Cominco			0.073	0.12		0.0047	0.184		0.0337		1.39
6/8/95	Cominco			0.105	0.0124		0.0042	0.237		0.0393		1.54
6/11/95	Cominco				0.0139		0.0034			0.0226		1.43
6/13/95	Cominco				0.0141		0.0027			0.0181		1.62
6/18/95	Cominco				0.019		0.0036			0.027		1.83
6/25/95	Cominco				0.0196		0.0034			0.0202		2.34
6/27/95	Cominco											
6/29/95	Cominco			0.05	0.0176		0.0033	0.1		0.0254		2.27
6/29/95	Cominco				0.237		0.0037			0.0189		2.58
7/2/95	Cominco			0.072	0.0176		0.0036			0.0249		2.05
7/10/95	Cominco			0.092	0.0195		0.0043	0.136		0.0187		2.669
7/12/95	Cominco				0.0202		0.0043			0.0134		2.72
7/16/95	Cominco		<	0.05	0.0249		0.0031	0.066		0.0165		2.55
7/23/95	Cominco				0.0254		0.002			0.0139		3.14
8/2/95	Cominco				0.0315		0.0026			0.016		3.08
8/6/95	Cominco		<	0.05	0.0308		0.0023	0.059		0.0143		3
8/16/95	Cominco		<	0.05	0.0349		0.0016	0.06		0.0162		3.67
8/20/95	Cominco		<	0.05	0.0328		0.0016	0.057		0.0131		3.31
8/27/95	Cominco				0.0353		0.0014			0.0204		3.56

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
8/5/91	Cominco	688	1020		6.5			2.1	910	
8/6/91	Cominco	210	346		6.8	13.6	10.5	1.3	447	
8/15/91	Cominco	763	1310		6.0	16.0	9.1	6.1		
8/18/91	Cominco	751	1240		6.4	16.1	8.8	0.8		
8/23/91	Cominco	623	987		6.6	13.3	9.1	0.4	1570	
8/26/91	Cominco	355	631		7.2	5.3	11.7	1.3	455	
8/28/91	Cominco	298	560		7.6	5.7	12.1	1.3	440	
8/29/91	Cominco	315	527		7.4	12.1	9.8	1.3	490	
10/1/91	Cominco	547	986		6.0	3	12	0.5	1239	
10/4/91	Cominco	354	564		7.0	3	14	3	779	
10/7/91	Cominco	246	404		7.5	-0.2	16	1.3	577	
10/10/91	Cominco	215	370		7.3	0	16	0.5	553	
10/16/91	Cominco	333	568		7.0	0	14	0.5	785	
5/27/92	Cominco	349	410		7.1	2.4	4.1	1.3	0.701	
6/9/92	Cominco	28	50		6.4	0.3	7.1	2	0.076	
6/16/92	Cominco	36.1	54		6.5	6.1	10.2	4.5	0.928	
6/23/92	Cominco	44.8	72		6.1	7.3	15.9*	2.4	0.105	
7/2/92	Cominco	95	143		6.7	13.0	8.6	0.90	0.178	
7/9/92	Cominco	145	208		7.2	13.0	8.7		0.301	
7/11/92	Cominco	145	230		7.0	11.7	8.8		0.334	
7/15/92	Cominco	538	787		6.7	10.7		0.43	0.907	
7/18/92	Cominco	411	642		6.9	12.6	6.2	0.85	0.833	
7/22/92	Cominco	662	1010		7.0	15.5	8.3	0.12	1.200	
7/25/92	Cominco	791	1250		6.9	15.3	8.5	0.19	1.430	
7/29/92	Cominco	918	1400		6.7	19.4	7.6	0.24	1.600	
7/31/92	Cominco	983	1470		6.6	15.6	9.3	0.30	1.570	
8/3/92	Cominco	781	1170		6.4	12.8	11.0	0.2	1.300	
8/6/92	Cominco	1230	1940		6.4	14.2	12.0	0.4	1.790	
8/12/92	Cominco	372	566		7.1	8.2	6.6	0.6	0.184	
8/15/92	Cominco	532	762		6.8	5.5	6.9	0.2	0.958	
8/18/92	Cominco	562	828		6.2	4.8	24**	0.2	0.954	
8/22/92	Cominco	267	383		7.7	7.4	1.8	11.0	0.090	
8/28/92	Cominco	287	447		6.5	8.6	9.0	0.5	0.607	
8/30/92	Cominco	481	791		6.9	10.6	8.3	0.9	0.100	
9/3/92	Cominco	174	250		7.5	4.2	7.3	0.45	0.375	
9/4/92	Cominco	579	815		7.5	6.1	9	0.4	1.014	
9/7/92	Cominco	672	958		7.7	5.1	9.9	0.17	1.157	
9/10/92	Cominco	560	805		6.7	4.5	12.8	0.38	0.973	
9/18/92	Cominco	1240	1860		8.0	5	11	0.45	1.260	
9/24/92	Cominco	1290	1890		6.8	0	11.2	0.15	2.060	
9/26/92	Cominco	1240	1980		7.2	0	12.7	0.45	2.230	
9/29/92	Cominco	1410	2060		6.9	0	13.4	0.15	2.480	
10/1/92	Cominco	1510	2230		6.8	0	13.3	0.18	2.560	
10/10/92	Cominco	1560	2210		7	1.2	10	0.73	2.300	
10/15/92	Cominco	1110	1740		6.3	0.3	12.2	0.28	2.040	
5/18/93	Cominco	32.9	71		6.4	1.5	12.5	3.7		
5/27/93	Cominco		58		6.9	2	12.1	3		
6/4/93	Cominco		57		7.4					
6/12/93	Cominco		74		7.7	3				
6/17/93	ADEC-Nome	74	111		7.19	5.0				
6/17/93	Cominco		100		6.6	5				

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
6/23/93	Cominco		407		7.2	12				
6/30/93	Cominco		751							
7/8/93	Cominco		290		6.6	9				
7/15/93	Cominco		194		6.8	12				
7/25/93	Cominco		235		7	13				
8/3/93	Cominco		190		6.8	7				
8/11/93	Cominco		198		6.3	7				
8/19/93	Cominco		362		7.3	9				
8/27/93	Cominco		497			9				
9/5/93	Cominco		961		7.2	6				
9/10/93	Cominco		278		7.1	3				
9/15/93	Cominco		160		6.7	3				
9/25/93	Cominco		244		7.4	0				
9/29/93	Cominco				7.2	0				
1/1/94	Cominco	218	355	210	7.2	2				
1/9/94	Cominco	160	230	140	7.4	5				
1/17/94	Cominco	271	391	250	7.3	13				
1/24/94	Cominco	245	361	220	7.4	13				
1/30/94	Cominco	273	404	250	6.9	6				
5/6/94	Cominco	1960	2930	1900	7.4	1				35.9
5/10/94	Cominco	406	637	410	6.4	1				37.2
5/19/94	Cominco	67.2	110	63	6.8	1				
5/25/94	Cominco	71.5	97	55	6.8	4				
7/9/94	Cominco	94	144	68	7.2	5				
7/13/94	Cominco	100	141	73	7.3	8				
7/21/94	Cominco	132	183	96	7.3	9				
7/29/94	Cominco	203	206	160						
8/6/94	Cominco	324	508	300	7.3	13				
8/13/94	Cominco	89	128	69	7	8				
8/20/94	Cominco	90.6	156	82	6.3	5				
8/23/94	Cominco	123	198	100	6.3	4				
8/25/94	Cominco									
9/1/94	Cominco	444	693	410	7.2	6				
9/10/94	Cominco	714	1080	730	7.3	6				
9/10/94	Cominco									
9/15/94	Cominco	313	510	300	7.3	4				
9/21/94	Cominco	1280	1780	1100	7.2	3				
9/29/94	Cominco	1520	1970	1300	8	4				
10/8/94	Cominco	1440	2210	1300	6.9	1				
10/15/94	Cominco	1440	2150	1300	8	0				
10/22/94	Cominco	1450	2280	1400	8.3	1				
10/26/94	Cominco	1580	2440	1500	8.7	1				
6/1/95	Cominco	356	525	360	7.1	7			660	
6/7/95	Cominco		1270		6.8	10			94	
6/9/95	Cominco	597	823	590	7.4	9.5			931	
6/12/95	Cominco		1210	800	7.6	8			1264	
6/15/95	Cominco		135		7.7	7			233	
6/18/95	Cominco		1210		6.8	7.9			1382	
6/24/95	Cominco		392		7				566	
6/25/95	Cominco		1450							
6/27/95	Cominco		1460	1200	7.4	8			167	

