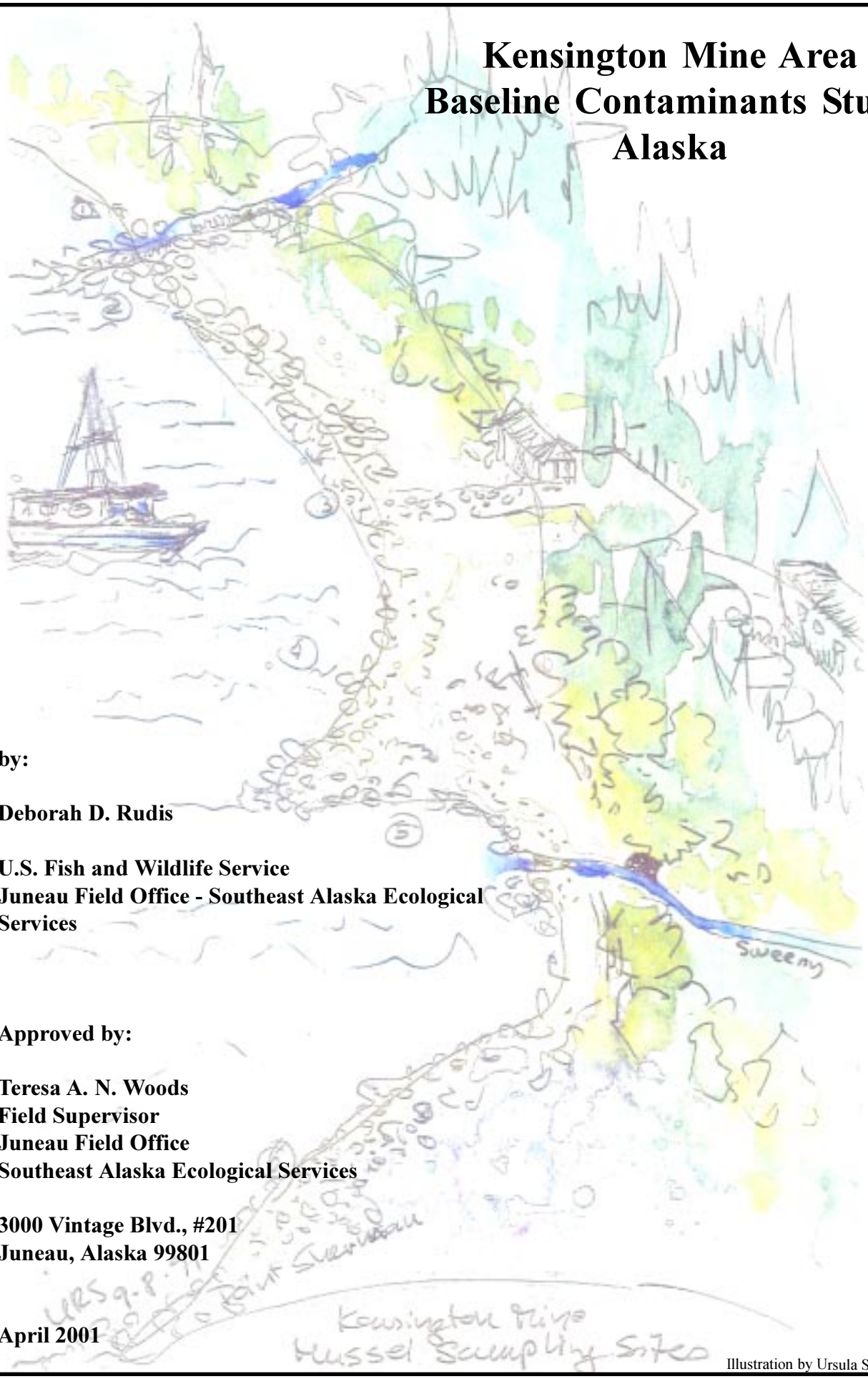
Kensington Mine Area Baseline Contaminants Study Alaska



by:

Deborah D. Rudis

U.S. Fish and Wildlife Service
Juneau Field Office - Southeast Alaska Ecological Services

Approved by:

Teresa A. N. Woods
Field Supervisor
Juneau Field Office
Southeast Alaska Ecological Services

3000 Vintage Blvd., #201
Juneau, Alaska 99801

April 2001

Illustration by Ursula Spannagal

SEES-TR-01-01
April 2001

Kensington Mine Area

Baseline Contaminants Study,

Alaska

by:

Deborah D. Rudis

U.S. Fish and Wildlife Service
Juneau Field Office - Southeast Alaska Ecological Services

Approved by:

Teresa A. N. Woods
Field Supervisor
Juneau Field Office - Southeast Alaska Ecological Services

3000 Vintage Blvd. #201
Juneau, Alaska
99801

April 2001

This report may be cited as follows:

Rudis, D.D. 2001. Kensington mine area baseline contaminants study, Alaska. Juneau Field Office, Southeast Alaska Ecological Services, Juneau Alaska, U.S. Fish and Wildlife Service, Technical report SEES-TR-01-01.16 pp.

Abstract

Hardrock mining for gold and other metals is proposed for the Kensington Mine, located on Lynn Canal in Southeast Alaska, approximately 45 miles north of Juneau. The adjacent Jualin Mine is in the exploration phase. Over a ten-year period, various scenarios have been proposed for the Kensington Mine, including the cyanidation process to extract gold from crushed ore-bearing rock, a tailings pond for tailings disposal above anadromous fish streams, mixing zones for excess tailings water into fresh and/or marine waters, dry upland tailings storage, and most recently, submarine tailings disposal, and on-site process water treatment. The Kensington Mine is located adjacent to marine waters that support large numbers of migratory waterfowl, salmon, and herring. There are few baseline data on metals in local organisms available to compare with later monitoring data if this and other mines become operational. The object of this study is to produce a set of data to be used as a pre-development baseline for metal and cyanide concentrations in sediments and biota from potentially affected areas near Kensington and adjacent mining properties.

Marine sediment was collected in 1994 from two coastal locations and blue mussels (*Mytilus trossulus)* were taken from six locations adjacent to the Kensington Mine site. Total metals and cyanide analyses were done for all samples. Dolly Varden (*Salvelinus malma*) and prickly sculpin (*Cottus asper*) were collected from Sherman and Sweeny Creeks, which flow through the Kensington Mine site. Metal concentrations in sediments (mean concentrations in ppm dry weight [DW]: As 9.65, Cd <0.1, Cr 24.41, Cu 43.94, Hg 0.027, Ni 17.75, Pb 6.07, Zn 47.24) were comparable to other Southeast Alaska locations that have not been affected by human activities. Cyanide concentrations (mean of 0.07 ppm DW) were close to the level of detection in all marine sediment samples. Metal concentrations in blue mussels were also comparable to those in mussels from other Southeast Alaska locations with the exception of cadmium. Cadmium concentrations (mean of 9.95 ppm DW) were higher than any concentrations previously reported from Southeast Alaska mussels. Composite samples of Dolly Varden and sculpin arsenic concentrations (1.88, 1.37 ppm DW, respectively) were higher than expected when compared to fish from other Southeast Alaska locations, but reflect naturally high arsenic levels reported in water from Sweeny and Sherman Creeks collected by Coeur Alaska. Other freshwater fish metal concentrations were similar to those reported in previous baseline studies from Southeast Alaska. These data will provide partial baseline data prior to any mine development.

Key words: Alaska, Kensington Mine, baseline metals, blue mussels, marine sediments, freshwater fish, cyanide

Table of Contents

Tables

Figures

Introduction

Hardrock mining for gold and other metals is proposed for the Kensington Mine and potentially for the adjacent Jualin Mine. Both of these mines are located on the west side of the Kakuhan Range adjacent to Lynn Canal in the northern section of Southeast Alaska (Fig.1), about 72 km (45 miles) north of Juneau, Alaska. Mining operations occurred intermittently between 1891 and 1937 in nearby Lionshead Mountain. Mine exploration work was initiated again in 1987. The proposed Kensington and Jualin mines are planned as underground mines employing the cyanidation process to extract gold from crushed ore-bearing rock. Coeur Alaska's 1999 plans for the Kensington Mine include submarine tailings disposal, and on-site process water treatment. Former plans included various options for wet and dry tailings disposal above anadromous fish streams, paste backfill of a portion of the tailings, and mixing zones for excess tailings water into fresh or marine waters.

Lynn Canal's marine waters support large numbers of migratory waterfowl, salmon and herring. Commercial gillnet fishing in the area is primarily for sockeye salmon *(Onchorhynchus nerka).* Herring (*Clupea harrengus*) fishing has occurred in the past but has been closed in recent years due to low stock abundance. Lynn Canal also supports a commercial Tanner crab (*Chionoecetes bairdi*) fishery. Dungeness *(Cancer magister)* and king crab species *(Paralithodes* spp.*)* are also present. Various species of shrimp, flatfishes, and other bottom fish occur in fair abundance (Dames and Moore 1987).

Sherman and Sweeney Creeks provide spawning areas for pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), and coho salmon (*O. kisutch*). Sherman Creek freshwater fish metals data and baseline fish and invertebrate population data were collected in Sherman and Sweeny Creeks by Konopacky Environmental for the mining company, Coeur Alaska. Water quality data was collected in Sherman and Sweeny Creeks by Coeur Alaska to meet various permit stipulations during this pre-development period.

