Memo

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Date	**29 September 2003**		
Subject	**Supplemental Sediment Quality Report – Jericho Project**		

SEDIMENT QUALITY BASELINE – JERICHO PROJECT

INTRODUCTION

Sediment samples have been collected from a number of Project area water bodies summarized in Table 2-1 and located on Figure 2-1.

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TABLE 2-1
SUMMARY OF SEDIMENT SAMPLING

Water Body	Collection Year
Cigar Lake	1995
Lake C3	1995, 2000
Carat Lake	1995, 2000
Jericho Lake	1995, 2000
Lake C1 (designated C13 in 1995)	1995, 2000
Jericho River, middle	1995
Jericho River, north	1995
Kathawachaga Lake (W)	1995
Kathawachaga Lake (C)	1995
Key Lake	1996, 2000
Pocket Lake	1996
Lynne Lake	1996, 2000
Ash Lake	1996, 2000
Bay on Contwoyto Lake	1996, 2000
Control Lake	1999, 2000
Lake C3	1999, 2000
Stream TC3	1999
Carat Lake, optional outfall	2000

METHODS

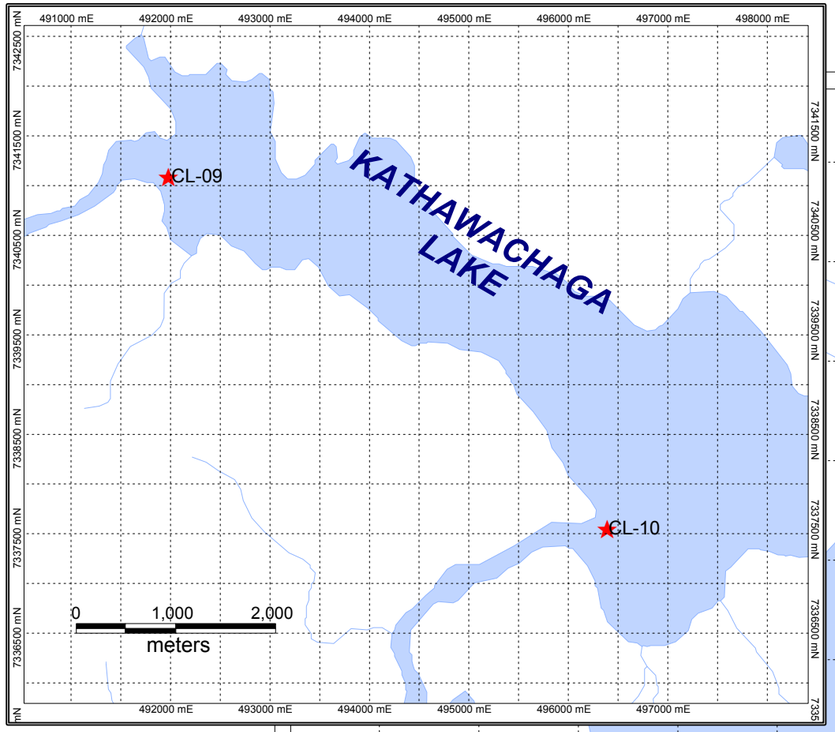
1995 – 1996

1.1.1 Field

Sediment samples were collected using a depression corer. The corer was deployed vertically and penetrated deep within the substrate. Excess water above the sediment sample was decanted prior to placement in the container. When possible the sediment was gravity fed into the container. Otherwise, a pre-washed (5% HNO3) stainless steel spoon was used to remove the sediment. Sediment samples were placed in containers supplied or recommended by CanTest Ltd. laboratory in Vancouver. Sample bottles were labeled with the sample location, date and preservative added if required. Samples were kept cool (optimum temperature of 4°C) and shipped to CanTest as soon as possible after collection.

1.1.2 Laboratory

The sediment samples were analysed by CanTest Ltd. laboratory in Vancouver. The samples were analysed for 28 metal constituents, organic carbon, nitrogen, phosphorus and % moisture content.



Tahera Corporation

Jericho Sediment Sample Locations

Figure 2-1

Date: 14/1/2000	
Author: MJ	
Office: VAN	
Inset: 1: 60,000	Projection: UTM Zone 12 (NAD 27 Canada)

Undried samples tested for metals were digested with a mixture of nitric acid and hydrochloric acid ("Aqua Regia"). Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICAP) or by specific methods as described. Arsenic and selenium were analyzed by Zeeman background-corrected Graphite Atomic Absorption Spectrophotometry. Cadmium and lead were analyzed by background-corrected Flame Atomic Absorption Spectrophotometry. Mercury analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry. Uranium was analyzed by Inductively Coupled Argon Plasma Mass Spectroscopy (ICP/MS). Moisture was determined gravimetrically at 105°C on separate portions of the samples.

