APPENDIX C
Marine Sampling in Strathcona Sound, July, 2003

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November 19, 2003

Mr. Robert Carreau
Corporate Manager, Environmental Affairs
Breakwater Resources Limited
Suite 2000, 95 Wellington Street East
Toronto, Ontario
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JWEL 15058

Dear Mr. Carreau,

Re: Marine Sampling in Strathcona Sound, July, 2003

This letter is to provide you with the results of the biological and sediment sampling that was carried out in Strathcona Sound, during July, 2003. Specifically, sampling included collection of fish tissue and sediment core samples for chemical analysis. The purpose of the fish tissue sampling was to evaluate whether consumption of fish caught near the Nanisivik loading dock may pose any risk to human health. The purpose of the sediment sampling was to evaluate whether recently deposited (surface) sediments near the mouth of Twin Lakes Creek have higher metal concentrations than older (deeper) sediments. This comparison will help to evaluate whether activities associated with the development and operation of the Nanisivik Mine over the past three decades have substantially changed the rate of metal deposition in sediments. The remainder of this letter provides a brief description of the methods used to collect the samples, the results of the chemical analyses, and the conclusions reached as a result of the new data.

Information on the specific samples collected, and sampling locations, can be found in Tables A1 and A2, in Appendix A to this letter.

Methods

Samples of Shorthorn Sculpin were collected on July 12, 2003, by angling with baited jigs at the marine wharf. A total of 12 fish were collected. The fish were frozen shortly after collection, and were held in a frozen condition until they could be returned to Fredericton, New Brunswick, for dissection. The dissections were carried out in a laboratory in Fredericton in order to avoid any possibility heavy metal contamination in the Nanisivik mine and townsite environment. After dissection, muscle tissue samples (fillet with skin on) were submitted to the Research and Productivity Council (RPC) laboratory in Fredericton, New Brunswick, for heavy metal analysis. RPC is a CAEAL-accredited laboratory that specializes in environmental analytical chemistry.

Sediment samples (2 cores) were collected on July 13 and 14, 2003, in the vicinity of the outlet of Twin Lakes Creek. The core sampler used was a Wildco KB gravity core sampler, with stainless steel barrel and nose cone, and polycarbonate core tube liners.

Core sampling proved to be difficult in the targeted area around the mouth of Twin Lakes Creek, due to a combination of factors. Although the bottom sediments could not be directly inspected, the majority of attempted core samples did not penetrate the sediments. Rather, the sampler appeared to strike the sediments and then fall over, without significant penetration. Occasional short plugs of silty sediments were recovered, but these were only about 5 cm in length, and were disturbed.

Based upon a subjective evaluation of the core sampler performance and the professional experience of the operator, it is suggested that the bottom of Strathcona Sound near Twin Lakes Creek is predominantly composed of gravel and sand, with only a patchy veneer of fine sediments. The bottom is steeply sloping in this area, and the Sound is relatively exposed to winds, currents, and tidal water movement in an east-west direction. These factors will tend to minimize the accumulation of sediments in shallow waters and in the sloping near-shore area, favouring periodic slumping and/or resuspension, with subsequent re-deposition in deeper and flatter areas of the Sound.

Results

Results as provided by RPC, for chemical analysis of fish tissues and sediment samples (including QA/QC samples), are presented in Appendix B to this letter. A summary of the results is provided in the context of similar data from 1974, and relevant guidelines for metal concentrations in fish products, in Table 1, below.

Fish Tissue Results

Canadian guidelines for chemical contaminants in fish and fish products exist for the heavy metals mercury (0.5 mg/kg in all fish products except swordfish), arsenic (3.5 mg/kg in fish protein concentrate) and lead (0.5 mg/kg in fish protein concentrate). The mean mercury concentration in Shorthorn Sculpin tissues was 0.15 mg/kg (range 0.07 to 0.26 mg/kg). The mean arsenic concentration was 5.3 mg/kg (range 2.02 to 9.98 mg/kg). The mean lead concentration was 0.48 mg/kg (range 0.027 to 2.22 mg/kg).

Of the three elements for which there are guidelines, only the mean arsenic concentration exceeds the guideline. However, arsenic concentrations in sediments near the mouth of Twin Lakes Creek are not excessive (see below). Arsenic concentrations in many marine biota, including shellfish, crustaceans and bottom-dwelling fish are commonly elevated, and of low significance to consumers. Many species of fish contain from 1 to 10 mg/kg total arsenic, and some bottom feeders and shellfish contain arsenic at or above 100 mg/kg (World Health Organization, 2001). Lobster tissues commonly contain from 10 mg/kg to 20 mg/kg total arsenic (U.S. Food and Drug Administration, 1993). Moreover, arsenic present in the tissues of marine organisms is predominantly present as a water-soluble organic form (arsenobetaine), which has low toxicity and does not biomagnify. There are no reported instances of toxicity in man or animals from the consumption of organic arsenic compounds in seafood. Therefore, the fact that Shorthorn Sculpin muscle tissues contain moderate concentrations of total arsenic (<10 mg/kg) should not be a source of concern.