In this study, marine sediment and blue mussel (*Mytilus trossulus)* samples were collected offshore of the Kensington site. Freshwater fish were collected from Sherman and Sweeny Creeks. All samples were analyzed for total metals and cyanide. These data will provide partial baseline data for Sherman and Sweeny Creeks and the near shore marine environment of Lynn Canal.

Study Objectives

1. Determine baseline metal and cyanide concentrations in marine sediments and select biota from the Kensington Mine area on Lynn Canal.

2. Determine baseline metal and cyanide concentrations in freshwater fish from Sherman and Sweeny Creeks.

Study Area and Methods

Beachfront vegetation at the site is predominately spruce and hemlock forest fringed with alder. The immediate shoreline of Lynn Canal is primarily large cobble and gravel with underlying fine sediments. The subtidal area sampled for sediment was below Mean Lower Low Water (the lowest of the low tides) in a zone of sand and mud past the upper zone of cobble substrate. Rocky outcrops occur at the mouth of Sherman Creek and north and south of Sweeny Creek. Blue mussel (*Mytilus trossulus)* mats occur at each of these locations. Other common inhabitants are acorn barnacles (*Balanus glandula*) and littorine snails (*Littorina sitkana*). Rockweed (*Fucus gardneri*) is found at the upper zone of the outcrops.

Riparian vegetation is intermittent and closely overhangs the stream margins. The lower reaches of Sherman and Sweeny Creeks contain gravel and boulders, and large woody debris is common, having been deposited upstream and transported downstream during high flow periods. Freshwater fish species recorded in these streams include rainbow trout (*Onchorhynchus mykiss*), Dolly Varden (*Salvelinus malma*), prickly sculpin (*Cottus asper*). The lower reaches seasonally support pink and coho salmon in Sherman Creek and also chum salmon in Sweeny Creek. Benthic macroinvertebrates found in both streams include all of the four primary functional feeding groups: shredders, collectors, scrapers, and predators (Konopacky Environmental 1992, 1995).

Sample Collection

Sampling was done from September 6 - 9, 1994, using the U.S. Fish and Wildlife Service vessel, the *M/V Curlew*. Weather during the sampling period was clear and initially windy. The wind abated in the afternoon of the second day allowing sediment sample collection. Marine sediment samples were taken at the mouth of Sherman Creek and just below the mouth of Sweeny Creek (Fig. 1). At two locations, north of Sherman Creek, and below Sherman Creek, bottom substrate was composed of rock and gravel with no fine sediments and samples could not be collected. A stainless steel 0.1 m^3 Smith McIntyre dredge was used to collect sediment grab samples. The dredge was rinsed with ambient seawater between each grab. A stainless steel spoon, washed with ambient seawater between grabs, was used to mix and transfer sediments to sample jars. Each sample was placed in precleaned jars (Environmental Sampling Supply), labeled, and refrigerated. The Sherman Creek offshore sample (94KS02) was split into three jars (A, B, C). The Sweeny Creek offshore sample (94KS04) was only sufficient to fill one sample jar. A field blank was included with the sediment samples. Location and time of sampling was recorded for all samples in a field notebook.

Blue mussels were selected as target marine organisms due to their abundance in the area, association with sediments, and standard as a monitoring species for contaminants in marine environments. During a low tide, blue mussels were collected by hand at six rocky outcrops (Fig. 1); north of Sherman Creek; at the mouth of Sherman Creek; about halfway between the two creeks; at a point north of Sweeny Creek; at Sweeny Creek; and at a point south of Sweeny Creek.

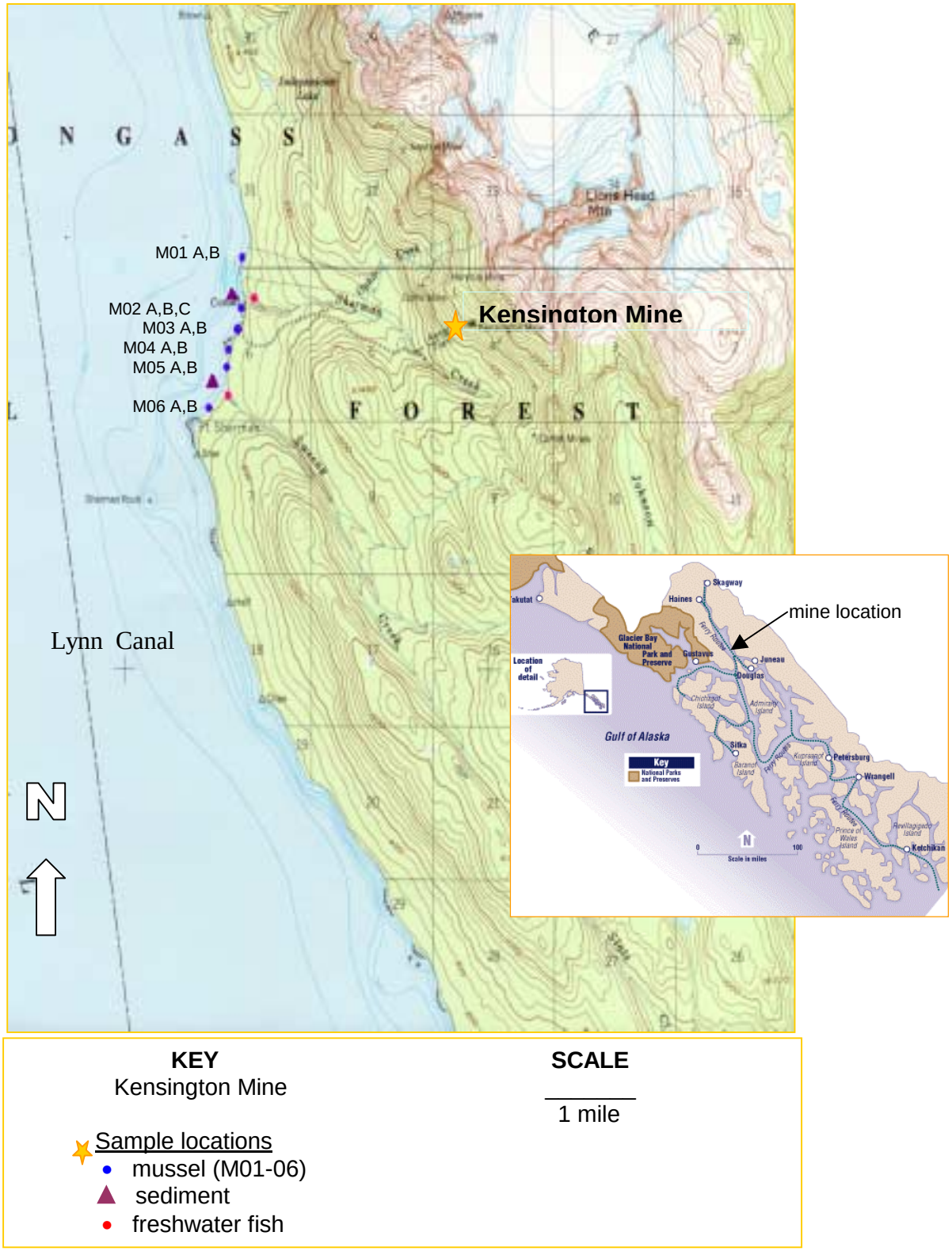


Fig. 1 Location map of the Kensington gold mine, Lynn Canal, near Juneau, Alaska, and sediment and biota sample sites.

At each location, two samples of at least 14 mussels each were collected and placed in labeled sealable Ziploc plastic bags. All mussels were depurated overnight in their collection bags in ambient seawater. Shell lengths were measured to the nearest millimeter using a digital caliper. Tissue was removed from shells using precleaned stainless steel scalpels, placed into precleaned jars (Environmental Sampling Supply), labeled, and frozen. Composite mussel sample weights were between 86 and 125 grams. Because mussel samples are usually about 80 percent moisture, approximately 90 grams of tissue was needed for metals analyses. Upon returning from the field, all samples were stored in a locked conventional freezer until shipment to the analytical laboratory.

Minnow traps (plastic) were baited with canned shrimp and set overnight in Sherman and Sweeny Creeks. Traps were brought aboard the *M/V Curlew*, fish were removed from traps, identified, and total length was measured to the nearest millimeter (Table 1). Minnow traps for freshwater fish were not reset for additional days due to the frequency of black bears feeding on salmon in the creeks. Due to the small body size and weight of the fish collected, one combination composite sample of Dolly Varden and prickly sculpin was made for each creek (Table 1). Whole fish were placed into precleaned jars (Environmental Sampling Supply), labeled, and frozen. There were seven individual fish in the Sherman Creek sample (six Dolly Varden and one sculpin) and six in the Sweeny Creek sample (four Dolly Varden and two sculpin). Whole bodies were used for all analyses. Sampling efforts for marine bottom fish by baited hook and line were unsuccessful.

Table 1. Freshwater fish collected in September 1994 from Sherman and Sweeny Creeks, Alaska.