Total Kjeldahl nitrogen was determined by rigorous acid digestion, steam distillation and titration. Kjeldahl nitrogen is defined as organic nitrogen (high energy compounds of amino acids and amines) and ammonia (intermediate compound formed during biological metabolism). These forms of nitrogen are indicators of recent pollution. It is reported on a dry weight basis, sample dried at 60°C. Total organic carbon was also reported on a dry weight basis and was determined by acid digestion analysis of residue by Leco Induction Furnace.

Parameters analyzed are listed in Table 2-2.

Table 2-2: 1995 – 1996 Sediment Analysis Parameters

Moisture	Mercury
	Molybdenum
Aluminum	Nickel
Antimony	Phosphorus
Arsenic	Selenium
Barium	Silver
Beryllium	Sodium
Boron	Strontium
Cadmium	Tin
Calcium	Titanium
Chromium	Uranium
Cobalt	Vanadium
Copper	Zinc
Iron	
Lead	Total Organic Carbon
Magnesium	Total Kjeldahl Nitrogen
Manganese	Phosphorus

1999 – 2000

1.1.3 Field

In 1999 and 2000, one set of sediment samples was collected (by means of a stainless steel Ekman grab - lakes, or shovel / coarse (20 mesh) screen – streams). Samples were removed from the Ekman grab by means of a stainless steel spoon rinsed in the water where the samples were collected. Samples were taken from the top 3 to 6 cm for lake samples. Grab samplers, having a wider collection area than corers will tend to average out patchiness in sediments more than the latter (Baudo 1990).

1.1.4 Laboratory

Triplicate samples (three samples from each site) were taken in late July 1999 and 2000 and analyzed for the parameters listed in Table 2-3, except that only total extractable metals were analyzed. In 1999, where possible, the -70 mm fraction of the sediment was analyzed to bias results in favour of particle sizes that are more biologically available. Due to coarseness of the surface material available, stream TC3 sediments were analyzed using the entire sample rather than the -70mm fraction. Review of the data indicates metals levels appear to be somewhat lower in Stream TC3, as expected.

Table 2-3: 1999 – 2000 Sediment Analysis Parameters	
Physical Tests	Nickel T-Ni
Moisture %	Phosphorus T-P
	Selenium T-Se
Total Metals	
Aluminum T-Al	Silver T-Ag
Antimony T-Sb	Sodium T-Na
Arsenic T-As	Strontium T-Sr
Barium T-Ba	Tin T-Sn
Beryllium T-Be	Titanium T-Ti
Boron T-B	Vanadium T-V
Cadmium T-Cd	Zinc T-Zn
Calcium T-Ca	
Chromium T-Cr	**Organic Parameters**
Cobalt T-Co	Total Organic Carbon C
Copper T-Cu	**Particle Size**
Iron T-Fe	1999: < 70μm except TC3
Lead T-Pb	2000
Magnesium T-Mg	Gravel (>2.00mm)
Manganese T-Mn	Sand (2.00mm - 0.063mm)
Mercury T-Hg	Silt (0.063mm - 4um)
Molybdenum T-Mo	Clay (<4um)

LABORATORY QA/QC

Laboratory QA/QC for 1996 samples is provided in Tables 2-4 and 2-5. For 1999 and 2000, triplicate sampling (results discussed below) provided the QA.

Table 2-4: Jericho Sediment QA/QC Analytical Results (1996)