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
7/1/95	Cominco	138	168	57	7.1	9		1.78	1268	
7/4/95	Cominco		1490		7.4	9		0.27	1691	
7/7/95	Cominco		1250		7.3	10		1.06	1470	
7/10/95	Cominco	736	1090	750	7.3	7		0.96	1323	
7/14/95	Cominco		1640		7.4	14		0.23	1764	
7/19/95	Cominco	1170	1720	1200	6.6	12		0.49	1880	
7/22/95	Cominco		1880		7.3	15.2		0.18	2110	
7/25/95	Cominco		2010		7.4	14.8		0.16	2110	
7/28/95	Cominco		2100			13.2				
7/30/95	Cominco		2090		7.2			0.16	1330	
8/4/95	Cominco		2190						2380	27.1
8/8/95	Cominco		2090	1500	7.2	12			2340	26.7
8/11/95	Cominco		2060		7.7	13.8			1990	27.6
8/13/95	Cominco		2100		7.8	13.1			2310	26.7
8/17/95	Cominco		2090	1400	7	12.5			2390	27.4
8/23/95	Cominco		2060	1500	7.6	13			2360	28
8/25/95	Cominco		2140		7.3	13.4			2270	28.9
8/27/95	Cominco		2040		7.6	12.5			226	28.8
8/31/95	Cominco		2090		7	12.4			2340	27.6

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek																	
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L
8/5/91	Cominco	TR		0.06		0.071	<	0.01	<	0.020		0.098		12.30
8/6/91	Cominco	TR	<	0.05		0.132	<	0.01	<	0.020		0.168		23.70
8/15/91	Cominco	TR		0.48		0.177	<	0.01		5.07		0.295		29.20
8/18/91	Cominco	TR		0.13		0.126	<	0.01		0.48		0.272		19.80
8/23/91	Cominco	TR	<	0.05		0.164	<	0.01		0.02		0.153		26.00
8/26/91	Cominco	TR	<	0.05		0.192	<	0.01		0.07		0.234		32.40
8/28/91	Cominco	TR	<	0.05		0.178	<	0.01		0.08		0.184		31.00
8/29/91	Cominco	TR	<	0.05		0.174	<	0.01		0.07		0.171		29.80
10/1/91	Cominco	TR	<	0.05		0.088	<	0.01		0.06		0.072		11.30
10/4/91	Cominco	TR		0.19		0.059	<	0.01		0.80		0.154		8.28
10/7/91	Cominco	TR		0.05		0.084	<	0.01		0.16		0.076		13.40
10/10/91	Cominco	TR	<	0.05		0.076	<	0.01		0.11		0.044		12.90
10/16/91	Cominco	TR	<	0.05		0.097	<	0.01		0.04		0.053		16.10
5/27/92	Cominco	TR	<	0.05	<	0.003	<	0.01		0.12		0.050		0.09
6/9/92	Cominco	TR		0.23		0.015	<	0.01		0.87		0.092		2.23
6/16/92	Cominco	TR		0.14		0.013	<	0.01		0.36		0.056		1.60
6/23/92	Cominco	TR		0.13		0.014	<	0.01		0.553		0.086		1.94
7/2/92	Cominco	TR	<	0.05		0.028	<	0.01		0.078		0.025		4.45
7/9/92	Cominco	TR	<	0.05		0.040	<	0.01	<	0.020		0.019		5.97
7/11/92	Cominco	TR	<	0.05		0.043	<	0.01	<	0.020		0.015		6.39
7/15/92	Cominco	TR	<	0.05		0.068	<	0.01		0.026		0.029		9.46
7/18/92	Cominco	TR	<	0.05		0.076	<	0.01		0.070		0.021		10.60
7/22/92	Cominco	TR		0.06		0.101	<	0.01		0.041		12.200		10.60
7/25/92	Cominco	TR		0.05		0.098	<	0.01		0.040		0.032		11.10
7/29/92	Cominco	TR		0.06		0.079	<	0.01		0.128		0.041		8.20
7/31/92	Cominco	TR		0.08		0.081	<	0.01		0.099		0.050		9.06
8/3/92	Cominco	TR	<	0.05		0.111	<	0.01		0.080		0.020		12.10
8/6/92	Cominco	TR	<	0.05		0.089	<	0.01		0.080		0.052		9.93
8/12/92	Cominco	TR		0.06		0.034	<	0.01		0.118		0.039		4.60
8/15/92	Cominco	TR	<	0.05		0.040	<	0.01		0.062		0.028		5.52
8/18/92	Cominco	TR	<	0.05		0.029	<	0.01		0.060		0.036		4.31
8/22/92	Cominco	TR		0.10		0.024		0.012		0.292		0.222		3.28
8/28/92	Cominco	TR	<	0.05		0.047	<	0.01		0.036		0.094		6.37
8/30/92	Cominco	TR		0.07		0.034	<	0.01		0.176		0.130		4.54
9/3/92	Cominco	TR		0.06		0.04	<	0.01		0.08		0.105		5.64
9/4/92	Cominco	TR	<	0.05		0.035	<	0.01		0.11		0.106		4.55
9/7/92	Cominco	TR	<	0.05		0.038	<	0.01		0.05		0.059		4.88
9/10/92	Cominco	TR	<	0.05		0.047	<	0.01		0.06		0.052		6.57
9/18/92	Cominco	TR	<	0.05		0.033	<	0.01		0.11		0.041		4.61
9/24/92	Cominco	TR												
9/26/92	Cominco	TR	<	0.05		0.06	<	0.01		0.13		0.040		7.39
9/29/92	Cominco	TR	<	0.05		0.071	<	0.01		0.06		0.033		8.44
10/1/92	Cominco	TR	<	0.05		0.074	<	0.01		0.061		0.028		8.47
10/10/92	Cominco	TR	<	0.05		0.059	<	0.01		0.078		0.037		6.73
10/15/92	Cominco	TR	<	0.05		0.147	<	0.01		0.05		0.030		18.70
5/18/93	Cominco	TR		0.16		0.026	<	0.01		0.672		0.142		3.21
5/27/93	Cominco	TR		0.28		0.014						0.152		1.64
6/4/93	Cominco	TR		0.12		0.014						0.104		1.78
6/12/93	Cominco	TR		0.13		0.013						0.112		1.64
6/17/93	ADEC-Nome	TR		0.053		0.015	<	0.01		0.118		0.057		2.06
6/17/93	Cominco	TR		0.06		0.017						0.066		2.21