Location	Species	Total length (mm)	Composite fresh weight (g)
Sherman Creek	Dolly Varden	45, 50, 50, 55, 55, 59	13.0 (7 fish)
(F01A)	prickly sculpin	80	
Sweeny Creek	Dolly Varden	60, 80, 81, 93	18.0 (6 fish)
(F02A)	prickly sculpin	26, 44	

Laboratory Analyses

All samples (USFWS catalog 7040024) were shipped frozen by Federal Express overnight service to Hazelton Environmental Service's laboratories in Madison, Wisconsin for analyses. All samples were analyzed for a metals suite (total metals), cyanide, and percent moisture. Grain size and total organic carbon (TOC) were determined for sediment samples. All analytical data are reported in parts per million (ppm) on a dry weight (DW) basis. All residue analyses (DW and wet weight), detection limits, and analytical methods descriptions are included in Appendix A.

Inductively Coupled Plasma Spectroscopy (ICP) was used to determine concentrations of cadmium, chromium, copper, nickel, lead, and zinc. Mercury was determined by Cold Vapor Atomic Absorption using a MHS-20 hydride generation unit. Samples were homogenized and

then digested with a mixture of sulfuric and nitric acid before assaying. Arsenic was determined by Graphite Furnace and samples were first digested with nitric acid.

Cyanide analysis was determined by EPA method 335.2 and Standard Method 4500-CN E, for total cyanide.

Quality Assurance / Quality Control

Methods for sediment and biota collection followed standard protocols as described in the U. S. Fish and Wildlife Service Contaminants Handbook (1985) with minor revisions. With each sample batch of the same matrix type, at least one duplicate, one sample spike, one analytical blank, and one appropriate Standard Reference Material (SRM) were assayed. The Quality Assurance (QA) program for residue data was conducted at the USFWS Patuxent Analytical Control Facility (PACF) where duplicates, spike recoveries, and procedural blanks were reviewed to determine laboratory data acceptability. There were two duplicates, two spikes, and two procedural blanks per analyte, one each for sediment and tissue. Sources of SRMs for this study included the National Institute of Standards and Technology and the National Research Council of Canada. Acceptable accuracy for percent recovery of metals in spiked samples and SRMs by Atomic Absorption was 85 to 115 percent; by ICP measurements it was 80 to 120 percent (U.S. Fish and Wildlife Service Criteria, Moore 1990).

Relative Percent Difference: Because the laboratory duplicate arsenic tissue analysis had a Relative Percent Difference (RPD) of almost 34 percent between samples, arsenic concentrations in mussel and fish tissue are suspect. Acceptable RPDs should be ≤ 20 percent. All other duplicate analyses for sediment and tissue samples had RPDs that were ≤ 20 percent.

Limits of Detection: Field blank metal values were all below Limits of Detection (LOD). Procedural blanks were above the LOD for some samples but were not considered significant. The mussel tissue data set for most chromium, mercury, nickel, and lead values will be adequate for comparisons with future sampling data on a qualitative basis because these mussel metal concentrations were not twice the Limits of Detection (LOD). Most arsenic, cadmium, copper, zinc, and cyanide data allow quantitative comparisons. These mussel tissue metal concentrations were greater than twice the LOD for all samples. All mussel tissue cyanide concentrations were greater than twice the LOD.

Fish tissue metal concentrations were all twice the LOD with the exception of one nickel analysis for the Sweeny Creek fish sample (F02A). Fish tissue cyanide concentrations were not twice the LOD.

The sediment metals data set can be used for quantitative analyses, with the exception of cadmium and mercury data for S04A, which can only be used qualitatively as these results were not greater than twice the LOD. Cyanide concentrations in sediments were not twice the LOD.

Spike samples: Percent recoveries for spike samples were within the PACF acceptable ranges and are considered qualitative. Some spike to background ratios were below 1.0, indicating

these data cannot be used as a measure of matrix effects, due to the sample composition for the following samples and analytes; sediments for arsenic, chromium, copper, nickel, and lead; mussel tissue for cadmium and zinc. These data can only be considered qualitative; there is too much variability in the data for quantitative analyses.

Data review incorporates all components of the QA program, accordingly, RPD, LOD and spike samples must be considered to determine data accuracy. Incorporating these QA components for this data set review allows quantitative analyses for fish - copper, mercury, and chromium; mussels - copper and cyanide; sediments - zinc. All other data can be used on a qualitative basis.

Total Organic Carbon and Grain Size: Marine sediment samples were relatively homogeneous in composition, consisting primarily of sand (mean of 92 percent). Total Organic Carbon (TOC) was less than one percent in samples from both locations (Table 2). The Relative Percent Difference (RPD) for the duplicate silt grain size analysis was greater than 20 percent. However, as silt was only a one to two percent component of the sediment samples, duplicate values are not critical.

The PACF QA officer reviewed these data to ensure that they met U.S. Fish and Wildlife Service standards before they were sent to the investigator. Laboratory QA data are included in Appendix A.

Table 2. Kensington Mine area, 1994 sediment sample grain size, metals and cyanide analyses (ppm, dry weight).

Sample number	Grain Size % Clay	Grain Size % Sand	Grain Size % Silt	Total Organic Carbon	% Moist-re	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	CN
94KS02A	5	94	1	0.47	20.3	9.06	<.13	26.85	54.33	0.045	18.57	6.25	54.83	0.074
94KS02B	6	92	2	0.53	20.9	10.24	<.13	21.24	33.75	0.027	15.04	6.06	46.27	0.087
94KS02C	6	92	2	0.58	22.4	10.81	<.13	23.58	54.12	0.026	17.27	6.08	48.2	0.096
94KS04A	6	92	2	0.28	12.8	4.79	<.11	25.23	22.25	0.011	18.23	2.39	41.51	0.068
	-	-	-	-	0	<.34	<.1	<.25	<.25	<.01	<.3	<.1	<.5	<0.050
ERL value[1]						33.0	5.0	145.0	70.0	0.2	30.0	35.0	120.0	-
gmean S2 (A,B,C)	5.65	92.66	1.59	0.53	21.18	10.01	-	23.78	46.30	0.03	16.90	6.13	49.64	0.09
gmean S2+S4	5.82	92.33	1.78	0.38	-	6.92	-	44.31	41.62	0.04	20.99	8.00	45.39	0.08
count (n)	2	2	2	2	2	2		2	2	2	2	2	2	2

[1] Long and Morgan 1990

Results

All metal concentrations are reported in ppm DW (Tables 2 and 3) for each sediment, mussel and fish sample. Arsenic, chromium, copper, mercury, nickel, lead, and zinc were detected in sediment samples at concentrations comparable to those reported in other Southeast Alaska background investigations (Rudis 1996). Concentrations indicate an unpolluted and mineralized area. Cadmium was not detected at or above the limit of detection (0.13 ppm DW) in sediment samples. Mean metal concentrations were calculated using the mean of samples 2A, 2B, 2C, and 4A. Mean metal concentrations (ppm, DW) for the sediment samples were; arsenic - 9.65, cadmium - <0.13, chromium - 24.41, copper - 43.94, mercury - 0.027, nickel - 17.75, lead - 6.07, and zinc - 47.24. Copper concentrations were the most variable within and among samples, ranging from 22.23 to 54.33 ppm (Fig. 2).

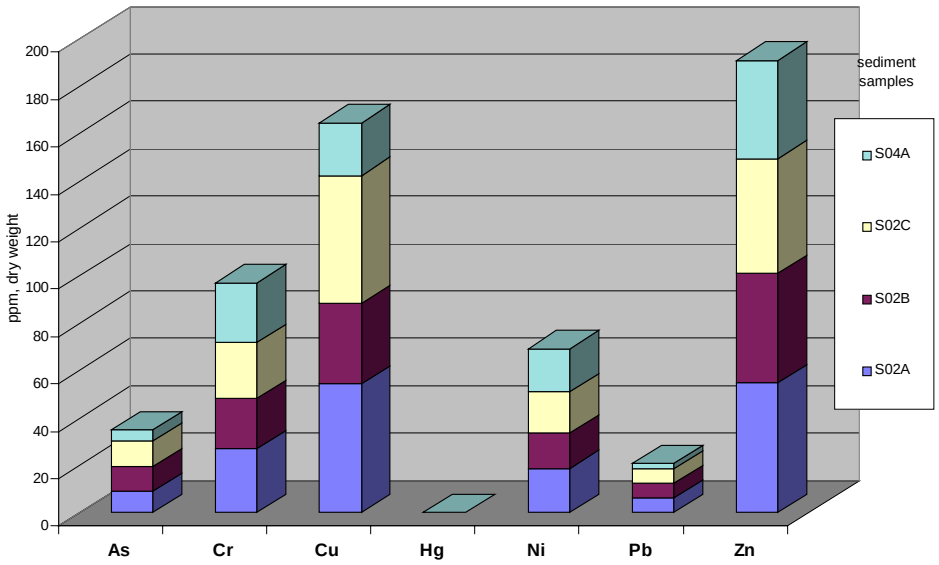


Fig. 2 Metal concentrations (ppm, dry weight) in marine sediments - 1994, from the Kensington Mine area, Lynn Canal, Alaska.