Lead concentrations in fish tissues approached the Canadian guideline for fish protein concentrate, and were relatively variable both from fish to fish, and within fish tissues analyzed as replicate subsamples. The source of this variability is not clear, and such variability was not observed for most other elements. Much less variability was observed for zinc, for example. However, zinc concentrations in fish tissue are subject to biological regulation, whereas lead may not be. The conclusion remains that most fish collected at the wharf have low lead concentrations, and that the average exposure to lead from consuming these fish would be low.

In addition to the above metals, cadmium, copper and zinc are worthy of mention. Cadmium concentrations in Shorthorn Sculpin tissues were low (averaging 0.029 mg/kg, and ranging from 0.01 to 0.057 mg/kg). Copper concentrations were also low, and lay within a very narrow range (averaging 0.56 mg/kg, and ranging from 0.45 to 0.72 mg/kg), consistent with active biological regulation. Zinc concentrations were slightly elevated, but also lay within a narrow range consistent with active biological regulation (averaging 18.1 mg/kg, and ranging from 10.2 to 26.7 mg/kg). None of these metal concentrations merit concern about possible human consumption.

The data reported above can be compared with data collected by BC Research (1974). They reported arsenic concentrations in Shorthorn Sculpin fillet samples of 10.1 to 37.4 mg/kg dry weight. Assuming a water content of 80%, these results would translate into fresh tissue concentrations of 2.0 to 7.5 mg/kg, very similar to the results of the present survey. Lead concentrations were generally below the detection limit obtained by BC Research, however, reported results range from <7 to <46 mg/kg dry weight, with one reported detection of 4.6 mg/kg dry weight. The highest concentration reported during the 2003 survey was 2.2 mg/kg wet weight, which would translate into a dry weight concentration of about 11 mg/kg. Copper concentrations reported by BC Research ranged from 5.3 mg/kg to 26.3 mg/kg dry weight. This range would translate to a range of 1.1 to 5.3 mg/kg wet weight (results for 2003 were less than 1 mg/kg wet weight). Zinc concentrations reported by BC Research range from 57.6 to 144 mg/kg dry weight, which would translate to a range of 11.5 to 28.8 mg/kg wet weight. The zinc concentration reported for 2003 averaged 18.1 mg/kg wet weight. Taken overall, there appears to be a consistent weight of evidence to indicate that metal concentrations measured in the tissues of Shorthorn Sculpin in 2003 are very similar to those measured prior to the mine development, in 1974.

Table 1. Summary of Fish Tissue Metal Concentrations and Relevant Guideline Values

Metal	1974 Data* (mg/kg wet weight)	2003 Data (mg/kg wet weight)	Relevant Guideline (mg/kg wet weight)
Arsenic	2.0 – 7.5	2.02 – 9.98	3.5 mg/kg (fish protein concentrate)
Cadmium	not reported	0.01 – 0.057	not available
Copper	1.1 – 5.3	0.45 – 0.72	not available
Lead	ND – 0.92**	0.027 – 2.22	0.5 mg/kg (fish protein concentrate)
Mercury	not reported	0.07 – 0.26	0.5 mg/kg (all fish products except swordfish)
Zinc	11.5 – 28.8	.2 – 26.7	not available

*1974 data from BC Research (1975) were reported as mg/kg dry weight. They have been converted to mg/kg wet weight here by assuming 80% moisture content in fresh fish.

**BC Research (1975) reported detection limits for lead that ranged from <7 to <46 mg/kg dry weight. Only one sample contained detectable lead at that time, at a concentration of 4.6 mg/kg dry weight, which is converted here to a concentration of 0.92 mg/kg wet weight.

Sediment Core Results

Two short cores were successfully collected (see Figure A1 in Appendix A for locations), and both "surface" and "deep" samples were segregated from each core. The cores were as follows:

- Core S (samples S1 and S2) collected at position 73° 04′ 15.069″ N, 84° 32′ 13.127″ W in 56 m water depth. This core was collected some distance east of the wharf.
- Core F (samples F1 and F2) collected at position 73° 04′ 19.370″ N, 84° 32′ 43.873″ W in 80 m water depth. This core was collected between the outlet of Twin Lakes Creek and the wharf.

Chemical analysis of the core samples reflects the local mineralogy. High concentrations of calcium (>60,000 mg/kg) and magnesium (>50,000 mg/kg) were recorded, in addition to relatively high concentrations of iron (>25,000 mg/kg). Aluminum, while still a major element, was present at relatively low concentrations (12,000 to 14,000 mg/kg). These results presumably reflect the locally dominant dolomitic and shale rock types.

Arsenic concentrations (9 to 14 mg/kg), while above the CCME (1999) interim marine sediment quality guideline (ISQG) of 7.24 mg/kg, were well below the probable effects level (PEL) of 41.6 mg/kg. Elevated arsenic is often found in association with high concentrations of iron, and high iron can reduce the bioavailability of arsenic. Arsenic was not notably enriched in the surface sediment layer at either location.