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek																	
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn			
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L			
6/23/93	Cominco	TR		0.07		0.021						0.049		2.59			
6/30/93	Cominco	TR	<	0.05		0.026						0.041		3.09			
7/8/93	Cominco	TR	<	0.05		0.029						0.050		3.51			
7/15/93	Cominco	TR	<	0.05		0.026						0.045		3.13			
7/25/93	Cominco	TR	<	0.05		0.026						0.016		3.29			
8/3/93	Cominco	TR		0.21		0.024						0.177		3.11			
8/11/93	Cominco	TR	<	0.05		0.026						0.034		3.60			
8/19/93	Cominco	TR	<	0.05		0.028						0.049		3.53			
8/27/93	Cominco	TR	<	0.05		0.027						0.036		3.61			
9/5/93	Cominco	TR	<	0.05		0.032						0.029		3.83			
9/10/93	Cominco	TR		0.06		0.024						0.044		3.30			
9/15/93	Cominco	TR		0.38		0.029						0.348		3.50			
9/25/93	Cominco	TR	<	0.05		0.028						0.064		3.50			
9/29/93	Cominco	TR															
1/1/94	Cominco	TR	<	0.05		0.025						0.01		3.14			
1/9/94	Cominco	TR		0.068		0.016						0.095		2.10			
1/17/94	Cominco	TR	<	0.05		0.022						0.062		2.61			
1/24/94	Cominco	TR	<	0.05		0.024						0.046		2.96			
1/30/94	Cominco	TR	<	0.05		0.025						0.022		2.84			
5/6/94	Cominco	TR	<	0.05		0.52						0.094		5.39			
5/10/94	Cominco	TR		0.086		0.072						0.322		9.27			
5/19/94	Cominco	TR		0.414		0.026						0.26		3.37			
5/25/94	Cominco	TR		0.208		0.022						0.137		2.68			
7/9/94	Cominco	TR		0.065		0.027						0.115		3.64			
7/13/94	Cominco	TR		0.087		0.029						0.1		3.57			
7/21/94	Cominco	TR	<	0.05	<	0.025						0.038		3.09			
7/29/94	Cominco	TR		0.056		0.027						0.093		3.39			
8/6/94	Cominco	TR	<	0.05		0.028						0.078		3.26			
8/13/94	Cominco	TR		0.489		0.031						0.341		3.78			
8/20/94	Cominco	TR		0.766		0.086						0.232		10.10			
8/23/94	Cominco	TR		0.539		0.062						0.12		8.77			
8/25/94	Cominco	TR		0.673		0.067		0.03				0.165		8.86			
9/1/94	Cominco	TR		0.581		0.053						0.132		6.12			
9/10/94	Cominco	TR		0.624		0.059						0.084		8.05			
9/10/94	Cominco																
9/15/94	Cominco	TR		1.25		0.08		0.049				0.345		11.30			
9/21/94	Cominco	TR		0.174		0.046						0.08		5.53			
9/29/94	Cominco	TR	<	0.05		0.033						0.012		3.13			
10/8/94	Cominco	TR	<	0.05		0.034						0.013		2.92			
10/15/94	Cominco	TR	<	0.05		0.036						0.017		3.21			
10/22/94	Cominco	TR	<	0.05		0.051						0.022		4.13			
10/26/94	Cominco	TR	<	0.05		0.033						0.027		2.68			
6/1/95	Cominco			0.118		0.034	<	0.01	<	0.193		0.142		4.39			
6/7/95	Cominco			0.079		0.0327		0.0084				0.0676		4.14			
6/9/95	Cominco					0.0287		0.0075				0.0914		3.07			
6/12/95	Cominco					0.0296		0.0058				0.0651		3.14			
6/15/95	Cominco					7E-05		0.0012				0.0004		0.00			
6/18/95	Cominco					0.0418		0.0091				0.0946		3.71			
6/24/95	Cominco					0.0462		0.0069				0.109		8.06			
6/25/95	Cominco					0.0394		0.0071				0.0632		4.43			
6/27/95	Cominco			0.091		0.0458		0.0075				0.0704		4.90			

Appendix 12, continued.

Station 20: Middle Fork of Red Dog Creek												
Date	Reference	matrix		Al	Cd	Cu	Fe	Pb	Zn
				mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
7/1/95	Cominco			0.197	5E-05	0.0008	0.308	0.0009	0.01
7/4/95	Cominco				0.0352	0.006		0.0476	4.53
7/7/95	Cominco				0.0386	0.0078		0.061	5.29
7/10/95	Cominco			0.106	0.0431	0.109		0.0586	5.96
7/14/95	Cominco				0.0395	0.0062	0.124	0.0501	4.68
7/19/95	Cominco				0.0463	0.0073		0.0617	5.25
7/22/95	Cominco			0.112	0.0456	0.0038		0.0429	4.96
7/25/95	Cominco				0.0487	0.0042		0.0402	4.89
7/28/95	Cominco				0.0458	0.0038		0.0363	4.93
7/30/95	Cominco				0.0406	0.0042		0.0352	4.41
8/4/95	Cominco				0.0398	0.003		0.0301	5.11
8/8/95	Cominco		<	0.05	0.0425	0.0062	0.088	0.0368	4.38
8/11/95	Cominco				0.0432	0.0078		0.0374	4.92
8/13/95	Cominco				0.0537	0.0021		0.0391	4.92
8/17/95	Cominco		<	0.05	0.0496	0.002	0.077	0.0377	5.19
8/23/95	Cominco		<	0.05	0.0536	0.0018	0.071	0.0412	5.68
8/25/95	Cominco				0.0538	0.0023		0.0444	6.39
8/27/95	Cominco				0.0559	0.0002		0.0481	5.55
8/31/95	Cominco				0.0475	0.0022		0.0329	5.11

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
6/13/92	Cominco	242	40		6.6	4	10.2	5	0.066	
6/15/92	Cominco	25.2	47		6.1	4.2	9.7	3.7	0.065	
6/28/92	Cominco	49.1	79		6.3	6.2	6.9	1.8	0.077	
7/4/92	Cominco	75	111		6.0	10.0	8.5	2.10	0.177	
7/4/92	Cominco	75	111		6.0	10.0	8.5			2.10
7/11/92	Cominco	109	153		6.7	12.2	6.6	---	0.254	
7/11/92	Cominco	109	153		6.7	12.2	6.6			---
7/15/92	Cominco	118	197		6.5	8.4		1.00	0.285	
7/15/92	Cominco	118	197		6.5	8.4				1.00
7/18/92	Cominco	127	219		6.3	11.7	3.3	1.10	0.343	
7/18/92	Cominco	127	219		6.3	11.7	3.3			1.10
7/22/92	Cominco	146	266		6.6	12.4	5.2	0.17	0.370	
7/22/92	Cominco	146	266		6.6	12.4	5.2			0.17
7/25/92	Cominco	159	324		6.2	12.6	7.4	0.25	0.426	
7/25/92	Cominco	159	324		6.2	12.6	7.4			0.25
7/29/92	Cominco	173	323		6.6	15.4	4.8			0.35
7/29/92	Cominco	173	323		6.6	15.4	4.8	0.35	0.487	
7/31/92	Cominco	190	321		5.9	13.5	10.0	0.15	0.455	
7/31/92	Cominco	190	321		5.9	13.5	10.0			0.15
8/3/92	Cominco	209	394		5.7	13.6	9.8	0.2	0.500	
8/6/92	Cominco	214	412		6.6	10.6	6.8	0.4	0.515	
8/12/92	Cominco	109	166		6.4	5.9	6.4	1.0	0.055	
8/15/92	Cominco	126	180		6.2	3.5	6.4	0.4	0.213	
8/17/92	Cominco	120	165		7.4	4.8	16**	0.5	0.255	
8/21/92	Cominco	106	150		8.2	6.6	10.0	0.7	0.213	
8/28/92	Cominco	123	184		7.6	7.0	8.0	0.7	0.287	
8/30/92	Cominco	110	159		6.1	8.1	8.3	1.7	0.027	
9/3/92	Cominco	116	16.6		8.1	3.6	6	0.54	0.238	
9/5/92	Cominco	122	181		6.7	3.6	7.5	0.4	0.260	
9/8/92	Cominco	130	196		7.0	3.3	10.1	0.22	0.263	
9/10/92	Cominco	128	211		7.5	3.3	7.7	0.7	0.290	
9/18/92	Cominco	155	248		7.3	1.2	12.5	0.2	0.202	
9/24/92	Cominco	195	303		6.8	0	11.9	0.29	0.484	
9/25/92	Cominco	197	351		6.6	0	10.1	0.4	0.480	
9/29/92	Cominco	217	416		6.0	0	7.6	0.22	0.480	
10/1/92	Cominco	232	456		6.2	-0.1	5.4	0.16	0.580	
5/16/93	Cominco				6					
5/19/93	Cominco				6.2	2	13.2			