All mussels collected were between 45 and 85 mm shell length. Each sample was a composite of 14 to 29 mussels. Variation in metal concentrations among the 13 mussel samples is shown in Fig. 3. Mean metal concentrations (ppm, DW, for mussel samples (n = 13) were: arsenic - 9.15, cadmium - 9.68, chromium - 1.05, copper - 6.23, mercury - 0.069, nickel - 0.95, lead - 0.68, and zinc - 52.6. Chromium and nickel concentrations in mussel tissue are qualitative, due to duplicate RPDs at less than twice the limit of detection. Mercury was only detected in mussel samples from two locations (Fig. 1), sites two and six.

Concentrations for arsenic, cadmium, chromium, copper, mercury, and zinc, were similar in fish tissue samples from both streams (Table 3). Nickel and lead concentrations were not similar in fish samples between streams.

Table 3. Kensington Mine area, 1994 biota samples – metals and cyanide analyses (ppm, dry weight).

	% Moisture	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn	CN
	Fish									
F01A	76.60	1.88	0.17	1.39	4.91	0.09	2.10	1.54	88.46	<1.42
F02A	76.70	1.37	0.09	1.05	3.21	0.17	0.83	0.34	92.27	<1.43
	Mussels									
M01A	78.80	6.70	10.05	0.90	4.91	<0.47	0.81	0.47	46.60	1.01
M01B	78.10	8.95	7.76	0.93	5.71	<0.46	0.96	0.87	59.36	0.77
M02A	83.20	17.50	11.13	1.27	8.81	0.07	1.37	0.54	60.71	1.45
M02B	80.60	8.25	10.93	1.31	6.55	0.06	0.90	0.82	56.70	1.12
M02C	81.70	10.11	9.23	1.09	7.77	0.06	0.99	0.71	51.31	1.77
M03A	78.90	7.49	10.14	0.85	4.98	<.047	0.97	1.00	49.29	1.04
M03B	80.70	9.53	12.33	1.11	5.45	<.052	0.87	0.62	54.40	1.33
M04A	79.90	10.65	9.05	1.03	7.31	<.05	1.12	0.55	54.73	1.00
M04B	78.50	8.79	7.49	0.79	6.22	<.047	0.66	0.51	47.91	0.94
M05A	82.40	9.94	12.22	1.64	8.27	<.057	1.32	0.80	53.52	1.71
M05B	80.70	9.27	7.93	0.74	4.74	<.052	0.89	0.52	48.13	1.27
M06A	79.70	2.17	9.95	0.90	5.23	<.049	0.60	0.59	54.68	1.06
M06B	84.10	9.62	7.67	1.09	5.06	0.09	0.95	0.88	46.54	1.14
mean	80.60	9.27	9.95	1.03	5.71	0.06	0.95	0.62	53.52	1.12
geomean	80.54	8.45	9.55	1.03	6.10	0.07	0.93	0.66	52.41	1.17
stnd dev	1.86	3.32	1.68	0.25	1.39	0.02	0.22	0.17	4.73	0.30
count (n)	13.00	13.00	13.00	13.00	13.00	4.00	13.00	13.00	13.00	13.00

Cyanide was not detected in freshwater fish samples (Table 3). Cyanide concentrations detected in mussel samples were low, ranging from 0.772 to 1.77 ppm DW ($\bar{x}$ = 1.12 ppm). Cyanide concentrations were very low in sediment samples ($\bar{x}$ = 0.080) and were less than twice the LOD.

Discussion

This investigation was conducted to document predevelopment metal and cyanide concentrations in marine sediments, and marine and freshwater biota. These data can be considered baseline for comparison with samples that may be collected in the event of future mining activity. Although past mining activities occurred in the area and exploration is ongoing at the Kensington Mine, there have been no ore treatment activities that could result in metals contamination to either fresh or saltwater habitats. There was a 2,500 gallon diesel spill into Lynn Canal in 1990 (Juneau Empire 1990) that should not have resulted in any long-term metals contamination to the area.

The Kensington Mine lies within the Juneau Goldbelt, a highly mineralized area of Southeast Alaska. If any metals present in sediment are in a bioavailable form, metal levels that appear to be elevated could occur in resident biota, representing conditions that are normal for that site. Zinc concentrations in freshwater fish from Sweeny and Sherman Creeks may be reflecting these naturally high zinc concentrations. Konopacky Environmental (1996) also sampled Dolly Varden and prickly sculpin from Sherman and Ophir Creeks for metals analyses. A comparison of those data from Sherman Creek shows comparable values for cadmium, copper, mercury, and nickel in small size class (82 - 98mm) fish (Table 4). Arsenic, chromium, and lead tissue concentrations were higher in my study. Konopacky Environmental (1996) did not analyze for zinc or cyanide.

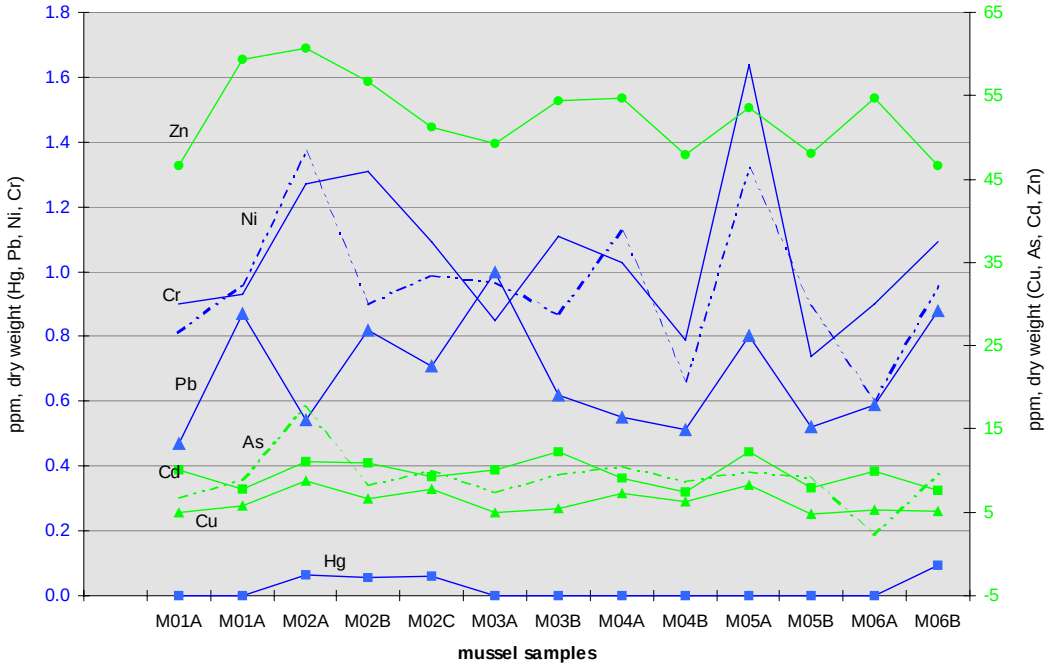


Fig. 3 Metal concentrations (ppm, dry weight) in mussel tissue from the Kensington Mine area, Lynn Canal, Alaska, 1994.

Chromium, mercury, and lead concentrations in this study were comparable with a Dolly Varden data set from Gold Creek, Juneau, Alaska (USFWS 1994) (Table 4). Arsenic, mercury, and zinc tissue concentrations were comparable to those reported in fish from Ready Bullion Creek on Douglas Island (Rudis 1996), also a highly mineralized area and the site of former mining activity. No statistical comparisons were made among these data sets due to the small sample size from this study.

Metal uptake in marine environments is often closely related to extractable fractions rather than total metal concentrations. Because this study analyzed for total metals, these data give no information on bioavailability of metals in sediments. None of the metal concentrations found in these marine sediment samples are at levels that could adversely affect biota (Buchman 1999).

All metal concentrations are below Effects Range-Low (ERLs) established by Long and Morgan (1990) for NOAA's National Status and Trends Program. ERLs were developed as an approach to determine effects-based sediment quality values.

Most metal concentrations from this study were comparable to mussel data from other undeveloped locations in Southeast Alaska (Rudis 1996). Cadmium was the only metal in mussel tissue that was relatively high in comparison to six other Southeast Alaska background mussel data samples (Rudis 1996). Cadmium concentrations in mussels ranged from 7.76 ppm to 12.33 ppm with a geometric mean of 9.55 ppm (Table 3). Continental Shelf studies reported similar cadmium concentrations in mussels from Port Dick and Anchor Cove on the Gulf Coast of the Kenai Peninsula (Burrell 1977). Molluscs biomagnify cadmium from the water column (Eisler 1985). Because cadmium concentrations in sediment samples were below limit of detection (<0.13 ppm), sediments are not a likely source of cadmium to biota. Mussel tissue cadmium concentrations are higher than those reported by the NOAA Mussel Watch program in mussels from most sampling locations on the West Coast (Lauenstein, et al. 1990; NOAA 1998). The Mussel Watch program data showed that higher cadmium concentrations were not linked to an area's level of urbanization. The concentrations found in mussels from this investigation are below those that are reported to have adverse effects on bivalves (Hillman, et al. 1992; Tsoerkan, et al. 1991). Mussel beds appeared to be healthy and robust and a range of sizes was observed. No visual abnormalities were observed; no histopathology or other tissue examination was conducted. Additional mussel tissue analysis would be useful over time to determine if cadmium concentrations have changed.