Cadmium concentrations (1.6 to 10.2 mg/kg) spanned the range of the PEL guideline (4.2 mg/kg). Cadmium has geochemistry similar to that of zinc, and is often found in association with zinc deposits. Cadmium concentrations were slightly elevated in the surface sediment layer of Core S when compared with the deeper layer (2.45 mg/kg compared to 1.6 mg/kg) but was present at a lower concentration in the surface of Core F than in the deeper layer (5.8 mg/kg compared with 10.2 mg/kg).

Chromium concentrations (23 to 27 mg/kg) were below the ISQG (52.3 mg/kg) in all cases.

Copper concentrations (26 to 40 mg/kg) were above the ISQG (18.7 mg/kg), but below the PEL (108 mg/kg) in all cases. Copper concentrations in the surface and deeper layers of both cores were comparable.

Lead concentrations (88.4 to 568 mg/kg) spanned the range of the PEL guideline (112 mg/kg). Lead concentrations were higher in the surface layer of Core S than in the deeper layer (143 mg/kg compared to 88.4 mg/kg). However, the lead concentration was lower in the surface layer of Core F than in the deeper layer (359 mg/kg compared with 568 mg/kg).

Mercury concentrations 0.03 to 0.1 mg/kg) were below the ISQG (0.13 mg/kg) in all cases.

Zinc concentrations (481 to 2,740 mg/kg) were above the PEL (271 mg/kg) in all cases. Zinc concentrations were higher in the surface layer of Core S than in the deeper layer (825 mg/kg compared to 481 mg/kg). However, the zinc concentration was lower in the surface layer of Core F than in the deeper layer (1,890 mg/kg compared to 2,740 mg/kg).

The results reported above are compared in Table 2 with data collected by BC Research (1975). They reported metal concentrations in 14 core samples collected throughout Strathcona Sound. Most if not all of the BC Research sediment samples were collected using a Shipek dredge (taking roughly the surface 10-cm of sediments) from "deepwater" portions of the Sound, where sediments would be accumulating. In particular, the two stations located closest to the mouth of Twin Lakes Creek were at depths of 247 m (Station 9) and 304 m (Station 10), and appear to represent sediments from beyond the "toe" of the shoreline slope.

Table 2. Trace Metal Concentrations in Marine Sediments from Strathcona Sound

Metal	1974 Data* (mg/kg)	2003 Data (mg/kg)	Relevant Guideline Values**	
			ISQG (mg/kg)	PEL (mg/kg)
Arsenic	1.0 – 7.9	9 – 14	7.24	41.6
Cadmium	<0.4	1.6 – 10.2	0.7	4.2
Chromium	not reported	23 – 27	52.3	160
Copper	3.7 – 27.9	26 – 40	18.7	108
Iron	2,820 – 34,000	25,000 – 35,400	not available	not available
Lead	3.9 – 19.3	88.4 - 568	30.2	112
Mercury	not reported	0.03 – 0.1	0.13	0.70
Nickel	3.9 – 27.3	21 – 24	not available	not available
Zinc	3.9 - 171	481 – 2,740	124	271

*1974 data from BC Research (1975)
**Guidelines from CCME (1999)

The comparison with BC Research (1975) data shows that while arsenic, copper, iron and nickel concentrations occupy similar ranges, the concentrations of cadmium, lead and zinc appear to be much higher in the near-shore sediments sampled during 2003. JWEL believes that the reason for this difference is that the near-shore sediments sampled during 2003 contain larger quantities of relatively coarse, dense mineral particles that would have been eroded from the exposed ore body, and been deposited in the alluvial fan at the mouth of Twin Lakes Creek. The samples collected by BC Research, coming from farther out in the Sound, would not contain these particles, and would therefore show less enrichment of the ore body metals, zinc, lead and cadmium.

Additional Observations

Twin Lakes Creek has a high flow rate in the springtime, and at the same time, the sea ice on Strathcona Sound is melting. The combined freshwater inputs from these two sources lead to the formation of a thin surface freshwater lens (1 to 2 parts per thousand total salinity) on top of more strongly marine influenced water (a halocline exists so that the salinity increases from about 4 ppt to 25 ppt at a depth of about 2 m. The halocline was strong enough to provide a reflecting surface for sonar, so that a hand-held sonar unit periodically gave depth readings of 2 m or less in waters that were substantially deeper.

As a result of the halocline, freshwater discharged from Twin Lakes Creek does not mix rapidly with the marine waters of Strathcona Sound. Instead, the freshwater lens extends some distance (perhaps several kilometres) away from the mouth of Twin Lakes Creek, and will be advected east-west by tidal action. Only the heaviest sediment particles will be deposited near the mouth of Twin Lakes Creek. These can be expected to include coarse particles including gravels and sands, and the denser fine-grained particles in the silt size range. Silt-sized particles with less dense mineralogy, and clay-sized particles will have low-enough settling rates to be advected a considerable distance away from the mouth of Twin Lakes Creek before settling. Likewise, dissolved trace metals can also be expected to be transported a considerable distance from the mouth of Twin Lakes Creek before mixing with the full water column. Therefore, it is not likely that substantial accumulations of fine-grained sediments will occur at the mouth of Twin Lakes Creek. However, most of the input of coarse material transported by the creek will deposit near the mouth.