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
5/25/93	Cominco									
6/4/93	Cominco									
6/9/93	Cominco				7	5				
6/10/93	Cominco									
6/17/93	Cominco									
6/26/93	Cominco									
6/30/93	Cominco									
7/6/93	Cominco									
7/16/93	Cominco									
7/25/93	Cominco									
8/2/93	Cominco				7	5				
8/11/93	Cominco				6.6	5				
8/18/93	Cominco				7	6				
8/24/93	Cominco				7.2	5				
9/1/93	Cominco				7.5	3		0.5	300	315.3
9/9/93	Cominco				7.9					
9/14/93	Cominco									6.2
9/24/93	Cominco				7	0				17.4
5/19/94	Cominco						6.8	1		66.4
5/27/94	Cominco						6.3			33.7
6/8/94	Cominco						7	6		26
6/16/94	Cominco						6.9	5		16
7/12/94	Cominco									33.7
7/21/94	Cominco									10.6
7/29/94	Cominco									25
8/13/94	Cominco									
8/23/94	Cominco									
9/6/94	Cominco						6.7	5		
9/23/94	Cominco						6.9	1		
10/8/94	Cominco									
10/27/94	Cominco						6.7	1		
6/4/95	Cominco		190							11.6
6/8/95	Cominco		105							24.2
6/8/95	Cominco		112							20.3
6/11/95	Cominco		109	71						20.3
6/14/95	Cominco		120							17.4
6/19/95	Cominco		131							12.6
6/21/95	Cominco		152							20.3
6/23/95	Cominco		163							6.9

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body										
Date	Reference	Hard	TDS	SO4	pH	Temp.	D.O.	Turb	Cond	Flow, cfs
		mg/L	mg/L	mg/L		°C	mg/L	NTU		
6/26/95	Cominco		273							
7/5/95	Cominco		230							
7/7/95	Cominco		232							
7/10/95	Cominco		210							
7/13/95	Cominco		298							
7/17/95	Cominco		327							
7/19/95	Cominco		327							
7/21/95	Cominco		397							
7/24/95	Cominco		428							
7/26/95	Cominco		447							
7/28/95	Cominco		490							
7/31/95	Cominco		561							
8/2/95	Cominco		566							2.3
8/4/95	Cominco		615							2.1
8/6/95	Cominco		624							2.3
8/9/95	Cominco		593							2.6
8/11/95	Cominco		587							3.4
8/13/95	Cominco		574							4.1
8/17/95	Cominco		557							3.2
8/20/95	Cominco		535							3.2
8/23/95	Cominco		535							4.4
8/25/95	Cominco		521							4.9
8/27/95	Cominco		542							4.9
8/30/95	Cominco		515							4.1

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body														
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L
6/13/92	Cominco	TR		0.14		0.012	<	0.01		0.396		0.111		1.47
6/15/92	Cominco	TR		0.14		0.012	<	0.01		0.354		0.071		2.07
6/28/92	Cominco	TR		0.06		0.017	<	0.01		0.169		0.057		2.25
7/4/92	Cominco	TR	<	0.05		0.025	<	0.01		0.083		0.046		3.99
7/4/92	Cominco	TR	<	0.05		0.025	<	0.01		0.083		0.046		3.99
7/11/92	Cominco	TR	<	0.05		0.035	<	0.01	<	0.020		0.072		5.76
7/11/92	Cominco	TR	<	0.05		0.035	<	0.01	<	0.020		0.072		5.76
7/15/92	Cominco	TR	<	0.05		0.054	<	0.01	<	0.020		0.117		9.99
7/15/92	Cominco	TR	<	0.05		0.054	<	0.01	<	0.020		0.117		9.99
7/18/92	Cominco	TR	<	0.05		0.074	<	0.01	<	0.020		0.182		138.00
7/18/92	Cominco	TR	<	0.05		0.074	<	0.01	<	0.020		0.182		138.00
7/22/92	Cominco	TR		0.07		0.117	<	0.01		0.023		0.181		21.60
7/22/92	Cominco	TR		0.07		0.117	<	0.01		0.023		0.181		21.60
7/25/92	Cominco	TR		0.06		0.129	<	0.01	<	0.020		0.242		23.10
7/25/92	Cominco	TR		0.06		0.129	<	0.01	<	0.020		0.242		23.10
7/29/92	Cominco	TR	<	0.05		0.165	<	0.01	<	0.020		0.352		28.60
7/29/92	Cominco	TR	<	0.05		0.165	<	0.01	<	0.020		0.352		28.60
7/31/92	Cominco	TR		0.07		0.187	<	0.01	<	0.020		0.394		33.80
7/31/92	Cominco	TR		0.07		0.187	<	0.01	<	0.020		0.394		33.80
8/3/92	Cominco	TR		0.05		0.192	<	0.01	<	0.020		0.438		34.60
8/6/92	Cominco	TR	<	0.05		0.199	<	0.01		0.047		0.504		36.20
8/12/92	Cominco	TR		0.08		0.024	<	0.01		0.134		0.057		3.51
8/15/92	Cominco	TR		0.07		0.030	<	0.01		0.063		0.050		5.00
8/17/92	Cominco	TR	<	0.05		0.028	<	0.01		0.055		0.052		4.41
8/21/92	Cominco	TR		1.61		0.032		0.07		3.690		1.940		3.75
8/28/92	Cominco	TR	<	0.05		0.038	<	0.01		0.055		0.206		5.43
8/30/92	Cominco	TR		0.10		0.037	<	0.01		0.111		0.306		4.65
9/3/92	Cominco	TR		0.06		0.032	<	0.01		0.13		0.170		4.44
9/5/92	Cominco	TR	<	0.05		0.034	<	0.01		0.05		0.148		4.94
9/8/92	Cominco	TR	<	0.05		0.037	<	0.01		0.03		0.117		5.87
9/10/92	Cominco	TR	<	0.05		0.042		0.01		0.04		0.110		7.04
9/18/92	Cominco	TR	<	0.05		0.078	<	0.01		0.02		0.170		14.10
9/24/92	Cominco	TR	<	0.05		0.112		0.01		0.02		0.204		20.70
9/25/92	Cominco	TR	<	0.05		0.145	<	0.01		0.02		0.266		26.40
9/29/92	Cominco	TR	<	0.05		0.194		0.01	<	0.020		0.400		34.80
10/1/92	Cominco	TR	<	0.05		0.216	<	0.01	<	0.020		0.408		39.90
5/16/93	Cominco			0.27		0.146		0.02		1.68		0.424		16.30
5/19/93	Cominco			0.17		0.029	<	0.01		0.584		0.326		3.14
5/25/93	Cominco			0.08		0.016						0.158		1.80