There are numerous sources of natural cyanide, including some species of bacteria, algae, fungi, and plants (Way 1984). The low concentrations reported in mussels and marine sediment in this study are most likely naturally occurring. Most effects concentrations are based on water exposure levels rather than body burden. There are no water cyanide data for either the marine waters or the streams.

The small sample size for freshwater fish did not allow statistical comparison of tissue metals data between streams. However, these data do provide a record of baseline metal concentrations in resident small fish from each stream. No fish tissue metal concentrations appeared atypical when compared to other Southeast Alaska data (Table 4). Metals, such as cadmium, that may accumulate more in older fish would not be expected to be present in elevated concentrations in the small juvenile fish that were sampled in my study. Future comparison studies would probably want to compare similar sized fish. Because the Konopacky data (Konopacky Environmental 1996) did not show differences in metal concentrations between Dolly Varden and sculpin from Sherman Creek, it appeared acceptable to combine these two fish species for analyses in my study. Investigators have reported greater metals concentrations in other sculpin species when compared with northern pike (Keith Mueller, pers. comm.).

Table 4. Metal concentrations (ppm, dry weight) in Dolly Varden (DV) and sculpin (SC) from four Southeast Alaska creeks.

Location	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Sherman Ck[1]	1.88	0.17	1.39	4.91	0.09	2.10	1.54	88.46
Sweeny Ck[1]	1.37	0.09	1.05	3.21	0.17	0.83	0.34	92.27
Sherman Ck[2 - DV]	0.74	0.25	0.43	6.03	0.06	0.91	0.08	-
Sherman Ck[2 - SC]	0.58	0.16	0.40	4.14	0.05	1.55	0.24	-
Sherman Ck[2 - DV & SC]	0.56	0.20	0.40	-	0.05	1.30	0.18	-
Ready Bullion Ck[3-DV]	1.90	1.38	-	6.63	0.41	-	14.70	-
Ready Bullion Ck[3-SC]	0.78	0.08	-	3.95	0.50	-	3.11	91.15
Gold Ck[4-DV]	<0.40-0.44	<0.44-0.84	<0.67-1.99	6.76-10.28	0.21 - <.22	0.84 - 1.68	1.08 - 1.64	219.63 - 283.51

[1] This study, two species combined for sample (see Table 1).

[2] Konopacky Environmental 1996. Each sample was a composite of two individuals.

[3] Rudis 1996. Sample size: DV - 1; SC - 2 samples, composites of 6 and 7 fish. (DV = Dolly Varden, SC = sculpin)

[4] USFWS 1994. Sample size of three individual fish analyzed separately.

Baseline data are necessary to determine if future environmental changes are the result of project activities. The analytical data from this investigation can be used as partial baseline for later comparison with future monitoring data to determine if there are any measurable effects from the mine project or other future development to the freshwater and marine environments in this area.

Acknowledgments

I thank Ted Estrada, retired captain of the *M/V Curlew,* for his seamanship skills and assisting with sampling logistics. Ursula Spannagal, formerly with the Alaska Department of Environmental Conservation, assisted with sample collection and preparation, she also graciously allowed the use of her original watercolor as the background cover illustration. She also reviewed the manuscript. Deborah Groves, Lanette Dickinson, Lynette McNutt, and Tina Racy assisted with graphics preparation. Other reviewers were Philip Johnson and Keith Mueller of the U.S. Fish and Wildlife Service.

Hazelton Environmental Services, Inc. of Madison, Wisconsin performed analytical chemistry for metals and cyanide. Funding for this project was through U.S. Fish and Wildlife Service, Environmental Contaminants Program funds for off-refuge investigations.

Literature Cited

Buchman, M. F., 1999. NOAA Screening Quick Reference Tables, NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pp.

Burrell, D.C., 1977. Natural distribution of trace heavy metals and environmental background in Alaskan Shelf and estuarine areas. Pages 290-506 *In* Environmental Assessment of the Alaskan Continental Shelf, Annual reports of the principal investigators. Vol. XIII. National Oceanographic and Atmospheric Administration and Bureau of Land Management.

Coeur Alaska. 1995. Coeur Alaska Kensington Mine Project New Sources and New Discharges Application for Permit to Discharge Process Wastewater with attachments. Prepared for U.S. EPA, Region 10, Seattle, WA.

Dames and Moore. 1987. Kensington Mine Project Marine Biophysical Information Search. 5 pp. Dames and Moore Inc., Anchorage, AK

Eisler, R. 1985. Cadmium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish Wildl. Serv. Biol. Rep. 85(1.2). 46 pp.

Juneau Empire. August 24, 1990. Diesel fuel spills at Kensington project. pr.

Long, E.R. and Morgan, L.G. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Tech. Memo. NOS OMA 52, Rockville, MD 167 pp.

Hillman, R.E., R.A. Lordo, R.G. Menton, C.S. Peven, A.D.Uhler, E. Crecelius, and W.G. Steinhauer. 1992. Relationship of environmental contaminants to occurrence of neoplasia in mussels (*Mytilus edulis*) from East and West Coast Mussel Watch sites. Pages 230 - 239 *In* MTS '92: Global Ocean Partnership. Proc. Mar. Technol. Conf., Washington, DC.

Konopacky Environmental. 1992. Baseline monitoring studies of fish and fish habitat in Sherman and Sweeny Creeks, located near the Kensington Mine, Alaska, during 1991. Annual Report - 1991. Vol. 2 of 2. Prepared for the Kensington Venture, Boise, Idaho. 110 pp.

Konopacky Environmental. 1996. Concentrations of nine trace elements in various size-classes of Dolly Varden char, prickly sculpin, and pink salmon collected from Sherman Creek, located near the Kensington Mine, Southeast Alaska, during 1995 and 1996. Annual Report - 1995/1996. Vol. 2 of 2. Prepared for Coeur-Alaska, Inc., Juneau, AK. 103 pp.

Lauenstein, G.G., A. Robertson, and T.P. O'Connor. 1990. Comparison of trace metal data in mussels and oysters from a Mussel Watch Program of the 1970's with those from a 1980's program. Mar. Poll. Bull. 21:440 - 447.

NOAA. 1998 (on-line). "Chemical Contaminants in Oysters and Mussels" by Tom O'Connor. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

Moore, J. 1990. Patuxent Analytical Control Facility Reference Manual. U.S. Fish Wildl. Serv., Laurel, MD.

Rudis, D.D. 1996. Metal Concentrations in Sediments and Selected Biota in Gastineau Channel, Juneau, Alaska. Tech. Rep. SEES - TR - 92 - 01. 36 pp + app., U.S. Fish Wildl. Serv., Juneau, AK

Tsoerkan, M.B.V., D.A. Holwerda, and D.I. Zandee. 1991. Anoxic survival time and metabolic parameters as stress indices in sea mussels exposed to cadmium or polychlorinated biphenyls. Arch. Environ. Contam. Toxicol. 20 (2):259 - 265.

U.S. Fish and Wildlife Service. 1985. Field Operations Handbook for Resource Contaminant Assessment. Sec. 1.6, U.S. Fish Wildl. Serv., Arlington, VA.

U.S. Fish and Wildlife Service. 1994. Gold Creek Fish Kill - March 3, 1994 Metals Residues in Dolly Varden. USFWS, Juneau, AK. 8 pp.

Way, J.L. 1984. Cyanide intoxication and its mechanism of antagonism. Ann. Rev. Pharmacol.Toxicol. 24:451-481.

Appendix A

ECDMS ANALYTICAL REPORT (6)

11-Sep-95

Catalog: 7040024 Regional Study Id: 7F09 Purchase Order: 98210-4-1907

User Id: R7JFO Submitter: Deborah Rudis - Juneau, AK

Kensington - Sediment and Biota - Metals and Cyanide

Lab Name: Hazleton Environmental Services, Inc. (HAZL)

Report Includes the Following Sections:

- Weight, % Moisture, % Lipid, % Ash, Total Suspended Solids
- Soil / Sediment Parameters
- Contaminant Concentrations
- Procedural Blanks
- Duplicates
- Reference Materials
- Spike Recoveries
- Comments (Result Modifers and QA/QC Comments)
- Analytical Methods

WEIGHT, % MOISTURE, % LIPID, % ASH, TOTAL SUSPENDED SOLIDS

Sample Number	Sample Matrix	Sample Weight (g)	Percent Moisture	Percent Lipid	Percent Ash	Total Suspended Solids (%)
94KS02A	Sediments	215	20.3			
94KS02B	Sediments	206	20.9			
94KS02C	Sediments	234	22.4			
94KS04A	Sediments	220	12.8			
blank	Sediments	0	0			
94KF01A	Whole Body	11.8	76.6			
94KF02A	Whole Body	15.8	76.7			
94KM01A	Whole Body	0	78.8			
94KM01B	Whole Body	129	78.1			
94KM02A	Whole Body	106	83.2			
94KM02B	Whole Body	117	80.6			
94KM02C	Whole Body	109	81.7			
94KM03A	Whole Body	126	78.9			
94KM03B	Whole Body	115	80.7			
94KM04A	Whole Body	122	79.9			
94KM04B	Whole Body	121	78.5			
94KM05A	Whole Body	92.5	82.4			
94KM05B	Whole Body	97.4	80.7			
94KM06A	Whole Body	100	79.7			
94KM06B	Whole Body	103	84.1			

fish {

SOIL / SEDIMENT PARAMETERS

Sample Number	Percent TVS	Percent TOC	Particle Size %Sand	%Silt	%Clay
94KS02A		.47	94	1	5
94KS02B		.53	92	2	6
94KS02C		.58	92	2	6
94KS04A		.28	92	2	6