In addition to the behaviour of suspended solids and dissolved trace metals discharged from Twin Lakes Creek, the sedimentary environment along the south shore of Strathcona Sound is worthy of discussion. There is a rapid drop off in depth from the mouth of Twin Lakes Creek, so that depths of 50 m or more are reached within approximately 200 m of the shoreline. The bottom is also exposed to erosional forces from tidal water movements in an east-west direction. As a result of these factors, it is expected that any fine-grained (silty) sediment that does accumulate near the shoreline will be susceptible to periodic slumping into deeper waters, or re-suspension by currents or wave action. As a result of the slumping process, it is likely that sediments at the toe of the slope in Strathcona Sound are highly disturbed.

The core sampling efforts that were conducted at water depths of 3 m to 80 m in front of Twin Lakes Creek during July, 2003, support this interpretation. At the 3 m water depth, the core sampler was observed to strike the sand and gravel bottom without significant penetration, and subsequently to fall over on its side. These coarse-grained materials resist penetration using a gravity core sampler, and are too loose to be retained in such a device. Although not directly observed, the core sampler could be felt as it hit the sediments in deeper water, without an audible "click" as would be heard if the sampler was striking bedrock or a substantial boulder. The core sampler could subsequently be felt as it fell over, indicating that there had been minimal penetration of sediments. Based upon these observations, it is believed that sand and gravel sediments predominate on the slope of Strathcona Sound at Twin Lakes Creek. There appear to be thin veneers of fine-grained (silty) sediments in some areas, and short plugs (approximately 10 cm in length) of these sediments were occasionally brought to the surface, although it was very difficult to recover them undisturbed from the core sampler. As noted above, thicker deposits of fine-grained sediments are not likely to be stable on the slope of the Sound.

Conclusions

Fish (Shorthorn Sculpin) muscle tissue concentrations of arsenic and lead marginally exceed relevant guidelines for fish and fish products. However, they do not appear to have increased significantly in comparison with data collected by BC Research in 1974, nor do they appear to be high enough to justify concern about occasional consumption.

Concentrations of cadmium, lead and zinc in the two recovered sediment samples collected in the vicinity of the ship loading wharf and the mouth of Twin Lakes Creek exceeded the CCME (1999) PEL guidelines. Concentrations of these elements also exceeded concentrations measured in sediments by BC Research (1974). However, the historical samples were not collected in close proximity to the mouth of Twin Lakes Creek, and may not have properly reflected the natural background condition in this area. A comparison of surface (0-5 cm) to deeper (5-10 cm) sediments was ambiguous, in that higher concentrations of cadmium, lead and zinc were present in the deeper sediments of Core F than in the surface sediments.

Sediment deposition in the alluvial fan of Twin Lakes Creek is likely to be restricted to coarser grained sediments, or those fine-grained sediment particles that are composed of denser minerals. The physical aspects of the marine environment during spring runoff are such that fine-grained particles and dissolved metals are likely to be widely dispersed in Strathcona Sound before they are deposited to sediments.

Closing

We trust that this letter provides the information you require. Please do not hesitate to contact the undersigned at (506) 457-3200 should you require any further information.

Sincerely,

JACQUES WHITFORD ENVIRONMENT LIMITED

Malcolm Stephenson, Ph.D.
Senior Aquatic Scientist

References

BC Research. 1975. Baseline Survey of the Marine Environment at Strathcona Sound, NWT. Project 1552, Progress Report No. 1. March, 1975.

Canadian Council of Ministers of the Environment (CCME). 1999. Interim Marine Sediment Quality Guidelines for the Protection of Aquatic Life.

United States Food and Drug Administration. 1993. Guidance Document for Arsenic in Shellfish. Accessed via internet site: http://www.cfsan.fda.gov/~frf/guid-as.html

World Health Organization. 2001. Environmental Health Criteria 224. Arsenic and Arsenic Compounds. Accessed via internet site: http://www.inchem.org/documents/ehc/ehc/ehc224.htm