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body														
Date	Reference	matrix		Al		Cd		Cu		Fe		Pb		Zn
				mg/L		mg/L		mg/L		mg/L		mg/L		mg/L
6/4/93	Cominco	TR		0.15		0.012						0.208		1.63
6/9/93	Cominco	TR		0.1		0.016						0.141		1.62
6/10/93	Cominco	TR		0.09		0.011	<	0.01		0.17		0.101		1.13
6/17/93	Cominco	TR		0.07		0.010						0.112		1.10
6/26/93	Cominco	TR		0.07		0.012						0.089		1.34
6/30/93	Cominco	TR	<	0.05		0.014						0.080		1.27
7/6/93	Cominco	TR	<	0.05		0.012						0.064		1.32
7/16/93	Cominco	TR	<	0.05		0.019						0.084		1.97
7/25/93	Cominco	TR	<	0.05		0.020						0.051		1.89
8/2/93	Cominco	TR		0.21		0.030						0.580		2.92
8/11/93	Cominco	TR	<	0.05		0.025						0.093		3.08
8/18/93	Cominco	TR	<	0.05		0.025						0.059		2.69
8/24/93	Cominco	TR		0.08		0.024						0.074		2.60
9/1/93	Cominco	TR	<	0.05		0.025						0.050		2.77
9/9/93	Cominco	TR		0.06		0.023						0.096		2.63
9/14/93	Cominco	TR		0.46		0.017						0.366		1.89
9/24/93	Cominco	TR		0.08		0.032						0.299		3.53
5/19/94	Cominco	TR		0.392		0.035						0.54		4.11
5/27/94	Cominco	TR		0.105		0.024						0.23		2.62
6/8/94	Cominco	TR		0.103		0.012						0.22		1.57
6/16/94	Cominco	TR	<	0.05	<	0.015				0.101		0.2		1.81
7/12/94	Cominco	TR		0.088		0.029						0.16		2.57
7/21/94	Cominco	TR		0.055		0.032						0.13		3.88
7/29/94	Cominco	TR		0.072		0.031						0.14		3.23
8/13/94	Cominco	TR		0.263		0.039						0.21		4.37
8/23/94	Cominco	TR		1.05		0.1		0.058				0.21		13.20
9/6/94	Cominco	TR		1.47		0.114						0.21		15.70
9/23/94	Cominco	TR		0.699		0.137						0.49		18.50
10/8/94	Cominco	TR	<	0.05		0.148						0.15		20.00
10/27/94	Cominco	TR		0.077		0.15						0.21		29.50
6/4/95	Cominco	TR				0.058		0.015				0.24		8.69
6/8/95	Cominco	TR		0.196		0.033		0.01		0.236		0.18		5.03
6/8/95	Cominco	TR				0.034		0.011				0.18		5.74
6/11/95	Cominco	TR				0.032		0.01				0.16		4.78
6/14/95	Cominco	TR				0.032		0.012				0.2		5.59
6/19/95	Cominco	TR				0.033		0.013				0.18		5.87
6/21/95	Cominco	TR				0.037		0.011				0.25		6.60
6/23/95	Cominco	TR				0.039		0.013				0.21		7.50

Appendix 12, continued.

Station 140: Bypass Channel around Ore Body								
Date	Reference	matrix	Al	Cd	Cu	Fe	Pb	Zn
			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
6/26/95	Cominco	TR		0.074	0.015		0.24	13.40
7/5/95	Cominco	TR		0.063	0.017		0.17	11.50
7/7/95	Cominco	TR		0.058	0.017		0.14	11.40
7/10/95	Cominco	TR		0.063	0.02		0.13	11.80
7/13/95	Cominco	TR		0.071	0.016		0.16	14.70
7/17/95	Cominco	TR		0.085	0.019		0.19	15.70
7/19/95	Cominco	TR		0.089	0.016		0.17	18.40
7/21/95	Cominco	TR		0.106	0.016		0.15	21.00
7/24/95	Cominco	TR		0.103	0.008		0.16	23.20
7/26/95	Cominco	TR		0.112	0.007		0.15	25.30
7/28/95	Cominco	TR		0.262	0.014		0.35	25.50
7/31/95	Cominco	TR		0.115	0.006		0.17	29.10
8/2/95	Cominco	TR		0.148	0.006		0.19	30.30
8/4/95	Cominco	TR		0.15	0.006		0.19	32.80
8/6/95	Cominco	TR		0.17	0.019		0.21	33.60
8/9/95	Cominco	TR		0.168	0.017		0.22	33.20
8/11/95	Cominco	TR		0.156	0.015		0.23	31.20
8/13/95	Cominco	TR		0.15	0.014		0.2	25.80
8/17/95	Cominco	TR		0.141	0.008		0.16	30.30
8/20/95	Cominco	TR		0.143	0.011		0.17	29.20
8/23/95	Cominco	TR		0.145	0.012		0.22	28.20
8/25/95	Cominco	TR		0.138	0.012		0.18	28.40
8/27/95	Cominco	TR		0.136	0.013		0.22	24.10
8/30/95	Cominco	TR		0.135	0.01		0.16	26.90

Appendix 12, continued.

North Fork of Red Dog Creek											
Water Quality											
Station	Date	Reference	Hard	TDS	SO4		TSS	pH	Temp.	Turb	Cond
			mg/L	mg/L	mg/L		mg/L		°C	NTU	
Station 12	9/7/92	Cominco	208	248		<	5	7.7	3	0.44	0.363
Station 12	9/12/92	Cominco	218	273			5	7.8	2.8	0.6	0.357
Station 12	6/1/95	Cominco		101				7.5	7		
Station 12	6/7/95	Cominco		152		<	5	7.7	7		
Station 12	6/12/95	Cominco		155	55	<	5	8.1	5.2		
Station 12	6/18/95	Cominco		148		<	5	8		2	229
Station 12	6/27/95	Cominco		225		<	5				
Station 12	7/1/95	Cominco		1030		<	5				
Station 12	7/7/95	Cominco		201		<	5				
Station 12	7/10/95	Cominco		178		<	5				
Station 12	7/19/95	Cominco		223		<	5				
Station 12	7/25/95	Cominco		256		<	5				
Station 12	7/30/95	Cominco		290		<	5				
Station 12	8/8/95	Cominco		317		<	5				
Station 12	8/13/95	Cominco		297		<	5				
Station 12	8/23/95	Cominco		279		<	5		10		
Station 12	8/27/95	Cominco		310		<	5				

Appendix 12, continued.

North Fork of Red Dog Creek											
Metals Concentrations											
Station	Date		Al		Cd		Cu		Pb		Zn
			mg/L		mg/L		mg/L		mg/L		mg/L
Station 12	9/7/92	<	0.05	<	0.003	<	0.01	<	0.002	<	0.01
Station 12	9/12/92	<	0.05	<	0.003	<	0.01	<	0.002	<	0.01
Station 12	6/1/95		0.156	<	0.003	<	0.01	<	0.002		0.1
Station 12	6/7/95				0.00009		0.0013		0.00036		0.008
Station 12	6/12/95			<	0.00004		0.0012		0.00012		0.008
Station 12	6/18/95				0.00004		0.0008		0.0002		0.01
Station 12	6/27/95				0.00008		0.0025		0.00015		0.013
Station 12	7/1/95				0.032		0.0107		0.165		3.94
Station 12	7/7/95			<	0.00004		0.0012		0.00014	<	0.01
Station 12	7/10/95		0.131								
Station 12	7/19/95				0.00006		0.0011		0.00029		0.013
Station 12	7/25/95			<	0.00004		0.0011		0.00009		0.018
Station 12	7/30/95				0.00004		0.0009		0.00011		0.008
Station 12	8/8/95				0.0002		0.0009		0.00009		0.009
Station 12	8/13/95				0.0008		0.0009		0.0001		0.009
Station 12	8/23/95				0.00025		0.0005		0.00039		0.011
Station 12	8/27/95				0.00012		0.0004		0.00012		0.008

Appendix 12, continued.