CONTAMINANT CONCENTRATIONS

Analyte	Sample Number	Sample Matrix	Result (ppm Dry Wt.)	Detection Limit (ppm Dry Wt.)	Result (ppm Wet Wt.)	Detection Limit (ppm Wet Wt.)
As	94KS02A	Sediments	9.06	.13	7.22	.1
	94KS02B	Sediments	10.24	.13	8.1	.1
	94KS02C	Sediments	10.81	.13	8.39	.1
	94KS04A	Sediments	4.79	.11	4.18	.1
	blank	Sediments	< .34	.34	< .34	.34
	94KF01A	Whole Body	1.88	.43	.44	.1
	94KF02A	Whole Body	1.37	.43	.32	.1
	94KM01A	Whole Body	6.7	.47	1.42	.1

Analyte	Sample Number	Sample Matrix	Result (ppm Dry Wt.)	Detection Limit (ppm Dry Wt.)	Result (ppm Wet Wt.)	Detection Limit (ppm Wet Wt.)
	94KM01B	Whole Body	8.95	.46	1.96	.1
	94KM02A	Whole Body	17.5	.6	2.94	.1
	94KM02B	Whole Body	8.25	.52	1.6	.1
	94KM02C	Whole Body	10.11	.55	1.85	.1
	94KM03A	Whole Body	7.49	.47	1.58	.1
	94KM03B	Whole Body	9.53	.52	1.84	.1
	94KM04A	Whole Body	10.65	.5	2.14	.1
	94KM04B	Whole Body	8.79	.47	1.89	.1
	94KM05A	Whole Body	9.94	.57	1.75	.1
	94KM05B	Whole Body	9.27	.52	1.79	.1
	94KM06A	Whole Body	2.17	.49	.44	.1
	94KM06B	Whole Body	9.62	.63	1.53	.1
Cd	94KS02A	Sediments	< .13	.13	< .1	.1
	94KS02B	Sediments	< .13	.13	< .1	.1
	94KS02C	Sediments	< .13	.13	< .1	.1
	94KS04A	Sediments	< .11	.11	< .1	.1
	blank	Sediments	< .1	.1	< .1	.1
	94KF01A	Whole Body	.17	.043	.04	.01
	94KF02A	Whole Body	.09	.043	.02	.01
	94KM01A	Whole Body	10.05	.47	2.13	.1
	94KM01B	Whole Body	7.76	.46	1.7	.1
	94KM02A	Whole Body	11.13	.6	1.87	.1
	94KM02B	Whole Body	10.93	.52	2.12	.1
	94KM02C	Whole Body	9.23	.55	1.69	.1
	94KM03A	Whole Body	10.14	.47	2.14	.1
	94KM03B	Whole Body	12.33	.52	2.38	.1
	94KM04A	Whole Body	9.05	.5	1.82	.1
	94KM04B	Whole Body	7.49	.47	1.61	.1
	94KM05A	Whole Body	12.22	.57	2.15	.1
	94KM05B	Whole Body	7.93	.52	1.53	.1
	94KM06A	Whole Body	9.95	.49	2.02	.1
	94KM06B	Whole Body	7.67	.63	1.22	.1
Cr	94KS02A	Sediments	26.85	.31	21.4	.25
	94KS02B	Sediments	21.24	.32	16.8	.25
	94KS02C	Sediments	23.58	.32	18.3	.25
	94KS04A	Sediments	25.23	.29	22	.25
	blank	Sediments	< .25	.25	< .25	.25
	94KF01A	Whole Body	1.39	.43	.32	.1
	94KF02A	Whole Body	1.05	.43	.24	.1
	94KM01A	Whole Body	.9	.47	.19	.1
	94KM01B	Whole Body	.93	.46	.2	.1
	94KM02A	Whole Body	1.27	.6	.21	.1
	94KM02B	Whole Body	1.31	.52	.25	.1
	94KM02C	Whole Body	1.09	.55	.2	.1
	94KM03A	Whole Body	.85	.47	.18	.1
	94KM03B	Whole Body	1.11	.52	.21	.1
	94KM04A	Whole Body	1.03	.5	.21	.1
	94KM04B	Whole Body	.79	.47	.17	.1
	94KM05A	Whole Body	1.64	.57	.29	.1
	94KM05B	Whole Body	.74	.52	.14	.1
	94KM06A	Whole Body	.9	.49	.18	.1
	94KM06B	Whole Body	1.09	.63	.17	.1

Analyte	Sample Number	Sample Matrix	Result (ppm Dry Wt.)	Detection Limit (ppm Dry Wt.)	Result (ppm Wet Wt.)	Detection Limit (ppm Wet Wt.)
Cu	94KS02A	Sediments	54.33	.31	43.3	.25
	94KS02B	Sediments	33.75	.32	26.7	.25
	94KS02C	Sediments	54.12	.32	42	.25
	94KS04A	Sediments	22.25	.29	19.4	.25
	blank	Sediments	< .25	.25	< .25	.25
	94KF01A	Whole Body	4.91	.43	1.15	.1
	94KF02A	Whole Body	3.21	.43	.75	.1
	94KM01A	Whole Body	4.91	.47	1.04	.1
	94KM01B	Whole Body	5.71	.46	1.25	.1
	94KM02A	Whole Body	8.81	.6	1.48	.1
	94KM02B	Whole Body	6.55	.52	1.27	.1
	94KM02C	Whole Body	7.77	.55	1.42	.1
	94KM03A	Whole Body	4.98	.47	1.05	.1
	94KM03B	Whole Body	5.45	.52	1.05	.1
	94KM04A	Whole Body	7.31	.5	1.47	.1
	94KM04B	Whole Body	6.22	.47	1.34	.1
	94KM05A	Whole Body	8.27	.57	1.45	.1
	94KM05B	Whole Body	4.74	.52	.91	.1
	94KM06A	Whole Body	5.23	.49	1.06	.1
	94KM06B	Whole Body	5.06	.63	.8	.1
Hg	94KS02A	Sediments	.045	.013	.036	.01
	94KS02B	Sediments	.027	.013	.021	.01
	94KS02C	Sediments	.026	.013	.02	.01
	94KS04A	Sediments	.011	.011	.01	.01
	blank	Sediments	< .01	.01	< .01	.01
	94KF01A	Whole Body	.09	.043	.021	.01
	94KF02A	Whole Body	.167	.043	.039	.01
	94KM01A	Whole Body	< .047	.047	< .01	.01
	94KM01B	Whole Body	< .046	.046	< .01	.01
	94KM02A	Whole Body	.065	.06	.011	.01
	94KM02B	Whole Body	.057	.052	.011	.01
	94KM02C	Whole Body	.06	.055	.011	.01
	94KM03A	Whole Body	< .047	.047	< .01	.01
	94KM03B	Whole Body	< .052	.052	< .01	.01
	94KM04A	Whole Body	< .05	.05	< .01	.01
	94KM04B	Whole Body	< .047	.047	< .01	.01
	94KM05A	Whole Body	< .057	.057	< .01	.01
	94KM05B	Whole Body	< .052	.052	< .01	.01
	94KM06A	Whole Body	< .049	.049	< .01	.01
	94KM06B	Whole Body	.094	.063	.015	.01
Ni	94KS02A	Sediments	18.57	.38	14.8	.3
	94KS02B	Sediments	15.04	.38	11.9	.3
	94KS02C	Sediments	17.27	.39	13.4	.3
	94KS04A	Sediments	18.23	.34	15.9	.3
	blank	Sediments	< .3	.3	< .3	.3
	94KF01A	Whole Body	2.1	.51	.49	.12
	94KF02A	Whole Body	.83	.52	.19	.12
	94KM01A	Whole Body	.81	.57	.17	.12
	94KM01B	Whole Body	.96	.55	.21	.12
	94KM02A	Whole Body	1.37	.71	.23	.12
	94KM02B	Whole Body	.9	.62	.17	.12
	94KM02C	Whole Body	.99	.66	.18	.12
	94KM03A	Whole Body	.97	.57	.21	.12