Appendix A

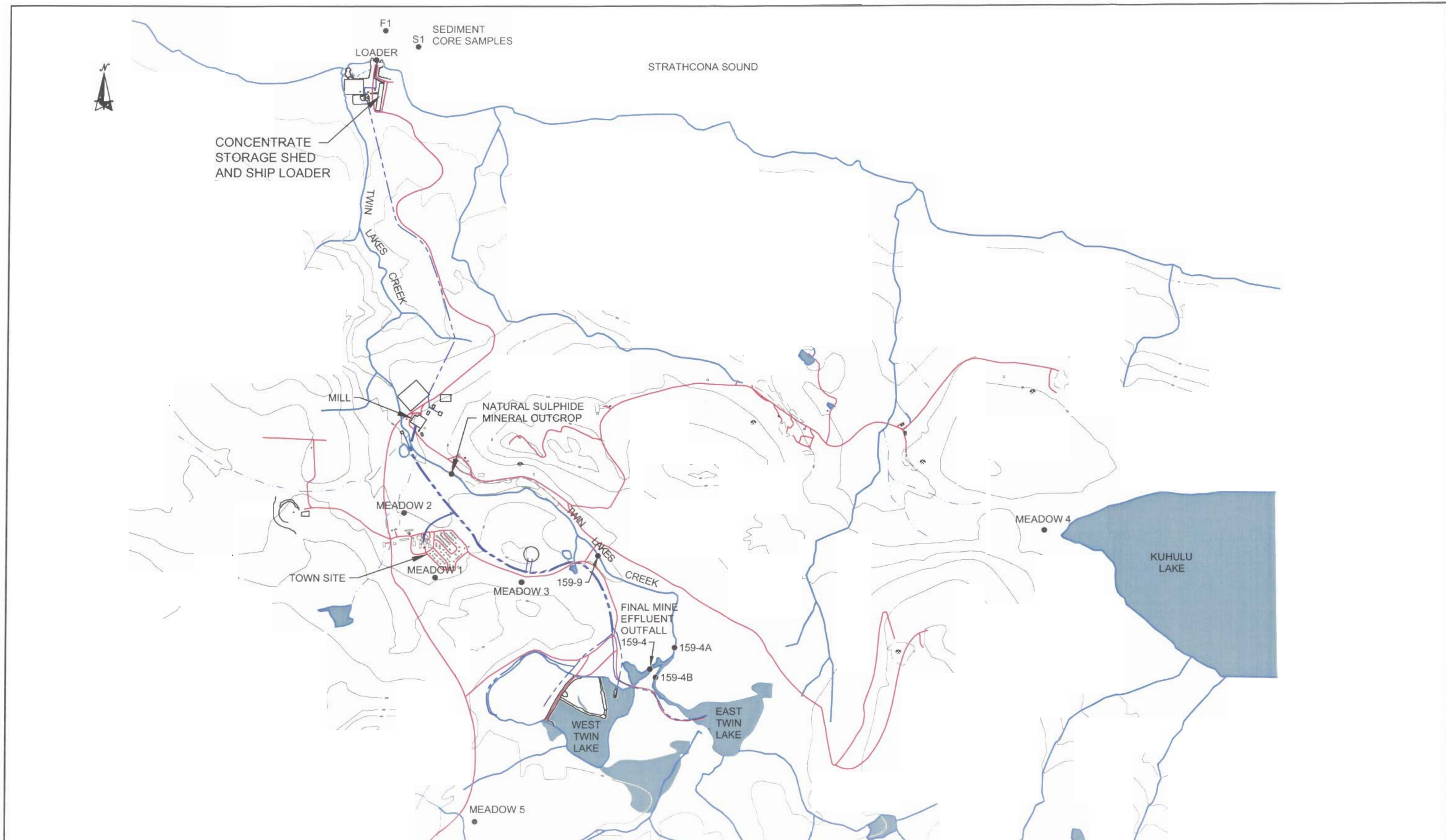
Information on Fish and Fish Tissue Samples (Table A1) and Location Information for Sediment Samples (Table A2) Figure A1 Core Locations

Table A1. Biological Data for Shorthorn Sculpin Caught at Nanisivik Mine Wharf, July, 2003.

Fish No.	Length (cm)	Weight (g)	Sex	Liver Wt. (g)	Gonad Wt. (g)	Muscle Tissue Sample (g)	Otolith Collected
SC1	29.3	370	F	13.02	13.27	48.86	Y
SC2	36.6	610	F	26.65	22.33	78.30	Y
SC3	29.1	370	F	18.81	20.78	57.13	Y
SC4	25.0	210	M	7.86	4.45	41.10	Y
SC5	35.0	580	F	24.2	21.64	75.82	Y
SC6	20.4	90	M	2.69	2.23	21.94	Y
SC7	30.8	460	F	29.14	12.24	50.24	Y
SC8	30.4	400	F	19.96	11.2	38.43	Y
SC9	29.7	380	F	14.6	12.64	46.77	Y
SC10	24.5	170	M	5.84	2.52	39.21	Y
SC11	24.5	170	M	4.07	2.45	33.67	Y
SC12	24.2	160	M	2.41	2.55	33.23	Y
Comments – All Shorthorn Sculpin samples were collected by angling at the ship loading wharf, on Saturday, July 12, 2003.							

Table A2. Sediment Core Sample Locations, Depth and Descriptions, Nanisivik Mine, July, 2003.