All data collected by Cominco Alaska Inc.																
Date	Hard		Al		Cd		Cu		Fe		Pb		Zn	pH
	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
Connie Creek														
5/12/95			0.37		0.005	<	0.01		1.22		0.196		0.615	6.60
5/31/95	51		0.11	<	0.003	<	0.01		0.17		0.016		0.088	6.70
6/7/95			0.17		0.003		0.0023		0.12		0.002		0.006	7.00
6/8/95			0.09		0.004		0.0021		0.12		0.009		0.065	6.60
6/26/95	79		0.08		0.007		0.0021		0.05		0.004		0.107	7.40
7/4/95	76.2		0.087		0.0006		0.0020		0.08		0.013		0.1	7.3
7/24/95	132	<	0.05		0.0011		0.002		0.06		0.005		0.16	
7/31/95	148	<	0.05		0.0009		0.002		0.06		0.005		0.14	
8/15/95			0.347		0.186		0.056				0.273		36.8	
9/3/95			0.073		0.0008		0.003		0.09		0.005		0.14	
9/21/95			0.05		0.0007		0.002		0.06		0.003		0.11	
10/7/95			0.101		0.0011		0.003		0.26		0.014		0.17	
Rachael Creek														
5/12/95			1.59	<	0.0030		0.06		0.25		0.048		0.202	4.70
5/31/95	164		2.19	<	0.0030		0.06		1.79		0.007		0.357	5.10
5/26/95	256		1.59		0.0023		0.05		1.57		0.002		0.506	5.80
7/4/95	252		1.81		0.0021		0.064		1.61		8E-04		0.51	5.9
			1.99	<	0.003		0.084			<	0.001		0.62	
7/19/95	413		1.57		0.003		0.06		3.3		5E-04		0.71	
7/31/95	491		1.17		0.0031		0.043		2.8		0.002		0.78	
8/15/95			1.53		0.0038		0.047		4.22		8E-04		0.84	
9/3/95			1.97		0.0033		0.073		4.28		3E-04		0.8	
9/21/95					0.0037		0.072				4E-04		0.83	
10/7/95			3.27		0.0031		0.073		3.77		8E-04		0.78	

Appendix 12, concluded.

All data collected by Cominco Alaska Inc.														
Date	Hard		Al		Cd		Cu		Fe		Pb		Zn	pH
	mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L	
Shelly Creek														
5/12/95			0.238		0.005	<	0.01		0.4		0.154		0.29	6.4
5/31/95	33.1		0.077	<	0.003	<	0.01		0.27		0.011		0.4	6.8
6/7/95			0.175		0.0006		0.003		0.4		0.028		0.47	6.7
6/7/95			0.108		0.0006		0.002		0.19		0.005		0.09	6.7
6/26/95	61.9		0.125		0.0104		0.006		0.2		0.018		1.35	7.1
7/4/95	61.1		0.137		0.01		0.006		0.19		0.02		1.28	7.3
7/12/95			0.304		0.017		0.014				0.049		1.89	
7/24/95	102		0.436		0.0237		0.015		0.55		0.05		3.23	
7/29/94		<	0.1		0.01				0.3		0.04		0.86	
7/31/95	116		0.549		0.0322		0.021		0.82		0.071		4.2	
8/15/95			0.461		0.0316		0.019		0.7		0.065		3.59	
9/3/95			0.472		0.0297		0.02		0.89		0.604		3.55	
9/21/95			0.504		0.0447		0.024		1.06		0.083		5.1	
10/7/95			0.511		0.0367		0.021		1.22		0.079		4.13	
Sulfur Creek														
5/12/95			5.97		0.009		0.02		20.10		2.120		1.240	6.50
5/31/95	87.3	<	0.05		0.004	<	0.01		0.153		0.193		0.494	7.00
6/26/95	130.0	<	0.05		0.012		0.0022		0.036		0.094		1.900	7.00
7/4/95	133		0.053		0.0049		0.001		0.06		0.089		0.7	7.4
7/12/95			0.061		0.003	<	0.01				0.069		0.4	
7/24/95	140	<	0.05		0.0096		0.003		0.05		0.066		1.68	
August	no flow													

Appendix 13. Water quality and metals concentrations in mine effluent, 1995.

Red Dog Mine Discharge, Water Quality												
Date	Hardness	TDS	SO4		TSS		Cn\Tot		Cn/WAD	pH	Temp.	Flow, cfs
	mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		°C	
5/9/95	1400		1200				0.04		0.05	9.5	4	7.33
5/10/95		1800		<	5					9.9	4	10.79
5/11/95										9.5	4	10.49
5/12/95		1300	750	<	5		0.06		0.06	9.5	4	10.49
5/13/95										9.7	4	10.73
5/14/95										9.5	3	10.63
5/15/95		1040	690	<	5		0.02		0.03	9.5	3	10.55
5/16/95										9.6	2	10.63
5/17/95										9.6	2	10.46
5/18/95		1370	890	<	5		0.01		0.01	9.7	2	11.31
5/19/95										9.7	3	10.78
5/20/95										10	3	10.55
5/21/95										10	3	3.45
5/22/95			1400	<	5		0.01		0.01	11	4	7.77
5/23/95		2060								10	4	10.94
5/24/95										10	4	11.12
5/25/95		2000	1200	<	5		0.01		0.01	10	4	11.1
5/26/95										10	5	11.65
5/27/95										10	4	5.24
5/28/95										10	4	11.04
5/29/95		1820	1200	<	5		0.01		0.01	10	5	10.7
5/30/95										10	6	10.02
5/31/95										10	6	6.62
6/1/95	1310	1780	1300	<	5		0.01		0.01	10	6	2.2
6/2/95												
6/3/95		2200		<	5					10	6	17.3
6/4/95	1550	1210	1600	<	5				0.02	10	5	17.1
6/4/95	1580						0.02					
6/4/95												
6/5/95							0.01		0.02	10	6	18.2
6/6/95		2240		<	5					10	6	15.4
6/7/95		2260		<	5		0.01		0.01	10	7	19.1
6/7/95							0.01					
6/8/95		2190		<	5		0.01			10	8	19.6
6/9/95	1540	2300	1200	<	5	<	0.01	<	0.01	10	9	19.6
6/10/95		2270		<	5	<	0.01	<	0.01	10	10	19.9

Appendix 13, continued.