Analyte	Sample Number	Sample Matrix	Result (ppm Dry Wt.)	Detection Limit (ppm Dry Wt.)	Result (ppm Wet Wt.)	Detection Limit (ppm Wet Wt.)
	94KM03B	Whole Body	.87	.62	.17	.12
	94KM04A	Whole Body	1.12	.6	.22	.12
	94KM04B	Whole Body	.66	.56	.14	.12
	94KM05A	Whole Body	1.32	.68	.23	.12
	94KM05B	Whole Body	.89	.62	.17	.12
	94KM06A	Whole Body	.6	.59	.12	.12
	94KM06B	Whole Body	.95	.75	.15	.12
Pb	94KS02A	Sediments	6.25	.03	4.98	.02
	94KS02B	Sediments	6.06	.03	4.79	.02
	94KS02C	Sediments	6.08	.03	4.72	.02
	94KS04A	Sediments	2.39	.02	2.08	.02
	blank	Sediments	< .1	.1	< .1	.1
	94KF01A	Whole Body	1.54	.09	.36	.02
	94KF02A	Whole Body	.34	.09	.08	.02
	94KM01A	Whole Body	.47	.09	.1	.02
	94KM01B	Whole Body	.87	.09	.19	.02
	94KM02A	Whole Body	.54	.12	.09	.02
	94KM02B	Whole Body	.82	.1	.16	.02
	94KM02C	Whole Body	.71	.11	.13	.02
	94KM03A	Whole Body	1	.09	.21	.02
	94KM03B	Whole Body	.62	.1	.12	.02
	94KM04A	Whole Body	.55	.1	.11	.02
	94KM04B	Whole Body	.51	.09	.11	.02
	94KM05A	Whole Body	.8	.11	.14	.02
	94KM05B	Whole Body	.52	.1	.1	.02
	94KM06A	Whole Body	.59	.1	.12	.02
	94KM06B	Whole Body	.88	.13	.14	.02
Zn	94KS02A	Sediments	54.83	.63	43.7	.5
	94KS02B	Sediments	46.27	.63	36.6	.5
	94KS02C	Sediments	48.2	.64	37.4	.5
	94KS04A	Sediments	41.51	.57	36.2	.5
	blank	Sediments	< .5	.5	< .5	.5
	94KF01A	Whole Body	88.46	.85	20.7	.2
	94KF02A	Whole Body	92.27	.86	21.5	.2
	94KM01A	Whole Body	46.6	.94	9.88	.2
	94KM01B	Whole Body	59.36	.91	13	.2
	94KM02A	Whole Body	60.71	1.19	10.2	.2
	94KM02B	Whole Body	56.7	1.03	11	.2
	94KM02C	Whole Body	51.31	1.09	9.39	.2
	94KM03A	Whole Body	49.29	.95	10.4	.2
	94KM03B	Whole Body	54.4	1.04	10.5	.2
	94KM04A	Whole Body	54.73	1	11	.2
	94KM04B	Whole Body	47.91	.93	10.3	.2
	94KM05A	Whole Body	53.52	1.14	9.42	.2
	94KM05B	Whole Body	48.13	1.04	9.29	.2
	94KM06A	Whole Body	54.68	.99	11.1	.2
	94KM06B	Whole Body	46.54	1.26	7.4	.2

PROCEDURAL BLANKS

Analyte	Lab Sample Number	Result Total UG
As	41001809	< .05
	41001833	< .25
Cd	41001809	< .05
	41001833	< .1
Cr	41001809	< .5
	41001833	< .5
Cu	41001809	< .5
	41001833	< .5
Hg	41001809	< .01
	41001833	< .01
Ni	41001809	< .6
	41001833	< .6
Pb	41001809	< .05
	41001833	< .1
Zn	41001809	< 1
	41001833	< 1

DUPLICATES

Analyte	Sample Number	Sample Matrix	Initial Result (ppm / %)	Duplicate Result (ppm / %)	Average	Relative % Difference
% Moisture	94KS02B	Sediments	20.9 %	21.5 %	21.2	2.83
	94KM01A	Whole Body	78.8 %	79.4 %	79.1	0.76
Tot. Organic Carbon	94KS02A	Sediments	.47 %	.42 %	0.445	11.24
Grain Size-Clay	94KS02A	Sediments	5 %	6 %	5.5	18.18
Grain Size-Sand	94KS02A	Sediments	94 %	92 %	93	2.15
Grain Size-Silt	94KS02A	Sediments	1 %	2 %	1.5	66.67
As	94KS02B	Sediments	10.24 Dry	10.16 Dry	10.2	0.78
	94KM01A	Whole Body	6.7 Dry	4.76 Dry	5.73	33.86
Cd	94KS02B	Sediments	< .13 Dry	< .13 Dry	0.065	0
	94KM01A	Whole Body	10.05 Dry	8.87 Dry	9.46	12.47
Cr	94KS02B	Sediments	21.24 Dry	21.11 Dry	21.175	0.61
	94KM01A	Whole Body	.9 Dry	.78 Dry	0.84	14.29
Cu	94KS02B	Sediments	33.75 Dry	34.13 Dry	33.94	1.12
	94KM01A	Whole Body	4.91 Dry	4.81 Dry	4.86	2.06
Hg	94KS02B	Sediments	.027 Dry	.027 Dry	0.027	0
	94KM01A	Whole Body	< .047 Dry	< .047 Dry	0.0235	0

Ni	94KS02B	Sediments	15.04 Dry	14.79 Dry	14.915	1.68
	94KM01A	Whole Body	.81 Dry	.89 Dry	0.85	9.41
Pb	94KS02B	Sediments	6.06 Dry	6.57 Dry	6.315	8.08
	94KM01A	Whole Body	.47 Dry	.42 Dry	0.445	11.24
Zn	94KS02B	Sediments	46.27 Dry	45.76 Dry	46.015	1.11
	94KM01A	Whole Body	46.6 Dry	46.13 Dry	46.365	1.01

REFERENCE MATERIALS

Analyte	Lab Sample Number	S.R.M. ID	S.R.M. Name	* Certified Reference Value (ppm / %)	95% Confidence Interval	Result (ppm / %)	Percent Recovery
As	41001836	ERA CRM 216		67.7 Dry		84.8 Dry	125.26
	41001812	NRCC DOLT-2	Dogfish Liver	16.6 Dry	1.1	13.4 Dry	80.72
Cd	41001836	ERA CRM 216		110 Dry		128 Dry	116.36
	41001812	NRCC DOLT-2	Dogfish Liver	20.8 Dry	.5	23.1 Dry	111.06
Cr	41001836	ERA CRM 216		189 Dry		163 Dry	86.24
	41001812	NIST 1577b				.55 Dry	
Cu	41001836	ERA CRM 216		141 Dry		133 Dry	94.33
	41001812	NIST 1577b	Bovine Liver	160 Dry	8	161 Dry	100.62
Hg	41001836	ERA CRM 216		2.36 Dry		2.32 Dry	98.31
	41001812	NRCC DORM-1	Dogfish Muscle	.798 Dry	.074	.699 Dry	87.59
Ni	41001836	ERA CRM 216		79.6 Dry		76.5 Dry	96.11
	41001812	NIST 1577b			< .6 Dry		
Pb	41001836	ERA CRM 216		100 Dry		96.7 Dry	96.7
	41001812	NRCC DOLT-2	Dogfish Liver	.22 Dry	.02	.24 Dry	109.09
Zn	41001836	ERA CRM 216		197 Dry		174 Dry	88.32
	41001812	NIST 1577b	Bovine Liver	127 Dry	16	108 Dry	85.04

* Only certified analytes list a confidence interval - all others are considered reference values.

SPIKE RECOVERIES

Analyte	Sample Number	Sample Matrix	Spike Level (ppm / %)	Amount Recovered (ppm / %)	* Spike / Background	Percent Recovery
As	94KS02B	Sediments	9.46 Dry	11.2 Dry	0.92	118.39
	94KM01A	Whole Body	37.64 Dry	41.22 Dry	5.62	109.51
Cd	94KS02B	Sediments	1.24 Dry	1.3 Dry	9.54	104.84
	94KM01A	Whole Body	4.72 Dry	4.15 Dry	0.47	87.92
Cr	94KS02B	Sediments	12.28 Dry	10.49 Dry	0.58	85.42
	94KM01A	Whole Body	23.4 Dry	22.45 Dry	26	95.94
Cu	94KS02B	Sediments	12.28 Dry	13.91 Dry	0.36	113.27
	94KM01A	Whole Body	23.4 Dry	22.31 Dry	4.77	95.34

Analyte	Sample Number	Sample Matrix	Spike Level (ppm / %)	Amount Recovered (ppm / %)	* Spike / Background	Percent Recovery
Hg	94KS02B	Sediments	.063 Dry	0.063 Dry	2.33	100
	94KM01A	Whole Body	.23 Dry	0.24 Dry	4.6	104.35
Ni	94KS02B	Sediments	12.28 Dry	11.13 Dry	0.82	90.64
	94KM01A	Whole Body	23.4 Dry	22.63 Dry	28.89	96.71
Pb	94KS02B	Sediments	4.96 Dry	5.34 Dry	0.82	107.66
	94KM01A	Whole Body	23.49 Dry	23.02 Dry	49.98	98
Zn	94KS02B	Sediments	122.76 Dry	113.02 Dry	2.65	92.07
	94KM01A	Whole Body	46.79 Dry	40.66 Dry	1	86.9

* For a spike to be a valid measure of method accuracy, this ratio must be higher than 1.0.

COMMENTS (RESULT MODIFERS AND QA/QC COMMENTS)

Analyte	Sample Number	Result Modifier
Pb	94KM01B	00021000

ANALYTICAL METHODS

Method Code	Method Description
001	LABORATORY: Hazleton Laboratories America, Inc.

Elemental Analysis by Inductively Coupled Plasma Spectroscopy

I. SCOPE:

This method is applicable to plant and animal tissue, soil/sediment, and water.
Sample Preparation:

1) Plant and Animal Tissue

- Digest 5.00 g of tissue in Teflon vessel with 5 mL nitric acid in microwave digester. Transfer into 50 mL volumetric flask and dilute to volume with 0.005% Triton X-100 solution. Filter.