Core ID	Core Sections	Sampling Location	Water Depth	Comments
S	S1 (0 to 5 cm) S2 (6 to 10 cm)	73° 04′ 15.069 N 84° 32′ 13.127 W	56 m	This was the only successful core out of about 10 attempts in water depths between 3 m and 80 m. Core collected on Monday July 14, 2003.
F	F1 (0 to 5 cm) F2 (6 to 10 cm)	73° 04′ 19.370 N 84° 32′ 43.873 W	80 m	Core collected after about four unsuccessful tries between 45 and 60 m water depth. Core collected on Wednesday, July 16, 2003.



FILE: SAMPLE

REFERENCE DRAWING FROM GARTNER LEE LIMITED PROJECT # 21-957 FILE NAME: 21957-D3-02.DWG OCT. 1, 2002	LOCATIONS OF TERRESTRIAL AND MARINE SAMPLING STATIONS NANISIVIK MINE, JULY 2003	Date: 2003 11 25 Job No.: 15058	Scale: 1 : 30 000 Fig. No.: 1

Jacques Whitford
Consulting Engineers
Environmental Scientists

Appendix B

Analytical Data Reports by RPC, for Fish Tissue and Sediment Samples

RPC
921 College Hill Rd,
Fredericton, N.B. E3B 6Z9
Report No.: 31733-IAS

Jacques Whitford Environment
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Fredericton NB E3B 5C2
Attn: M. Stephenson
Job No.: 15058

August 15, 2003
Revised: October 14, 2003

Fax: 506-452-7652

RECEIVED OCT 14 2003

Trace Metals Analysis

RPC ID	31733 RB1	31733 RB2	31733 RB3	DORM-2A	DORM-2B	DORM-2
Client ID	QA/QC	QA/QC	QA/QC	CRM	CRM	Target Values
	Concentration (mg/Kg)					
Aluminum	< 0.2	< 0.2	< 0.2	14.4	18.9	10.9 ± 1.7
Antimony	< 0.005	< 0.005	< 0.005	0.038	0.029	-
Arsenic	< 0.05	< 0.05	< 0.05	17.6	17.4	18.0 ± 1.1
Barium	< 0.05	< 0.05	< 0.05	2.60	4.20	-
Beryllium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	-
Bismuth	< 0.005	< 0.005	< 0.005	0.012	0.007	-
Boron	< 0.05	< 0.05	< 0.05	0.64	0.65	-
Cadmium	< 0.005	< 0.005	< 0.005	0.053	0.048	0.043 ± 0.008
Calcium	< 5	< 5	< 5	501	590	-
Chromium	< 0.05	< 0.05	< 0.05	31.5	30.4	34.7 ± 5.5
Cobalt	< 0.005	< 0.005	< 0.005	0.233	0.213	0.182 ± 0.031
Copper	< 0.05	< 0.05	< 0.05	2.76	2.62	2.34 ± 0.16
Iron	< 1	< 1	< 1	149	147	142 ± 10
Lead	< 0.005	< 0.005	< 0.005	0.218	0.065	0.065 ± 0.007
Lithium	< 0.005	< 0.005	< 0.005	0.079	0.078	-
Magnesium	< 0.5	< 0.5	< 0.5	969	1040	-
Manganese	< 0.05	< 0.05	< 0.05	4.74	4.24	3.66 ± 0.34
Mercury	< 0.01	< 0.01	< 0.01	4.32	4.15	4.64 ± 0.26
Molybdenum	< 0.005	< 0.005	< 0.005	0.382	0.349	-
Nickel	< 0.05	< 0.05	< 0.05	22.1	19.6	19.4 ± 3.1
Potassium	< 1	< 1	< 1	14100	14400	-
Rubidium	< 0.005	< 0.005	< 0.005	5.53	5.71	-
Selenium	< 0.05	< 0.05	< 0.05	1.34	1.59	1.40 ± 0.09
Silver	< 0.005	< 0.005	< 0.005	0.038	0.038	0.041 ± 0.013
Sodium	< 5	< 5	< 5	4340	4410	-
Strontium	< 0.05	< 0.05	< 0.05	2.54	2.76	-
Tellurium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	-
Thallium	< 0.005	< 0.005	< 0.005	0.005	< 0.005	-
Tin	< 0.005	< 0.005	< 0.005	0.131	0.091	-
Uranium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	-
Vanadium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	-
Zinc	< 0.2	< 0.2	< 0.2	25.1	27.7	25.6 ± 2.3

Portions of the samples were prepared by Microwave Assisted Digestion in nitric acid. The resulting solutions were diluted to volume for trace element analysis by ICP-MS and ICP-ES. Mercury was analysed by Cold Vapour AAS.