Red Dog Mine Discharge, Water Quality												
Date	Hardness	TDS	SO4		TSS		Cn\Tot		Cn/WAD	pH	Temp.	Flow, cfs
	mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		°C	
6/11/95		2230	1600	<	5					10	10	19.8
6/12/95	1530	2340	1600	<	5	<	0.01	<	0.01	10	10	20.1
6/13/95		2370	1600	<	5					10	9	20.5
6/14/95		2370	1600	<	5					10	9	20.7
6/14/95		2400		<	5							
6/15/95		2350	1800	<	5	<	0.01			9.9	10	21
6/16/95		2370		<	5					9.9	10	21.1
6/17/95		2420		<	5					9.9	9	21.4
6/18/95		2310		<	5					9.4	10	20.9
6/19/95		2430		<	5	<	0.01	<	0.01	9.4	11	21
6/20/95		2390		<	5					9.4	11	20
6/21/95	1590	2440	1700	<	5	<	0.01	<	0.01	9.5	11	20.4
6/22/95		2300		<	5					9.4	11	16.3
6/23/95	1590	2440		<	5	<	0.01	<	0.01	9.7	11	15.7
6/24/95		2310		<	5					9.6	11	13
6/25/95	1600	2410	1700	<	5					9.2	10	19.1
6/26/95	1630	1920	1700	<	5	<	0.01	<	0.01	9.4	10	19
6/27/95		2380		<	5					9.7	11	18.2
6/28/95		2340	1700	<	5					9.6	11	14.1
6/28/95		2450		<	5							
6/29/95	1630					<	0.01	<	0.01	9.6	12	25
6/30/95		2440		<	5					9.5	12	25.4
7/1/95		2384		<	5	<	0.01			9.7	12	25.5
7/2/95	1610	2290	1700	<	5					9.6	12	25.6
7/3/95		2330		<	5	<	0.01			9.7	13	25.6
7/4/95		2350		<	5					9.8	12	25.5
7/5/95		2350		<	5					9.7	11	25.2
7/6/95	1580	2300	1700	<	5	<	0.01			9.7	11	24.8
7/7/95	1600	2450	1700	<	5					9.7	11	25.4
7/8/95		2490		<	5					9.7	11	25.6
7/9/95		2450		<	5					9.7	11	25.7
7/10/95	1620	2410		<	5	<	0.01			9.7	11	22.6
7/11/95		2460	1700	<	5					9.6	12	25.3
7/12/95		2470		<	5					9.6	13	24.5
7/13/95	1660	2520	1700	<	5	<	0.01			9.6	14	24.7
7/14/95		2500		<	5					9.6	16	24.8
7/15/95		2540		<	5					9.5	15	24.5

Appendix 13, continued.

Red Dog Mine Discharge, Water Quality												
Date	Hardness	TDS	SO4		TSS		Cn\Tot		Cn/WAD	pH	Temp.	Flow, cfs
	mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		°C	
7/16/95		2540		<	5					9.5	16	24.4
7/17/95		2500		<	5					9.5	15	24.4
7/18/95		2300		<	5					9.5	15	24.9
7/19/95	1640	2420	1600	<	5	<	0.01			9.4	14	24.8
7/20/95	1560	2370		<	5					9.4	13	24.7
7/21/95		2400	1600	<	5	<	0.01			9.6	13	24.6
7/22/95	1710	2540		<	5					9.4	14	17.4
7/23/95	1730	2470	1700	<	5	<	0.01			9.4	13	24.5
7/24/95		2470		<	5					9.4	13	24.5
7/25/95		2470		<	5					9.4	13	24.5
7/26/95		2470	1700	<	5	<	0.01			9.4	13	24.5
7/27/95		2500		<	5					9.5	14	24.2
7/28/95		2430		<	5	<	0.01			9.5	15	23.2
7/29/95		2430		<	5					9.4	15	24.7
7/30/95		2450		<	5					9.7	15	24.9
7/31/95		2400		<	5	<	0.01			9.5	14	24.9
8/1/95		2450		<	5					9.8	14	25.4
8/2/95		2420		<	5					9.8	14	25.1
8/3/95	1760	2530	1700	<	5					9.8	14	25.1
8/4/95	1880	2610	1700	<	5	<	0.01			9.8	15	25
8/5/95		2440		<	5					9.8	14	25.2
8/6/95	1640	2450		<	5	<	0.01			9.8	13	24.8
8/7/95		2560	1700	<	5					9.8	13	24.8
8/8/95		2510		<	5					9.8	13	24.6
8/9/95	1680	2470		<	5	<	0.01			9.8	13	24.5
8/10/95		2460	1700	<	5					9.8	13	24.3
8/11/95	1670	2460	1800	<	5	<	0.01			9.8	14	24.2
8/12/95		2490		<	5					9.8	14	24.3
8/13/95		2570		<	5					9.8	14	22.6
8/14/95	1650	2490	1700	<	5	<	0.01			9.8	14	24.2
8/15/95		2560		<	5					9.8	13	24
8/16/95		2550		<	5					9.7	13	24
8/17/95		2590		<	5					9.7	13	24.1
8/18/95	1790	2460	1700	<	5		0.02			9.7	13	24.3
8/19/95		2510	1800	<	5					9.7	13	21.9
8/20/95	1710	2510		<	5	<	0.01			9.7	13	23.8
8/21/95		2480		<	5					9.7	13	24.1

Appendix 13, continued.

Red Dog Mine Discharge, Water Quality											
Date	Hardness	TDS	SO4		TSS		Cn\Tot		Cn/WAD	pH	Temp.	Flow, cfs
	mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		°C	
8/22/95		2500		<	5					9.4	13	24.3
8/23/95	1720	2460	1800	<	5	<	0.01			9.6	13	23.7
8/24/95		2510		<	5					9.5	13	24.2
8/25/95		2490		<	5	<	0.01			9.4	13	24
8/26/95		2570		<	5					9.5	13	24
8/27/95		2620		<	5					9.5	13	23.9
8/28/95	1580	2490	1800	<	5	<	0.01			9.8	13	23.9
8/29/95		2550		<	5					9.5	13	23.9
8/30/95		2590		<	5					9.5	13	23.9
8/31/95		2620		<	5					9.5	13	23.7

Appendix 13, continued.

Red Dog Mine Discharge, metals concentrations																
All metals are as total recoverable, sampled from the mine effluent.																
Date		Al		Cd		Cu		Hg		Pb		AG		Zn		
		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		
5/9/95	<	0.05		0.014		0.041		0.0005		0.004		0.003		0.13		
5/10/95																
5/11/95																
5/12/95	<	0.05		0.01		0.071		0.0005	<	0.002		0.01		0.04		
5/13/95																
5/14/95																
5/15/95	<	0.05		0.006		0.03		0.0005	<	0.002		0.01		0.05		
5/16/95																
5/17/95																
5/18/95	<	0.05		0.007	<	0.01		0.0005		0.012		0.01		0.13		
5/19/95																
5/20/95																
5/21/95																
5/22/95	<	0.05		0.009	<	0.01		0.0005		0.004		0.01		0.06		
5/23/95																
5/24/95																
5/25/95	<	0.05		0.008	<	0.01		0.0005		0.005		0.01		0.1		
5/26/95																
5/27/95																
5/28/95																
5/29/95	<	0.05		0.008	<	0.01		0.0005		0.005		0.01		0.12		
5/30/95																
5/31/95																
6/1/95	<	0.05		0.009	<	0.01				0.003		0.01		0.08		
6/2/95																
6/3/95				0.0083		0.0149		0.0005		0.00125				0.04		
6/4/95	<	0.05		0.0087		0.015		0.0005		0.00157		7E-05		0.04		
6/4/95	<	0.05		0.0095		0.0178		0.0005		0.00269		5E-05		0.08		
6/4/95				0.007		0.015		0.0005	<	0.002				0.03		
6/5/95				0.0091		0.0149				0.00094						
6/6/95				0.0078		0.0139		0.0001		0.00099				0.04		
6/7/95		0.08		0.0077		0.0127		0.0001		0.00094				0.04		
6/7/95				0.0081		0.0124		0.0001		0.0021		5E-05		0.17		
6/8/95				0.0074		0.0111		0.0001		0.00096				0.04		
6/9/95	<	0.05		0.0089		0.0108		0.0001		0.00133		0.01		0.05		
6/10/95				0.0093		0.0079		0.0001		0.001				0.04		
6/11/95				0.0096		0.0069		0.0001		0.0009				0.04		
6/12/95	<	0.05		0.0095		0.0069		0.0001		0.0009		0.01		0.05		

Appendix 13, continued.