2) Soil/Sediment

- Digest 1.00 g in covered Teflon beaker on hot plate using 10 mL nitric acid. Add 30% hydrogen peroxide in 1 mL aliquots until effervescence no longer occurs. Add 1.25 mL hydrochloric acid, heat 10 minutes, and transfer to a 50 mL volumetric flask. Dilute to volume with DDI water. Filter.

3) Water

- Digest 100.0 mL sample in Teflon beaker on hot plate with 0.5 mL nitric acid and 2.5 mL hydrochloric acid. Reduce volume to 15 to 20 mL. Transfer into 50 mL volumetric flask. Dilute to volume with DDI water. Filter.

PRINCIPLE: ANALYTICAL METHODS (Cont.)

Method Code	Method Description
001	Each analyte concentration in the sample solution is determined by comparing its emission intensity with the emission intensities of a known series of analyte standards. The analytical wavelengths are tabulated with the raw concentration data. Analytical data is corrected for background and interfering element effects by the spectrometer program. The detection limit of each analyte is listed in the data report with each respective unknown value, it is a function of the instrument detection limit (IDL), and the sample mass and volume to which it is diluted. With each batch of 20 samples of the same matrix type, at least one duplicate, one sample spike, one analytical blank, and one appropriate reference material are assayed.

REFERENCE:

1. Test Methods for Evaluating Solid Waste - EPA Publication No. SW-846, 3rd edition, Methods (3030, 3040, or 3050) and 6010, US EPA, Washington DC (revised December 1987).

2. Dahlquist, R.L. and Knoll, J.W., "Inductively coupled Plasma - Atomic Emission Spectrometry: Analysis of Biological Materials and Soils for Major, Trace, and Ultra-Trace Elements," Applied Spectroscopy, 32 (1) 1-29 (January/February 1978).

3. Official Methods of Analysis - 14th Edition, method 43.292-43.296, AOAC: Arlington, Virginia (1984).

4. Official Methods of Analysis - 1st Supplement, 14th Edition, Method 3.A01-3.A04, AOAC, Arlington, Virginia (1985).

5. U.S. Environmental Protection Agency Contract Laboratory program, Statement of Work, Inorganic Analysis, Multimedia, Multi-concentration, S.O.W. 7/88.

6. "Inductively Coupled Plasma-Atomic Emission Spectrometric Method of Trace Element Analysis of Water and Wastes," Method 200.7, edited by Theodore D. Martin and John F. Kopp, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

7. "Method Procedures, Analytical Chemistry Department, Inorganic Chemistry." Method MP-ICPS-MA, Hazleton Laboratories America, Inc., Madison, Wisconsin.

002 LABORATORY: Hazleton Laboratories America, Inc.

Mercury by Cold Vapor Atomic Absorption

II. SCOPE:

This method is applicable to most materials including animal tissues, plants, soils.

PRINCIPLE:

Sample weight: 2.00 g
Sample volume: 100 mL.

Samples are digested with a mixture of sulfuric and nitric acid. Mercury is reduced with sodium borohydride for determination. The

amount of mercury is determined at a wavelength of 253.7 nm by comparing the signal of the unknown sample, measured by the atomic absorption spectrophotometer with the MHS-20 hydride generation unit, with the signal of the standard solutions.

Using a 2.0-g sample, the lowest detection limit of this assay is 0.025 ppm.

REFERENCES:

Method Code | Method Description

002

1. Digestion: Analyst, 86:608 (1961) with modifications.

2. Determination: Analytical Chemistry, 40:2085 (1968).

3. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3030, 3040 or 3050 and 7470, U.S. EPA: Washington, D.C. (revised April 1984).

004 LABORATORY: Hazleton Laboratories America, Inc.

Arsenic by Graphite Furnace

IV. SCOPE:

This method is applicable to animal tissues, plants, sediments, sludges, and soils.

SAMPLE PREPARATION:

1) Animal or Plant Tissue

Digest 1.00 g with nitric acid in a microwave digestor. Transfer to 100 mL.

2) Sediment or Soil

Digest 1.00 g with nitric acid and 30% hydrogen peroxide using covered glass beakers on hot plates. Transfer to 100 mL.

PRINCIPLE:

The amount of arsenic is determined at a wave length of 193.7 nm by comparing the signal of the unknown sample, measured by the graphite furnace atomic absorption spectrophotometer, with the signal of the standard solutions. The method of standard additions is used where interferences are indicated. Nickel matrix modification is employed in the analysis.

Using a 1.00-g sample, the lowest detection limit of this assay is 0.1 ppm.

REFERENCES:

1. Test Methods for Evaluating Solid Waste, EPA Publication No. SW-846, 2nd Ed., Methods 3030, 3040 or 3050 and 7060, U.S. EPA: Washington, D.C. (revised April 1984).

2. Contract Laboratory Program Statement of Work No. 785, Method 206.2 CLP-M, U.S. EPA: Cincinnati, Ohio.

009 LABORATORY: Hazleton Laboratories America, Inc.

ANALYTICAL METHODS (Cont.)

Method Code	Method Description
019	LABORATORY: Hazleton Laboratories America, Inc.

Moisture Determination

XIX. SCOPE:

This method is applicable to plant tissue, animal tissue, and soil/sediment.

PRINCIPLE:

The prepared sample is weighed into a tared aluminum dish and is dried in an oven to constant weight (approximately 12-18 hours) at 100 C.

SENSITIVITY:

This method is capable of detecting 0.1% moisture.

REFERENCES:

1. Official Methods of Analysis, 15th Ed., Methods 926.08, 925.09, Assoc. of Off. Analytical Chemists, Arlington, VA (1990) modified.

2. USEPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Exhibit D, S.O.W. 3/90, Document No. ILMO1.0.

021 LABORATORY: Hazleton Laboratories America, Inc.

Total Organic Carbon

XXI. Total Organic Carbon

022 LABORATORY: Hazleton Laboratories America, Inc.

Grain Size

XXII. Grain Size

REFERENCES:

1. Official Methods of Analysis, 15th Ed., Methods 926.08, 925.09, Assoc. of Off. Analytical Chemists, Arlington, VA (1990) modified.

2. USEPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Exhibit D, S.O.W. 3/90, Document No. ILM01.0.

Revised/Corrected
to correct LOD
from 3/21/94

HES, INC.
525 Science Drive
Madison, WI 53711
(608) 232-3300

REPORT OF ANALYSIS

Patuxent Analytical Control Facility
U.S. Fish and Wildlife Service
Patuxent Wildlife Research Center
Laurel, MD 20708

Attn: John Moore
Analyte: CYANIDE

Catalog # 1907
Purchase Order # 98210-4-1907
Batch # : 7F09
Contract # 14-16-0009-87-007
Date Entered: 10/22/94
Date Printed: 03/11/96

	Lab #	Matrix	ppm (WET)	ppm (DRY)	LOD ppm	Sample	
1.	41001846	AT	<0.333	<1.42	1.42	94KF01A	fish
2.	41001847	AT	<0.333	<1.43	1.43	94KF02A	
3.	41001848	AT	0.214	1.01	0.236	94KM01A	
4.	41001849	AT	0.169	0.772	0.228	94KM01B	
5.	41001850	AT	0.244	1.45	0.298	94KM02A	
6.	41001851	AT	0.218	1.12	0.258	94KM02B	
7.	41001852	AT	0.324	1.77	0.273	94KM02C	
8.	41001853	AT	0.220	1.04	0.237	94KM03A	blue mussels n = 13
9.	41001854	AT	0.256	1.33	0.259	94KM03B	
10.	41001855	AT	0.201	1.00	0.249	94KM04A	
11.	41001856	AT	0.201	0.935	0.233	94KM04B	
12.	41001857	AT	0.301	1.71	0.284	94KM05A	
13.	41001858	AT	0.246	1.27	0.259	94KM05B	
14.	41001859	AT	0.216	1.06	0.246	94KM06A	
15.	41001860	AT	0.182	1.14	0.314	94KM06B	
16.	41001841	SS	0.0593	0.0744	0.063	94KS02A	sediment
17.	41001842	SS	0.0688	0.0870	0.063	94KS02B	
18.	41001843	SS	0.0744	0.096	0.064	94KS02C	
19.	41001844	SS	0.0593	0.0680	0.057	94KS04A	
20.	41001845	SS	<0.050	<0.050	0.050	BLANK	

fish
mussel
sediment $\bar{x} = 0.070$ w/ <LOD @ ½ value (SD = 0.0245)

Appendix B

Blue mussel samples collected from six locations at the Kensington Mine area 1994 – sample number, number in composite and average shell length (mm).

Sample Number	Number of mussels	Average shell length (mm)
94KM01A	18	70.7
94KM01B	17	71.5
94KM02A	23	62.7
94KM02B	25	59.4
94KM02C	26	56.0
94KM03A	42	60.9
94KM03B	23	61.9
94KM04A	18	65.4
94KM04B	13	71.7
94KM05A	29	53.8
94KM05B	23	56.9
94KM06A	14	75.6
94KM06B	20	62.1