Ross Kean

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Report No.: 31733-IAS

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Attn: M. Stephenson
Job No.: 15058

August 15, 2003
Revised: October 14, 2003

Fax: 506-452-7652

Trace Metals Analysis

RPC ID	31733-30A	31733-30B	31733-31	31733-32
Client ID	SC1	Duplicate	SC2	SC3
Aluminum	2.2	2.4	1.5	1.0
Antimony	< 0.005	< 0.005	< 0.005	< 0.005
Arsenic	5.63	5.46	9.98	7.44
Barium	0.50	0.30	0.20	0.08
Beryllium	< 0.005	< 0.005	< 0.005	< 0.005
Bismuth	0.006	0.005	< 0.005	< 0.005
Boron	1.58	1.60	1.72	2.09
Cadmium	0.050	0.031	0.017	0.023
Calcium	2710	1370	1880	1650
Chromium	0.12	0.07	0.15	0.18
Cobalt	0.011	0.011	0.012	0.008
Copper	0.63	0.60	0.46	0.46
Iron	9	8	6	4
Lead	0.259	0.560	0.192	0.083
Lithium	0.043	0.031	0.036	0.036
Magnesium	212	195	180	210
Manganese	0.75	0.51	0.43	0.37
Mercury	0.18	0.18	0.13	0.15
Molybdenum	0.005	< 0.005	0.009	< 0.005
Nickel	0.07	< 0.05	0.16	0.20
Potassium	2540	2460	2980	2780
Rubidium	0.546	0.540	0.637	0.531
Selenium	0.57	0.53	0.45	0.50
Silver	0.007	0.005	< 0.005	< 0.005
Sodium	1400	1280	1440	1370
Strontium	18.0	9.66	12.5	7.15
Tellurium	< 0.005	< 0.005	< 0.005	< 0.005
Thallium	< 0.005	< 0.005	< 0.005	< 0.005
Tin	< 0.005	0.006	0.018	0.005
Uranium	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	< 0.05	< 0.05	< 0.05	< 0.05
Zinc	26.7	20.2	19.5	13.9

RPC
921 College Hill Rd,
Fredericton, N.B. E3B 6Z9
Report No.: 31733-IAS

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Trace Metals Analysis

RPC ID	31733-33	31733-34	31733-35	31733-36	31733-37
Client ID	SC4	SC5	SC6	SC7	SC8
	Concentration (mg/Kg)				
Aluminum	0.2	0.8	0.3	6.6	7.6
Antimony	0.009	0.006	< 0.005	< 0.005	0.019
Arsenic	4.75	7.47	3.56	9.55	3.86
Barium	0.20	0.10	0.09	0.20	0.30
Beryllium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bismuth	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Boron	1.95	2.40	1.18	1.89	2.06
Cadmium	0.011	0.044	0.025	0.057	0.043
Calcium	1110	1180	584	3210	1890
Chromium	0.10	0.14	0.15	0.34	0.07
Cobalt	0.011	0.007	0.008	0.007	0.011
Copper	0.49	0.45	0.53	0.62	0.55
Iron	4	8	5	9	5
Lead	0.041	0.260	0.228	2.22	0.354
Lithium	0.025	0.034	0.028	0.040	0.034
Magnesium	208	260	178	215	206
Manganese	0.46	0.35	0.29	0.50	0.54
Mercury	0.11	0.19	0.07	0.24	0.26
Molybdenum	< 0.005	0.007	0.006	< 0.005	< 0.005
Nickel	0.10	0.07	0.07	0.13	0.07
Potassium	2390	2590	2460	2430	2240
Rubidium	0.452	0.440	0.425	0.456	0.440
Selenium	0.51	0.54	0.42	0.77	0.48
Silver	< 0.005	< 0.005	< 0.005	0.007	0.006
Sodium	1110	1710	1310	1850	1510
Strontium	7.60	8.42	4.18	16.4	14.0
Tellurium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Thallium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Tin	0.010	< 0.005	0.007	0.006	0.006
Uranium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zinc	18.8	17.0	14.7	24.8	18.0

RPC
921 College Hill Rd,
Fredericton, N.B. E3B 6Z9
Report No.: 31733-IAS

Jacques Whitford Environment
PO Box 1116
Fredericton NB E3B 5C2
Attn: M. Stephenson
Job No.: 15058

August 15, 2003
Revised: October 14, 2003

Fax: 506-452-7652

Trace Metals Analysis

RPC ID	31733-38	31733-39	31733-40	31733-41A	31733-41B
Client ID	SC9	SC10	SC11	SC12	Duplicate
	Concentration (mg/Kg)				
Aluminum	2.1	1.6	2.6	1.3	0.8
Antimony	< 0.005	0.015	< 0.005	< 0.005	< 0.005
Arsenic	4.92	3.13	2.02	3.25	3.32
Barium	0.30	0.10	0.20	0.20	0.20
Beryllium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Bismuth	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Boron	2.34	1.90	1.85	2.13	2.18
Cadmium	0.010	0.013	0.013	0.041	0.029
Calcium	2840	891	1440	1880	1930
Chromium	0.13	0.11	0.13	0.14	0.10
Cobalt	0.007	0.011	0.009	0.010	0.009
Copper	0.55	0.72	0.58	0.60	0.60
Iron	5	4	4	39	10
Lead	0.371	0.039	0.027	1.86	0.263
Lithium	0.044	0.028	0.036	0.037	0.038
Magnesium	222	190	208	221	234
Manganese	0.40	0.34	0.56	0.56	0.56
Mercury	0.13	0.09	0.10	0.13	0.13
Molybdenum	< 0.005	0.006	< 0.005	0.016	0.007
Nickel	0.09	0.07	0.06	0.06	0.07
Potassium	2610	2100	1750	2180	2250
Rubidium	0.455	0.396	0.341	0.395	0.398
Selenium	0.51	0.47	0.43	0.45	0.51
Silver	< 0.005	< 0.005	< 0.005	0.006	0.007
Sodium	1350	1340	1460	1490	1560
Strontium	16.6	6.65	8.79	12.8	12.6
Tellurium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Thallium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Tin	0.006	0.010	< 0.005	0.010	0.011
Uranium	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Vanadium	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Zinc	10.2	12.5	12.2	21.3	23.1