Red Dog Mine Discharge, metals concentrations												
All metals are as total recoverable, sampled from the mine effluent.												
Date		Al		Cd	Cu		Hg		Pb		AG	Zn
		mg/L		mg/L	mg/L		mg/L		mg/L		mg/L	mg/L
6/13/95				0.0092	0.0054		0.0001		0.0009			0.05
6/14/95				0.0084	0.0067		0.0005		0.001			0.04
6/14/95												
6/15/95	<	0.05		0.0079	0.0069		0.0005		0.00073		0.01	0.04
6/16/95				0.0086	0.0073		0.0005		0.00079			0.04
6/17/95				0.0079	0.0071		0.0005		0.00073			0.05
6/18/95				0.0278	0.0076		0.0002		0.00052			0.05
6/19/95				0.0338	0.0081		0.0002		0.00036			0.05
6/20/95				0.0159	0.0063		0.0005		0.0007			0.03
6/21/95	<	0.05		0.0136	0.0058		0.0005		0.00076		0.1	0.06
6/22/95				0.0136	0.0058		0.0005		0.00045			0.04
6/23/95	<	0.05		0.0137	0.006		0.0005		0.00074		0.01	0.05
6/24/95				0.0134	0.0054		0.0005		0.00102			0.06
6/25/95	<	0.05		0.0163	0.0066		0.0001		0.0011		0.01	0.09
6/26/95				0.0155	0.0058		0.0001		0.00054		0.01	0.04
6/27/95				0.0143	0.0055		0.0001		0.00045			0.04
6/28/95				0.0148	0.0068		0.0001		0.0005			0.04
6/28/95												
6/29/95	<	0.05			0.0039		0.0001		0.00047		0.01	0.04
6/30/95					0.0053		0.0001		0.00057			0.04
7/1/95				0.0135	0.0044		0.0001		0.00042			0.03
7/2/95	<	0.05		0.0137	0.004		0.0001		0.00036		0.01	0.03
7/3/95				0.0135	0.0044		0.0001		0.00042			0.03
7/4/95				0.0121	0.0046		0.0001		0.00035			0.03
7/5/95				0.0113	0.0048		0.0001		0.0003			
7/6/95	<	0.05		0.0126	0.004		0.0001		0.00035		0.01	0.03
7/7/95	<	0.05		0.0125	0.0049		0.0001		0.00037		0.01	0.03
7/8/95				0.0122	0.0047		0.0001		0.00041			0.03
7/9/95				0.0123	0.0048		0.0001		0.00041			0.03
7/10/95	<	0.05		0.0122	0.0053		0.0001		0.00035		0.01	0.03
7/11/95				0.0116	0.0046		0.0001		0.00214			0.04
7/12/95				0.0108	0.0039		0.0001		0.0005			0.03
7/13/95				0.011	0.0043		0.0001		0.00046			0.03
7/14/95				0.0112	0.0029		0.0001		0.00068			0.04
7/15/95				0.0111	0.0025		0.0001		0.00079			0.05
7/16/95				0.0125	0.0026		0.0001		0.00076			0.04
7/17/95				0.0162	0.0027		0.0001		0.00052			0.04
7/18/95				0.0188	0.0035		0.0001		0.00048			0.04

Appendix 13, continued.

Red Dog Mine Discharge, metals concentrations									
All metals are as total recoverable, sampled from the mine effluent.									
Date		Al	Cd	Cu	Hg	Pb	AG	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
7/19/95	<	0.05	0.0181	0.0033	0.0001	0.00053	0.01	0.04
7/20/95			0.0199	0.003	0.0001	0.00046		0.03
7/21/95	<	0.05	0.0203	0.0029	0.0001	0.0004	0.01	0.03
7/22/95	<	0.05	0.0126	0.0023	0.0001	0.00036	0.01	0.03
7/23/95	<	0.05	0.0111	0.002	0.0001	0.00031	0.01	0.03
7/24/95	<	0.05	0.0203	0.0021	0.0001	0.00026	0.01	0.03
7/25/95	<	0.05	0.0152	0.0023	0.0001	0.00033		0.03
7/26/95			0.0172	0.0031	0.0001	0.00044		0.04
7/27/95			0.0159	0.0027	0.0001	0.00042		0.03
7/28/95			0.0144	0.0033	0.0001	0.00058		0.04
7/29/95			0.0188	0.0028	0.0001	0.0005		0.03
7/30/95			0.0162	0.0039	0.0001	0.00048		0.03
7/31/95			0.0157	0.0035	0.0001	0.00063		0.03
8/1/95			0.0125	0.004	0.0001	0.00066		0.03
8/2/95			0.0139	0.0026	0.0001	0.00114		0.04
8/3/95			0.0145	0.0029	0.0001	0.00093	0.01	0.04
8/4/95	<	0.05	0.0125	0.0029	0.0001	0.00087	0.01	0.04
8/5/95			0.0138	0.0034	0.0003	0.0012		0.04
8/6/95	<	0.05	0.0147	0.0061	0.0002	0.00107	0.01	0.04
8/7/95			0.0144	0.0056	0.0003	0.00109		0.04
8/8/95			0.0142	0.0055	0.0002	0.00107		0.03
8/9/95	<	0.05	0.014	0.0053	0.0002	0.0009	0.01	0.34
8/10/95			0.0142	0.0079	0.0001	0.00099		0.03
8/11/95	<	0.05	0.0142	0.008	0.0001	0.00088	0.01	0.04
8/12/95			0.0149	0.0079	0.0001	0.00098		0.04
8/13/95			0.0193	0.0011	0.0001	0.00199		0.05
8/14/95	<	0.05	0.0179	0.0008	0.0001	0.0012	0.01	0.05
8/15/95			0.0154	0.0008	0.0001	0.00086		0.04
8/16/95			0.0161	0.001	0.0001	0.00077		0.04
8/17/95			0.017	0.0025	0.0001	0.00082		0.03
8/18/95	<	0.05	0.0166	0.0011	0.0001	0.00092	0.01	0.03
8/19/95			0.0157	0.001	0.0001	0.00123		0.03
8/20/95	<	0.05	0.032	0.0014	0.0001	0.00222	0.01	0.03
8/21/95			0.0307	0.0016	0.0001	0.00169		0.03
8/22/95			0.0308	0.0011	0.0001	0.0018		0.03
8/23/95	<	0.05	0.0172	0.0005	0.0001	0.00119	0.01	0.03
8/24/95			0.0184	0.0005	0.0001	0.00094		0.03
8/25/95			0.018	0.0005	0.0001	0.00114		0.03

Appendix 13, concluded.

Red Dog Mine Discharge, metals concentrations														
All metals are as total recoverable, sampled from the mine effluent.														
Date		Al		Cd		Cu		Hg		Pb		AG		Zn
		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L		mg/L
8/26/95				0.0175		0.0004		0.0001		0.0008				0.03
8/27/95				0.0201		0.0005		0.0001		0.00079				0.03
8/28/95	<	0.05		0.0187		0.0004		0.0001		0.00108		0.01		0.04
8/29/95				0.0175		0.0009		0.0001		0.00126				0.03
8/30/95				0.0159		0.0007		0.0002		0.00128				0.04
8/31/95				0.015		0.0008		0.0002		0.00117				0.04