RPC
921 College Hill Rd,
Fredericton, N.B. E3B 6Z9
Report No.: 31733-IAS

Jacques Whitford Environment
PO Box 1116
Fredericton NB E3B 5C2
Attn: M. Stephenson
Job No.: 15058

August 15, 2003
Revised: October 14, 2003

Fax: 506-452-7652

Trace Metals Analysis

RPC ID	32881 RB1	NIST 2709	NIST 2709
Client ID	QA/QC	CRM	Target Values
	Concentration (mg/Kg)		
Aluminum	< 1	24900	20000 - 31000
Antimony	< 0.1	0.8	< 10
Arsenic	< 1	18	< 20
Barium	< 1	454	392 - 400
Beryllium	< 0.1	0.8	-
Bismuth	< 1	< 1	-
Boron	< 1	33	-
Cadmium	< 0.1	0.3	< 1
Calcium	< 50	14700	14000 - 17000
Chromium	< 1	77	60 - 115
Cobalt	< 0.1	12.9	10-15
Copper	< 1	34	26 - 40
Iron	< 20	33100	25000 - 33000
Lead	< 0.1	11.7	12 - 18
Lithium	< 0.1	36.5	-
Magnesium	< 10	13300	12000 - 15000
Manganese	3	513	360 - 600
Mercury	< 0.01	1.43	1.40 ± 0.08
Molybdenum	< 0.1	1.4	< 2
Nickel	< 1	83	65 - 90
Potassium	< 20	4110	2600 - 3700
Rubidium	< 0.1	36.9	-
Selenium	< 1	2	-
Silver	< 0.1	0.3	-
Sodium	< 50	810	630 - 1100
Strontium	< 1	117	100 - 112
Tellurium	< 0.1	< 0.1	-
Thallium	< 0.1	0.3	-
Tin	0.2	0.9	-
Uranium	< 0.1	1.5	-
Vanadium	< 1	74	51 - 70
Zinc	2	98	87 - 120

Samples were air dried and sieved at 1mm. Portions were digested according to EPA Method 3050. The resulting solutions were diluted to volume for trace element analysis by ICP-MS and ICP-ES. Mercury was analysed by Cold Vapour AAS.

RPC
921 College Hill Rd,
Fredericton, N.B. E3B 6Z9
Report No.: 31733-IAS

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PO Box 1116
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Attn: M. Stephenson
Job No.: 15058

August 15, 2003
Revised: October 14, 2003

Fax: 506-452-7652

Trace Metals Analysis

RPC ID	32881-01A	32881-01B	32881-02	32881-03	32881-04
Client ID	S1	Duplicate	S2	F1	F2
	Concentration (mg/Kg)				
Aluminum	12800	13100	14000	12900	12100
Antimony	0.1	0.1	0.1	0.1	< 0.1
Arsenic	11	11	9	14	13
Barium	60	62	78	53	58
Beryllium	0.7	0.7	0.9	0.7	0.7
Bismuth	< 1	< 1	< 1	< 1	< 1
Boron	56	56	62	64	61
Cadmium	2.4	2.5	1.6	5.8	10.2
Calcium	67300	67200	60700	77200	83800
Chromium	24	25	27	23	24
Cobalt	9.1	9.2	9.0	9.9	10.5
Copper	28	29	26	37	40
Iron	26900	27100	25200	35400	33700
Lead	148	138	88.4	359	568
Lithium	51.9	52.8	57.4	53.4	54.3
Magnesium	55000	55000	51700	61800	64300
Manganese	256	256	246	315	288
Mercury	0.04	0.04	0.03	0.06	0.10
Molybdenum	1.4	1.3	2.0	2.3	2.1
Nickel	22	22	23	21	24
Potassium	4150	4250	4720	4550	4200
Rubidium	26.9	28.6	32.4	26.1	26.5
Selenium	1	< 1	< 1	1	< 1
Silver	0.7	0.8	0.4	1.6	2.2
Sodium	4570	4570	6900	8610	5340
Strontium	55	53	52	68	63
Tellurium	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	0.3	0.3	0.3	0.3	0.5
Tin	0.8	0.9	1.6	1.8	2.0
Uranium	1.1	1.2	1.2	1.1	1.2
Vanadium	53	55	59	58	56
Zinc	807	842	481	1890	2740