Site Identification Sample ID Date			CL 96 002 18-S1 17-Jul-96	CL 96 002 18-S1 17-Jul-96	CL 96 002 18-S1		
Parameter		**Units (dry weight)**		**Duplicate**	**Average**	**RPD**	**Detection Limits**
Moisture	H2O	%	58.60%	-	58.60%	-	0.01
Antimony	Sb	ug/g	<	<	<	NC	10
Arsenic	As	ug/g	2.8	3.2	3	14%	0.5
Barium	Ba	ug/g	37.3	54.2	45.7	37%	0.1
Beryllium	Be	ug/g	<	<	<	NC	1
Cadmium	Cd	ug/g	<	<	<	NC	0.25
Chromium	Cr	ug/g	22.8	34.6	28.7	41%	2
Cobalt	Co	ug/g	4.4	6.4	5.4	36%	1
Copper	Cu	ug/g	21.5	29.4	25.4	31%	1
Lead	Pb	ug/g	1.6	2.7	2.2	PASS	1
Mercury	Hg	ug/g	0.003	0.005	0.004	PASS	0.001
Molybdenum	Mo	ug/g	<	<	<	NC	4
Nickel	Ni	ug/g	18.3	26.8	22.6	37%	2
Selenium	Se	ug/g	<	<	<	NC	0.5
Silver	Ag	ug/g	<	<	<	NC	2
Tin	Sn	ug/g	<	<	<	NC	5
Vanadium	V	ug/g	22.8	33.3	28	38%	0.5
Zinc	Zn	ug/g	47.4	65.3	56.4	32%	1
Aluminum	Al	ug/g	8300	12300	10300	39%	10
Boron	B	ug/g	7.6	10.4	9	32%	0.5
Calcium	Ca	ug/g	2330	3470	2900	39%	1
Iron	Fe	ug/g	11100	16300	13700	38%	2
Magnesium	Mg	ug/g	3810	5630	4720	39%	0.1
Manganese	Mn	ug/g	152	228	190	40%	0.2
Sodium	Na	ug/g	190	274	232	36%	5
Strontium	Sr	ug/g	12	18.3	15.1	41%	0.1
Titanium	Ti	ug/g	544	529	536	3%	0.3
Uranium	U	ug/g	2	2.8	2.4	PASS	0.5
Phosphorus	PO4	ug/g	1360	1450	1400	6%	20

Results expressed as micrograms per gram (ug/g) on a "dry-weight" basis.
RPD = Relative Percent Difference
NC = Not calculable
PASS = RPD calculation not applicable to results less than 5X the detection limit.
< = Less than detection limit
% = percent

Table 2-5: QA/QC Blank Analysis Results (1996)

Components		Blank #1	Blank #2	Blank #3	Average	Std. Dev.	Detection Limit
Aluminum	Al	<	<	<	NC	NC	0.15
Antimony	Sb	<	<	<	NC	NC	0.15
Arsenic	As	<	<	<	NC	NC	0.01
Barium	Ba	<	<	<	NC	NC	0.001
Beryllium	Be	<	<	<	NC	NC	0.006
Boron	B	0.045	0.031	0.014	0.03	0.01	0.01
Cadmium	Cd	<	<	<	NC	NC	0.005
Calcium	Ca	<	<	<	NC	NC	0.01
Chromium	Cr	0.027	0.027	0.014	0.02	0.01	0.03
Cobalt	Co	<	<	<	NC	NC	0.02
Copper	Cu	<	<	<	NC	NC	0.015
Iron	Fe	0.31	0.22	0.2	0.24	0.05	0.03
Lead	Pb	<	<	<	NC	NC	0.08
Magnesium	Mg	0.003	<	<	NC	NC	0.001
Manganese	Mn	<	<	<	NC	NC	0.003
Mercury	Hg	<	<	<	NC	NC	0.0002
Molybdenum	Mo	<	<	<	NC	NC	0.04
Nickel	Ni	<	<	<	NC	NC	0.025
Phosphorus	PO4	<	<	<	NC	NC	0.4
Potassium	K	<	<	<	NC	NC	1
Selenium	Se	<	<	<	NC	NC	0.05
Silver	Ag	<	<	<	NC	NC	0.03
Sodium	Na	<	<	<	NC	NC	0.1
Strontium	Sr	<	<	<	NC	NC	0.001
Tin	Sn	<	<	<	NC	NC	0.03
Titanium	Ti	<	0.006	<	NC	NC	0.006
Vanadium	V	<	<	<	NC	NC	0.01
Zinc	Zn	0.016	0.018	<	NC	NC	0.015

Notes:
Results expressed as milligrams per liter (mg/L)
< = Less than
NC = Not calculable

RESULTS

Sediment Sample Water Depths

Table 2-6 lists water depths for sample collections. Depth of sediment collected was not provided for 1995 – 1996 data; depth of sediment collected from lakes in 1999 – 2000 was from 0 to 6 cm and from streams, the top 10 to 15 cm of sediment.

Table 2-6: Sediment Sample Water Depths

Lake	Year	Depth (m)
C1	2000	12
C3	1999, 2000	15, 15
Control	1999, 2000	41, 41
Carat Lake (E basin)	2000	26
Carat Lake (SE basin)	2000	15
Carat Lake (main basin)	1995	30
Carat Lake (W basin)	1995	9.4
Jericho Lake	1995, 2000	4.1, 5
Ash Lake	1996, 2000	7.5, 8
Key Lake	1996, 2000	11, 13
Lynne Lake	1996, 2000	15.4, 17
Contwoyto Lake	1996, 2000	14.4, 15
Tailings Lake	1995	4.3
Stream	**Year**	**Depth (m)**
Seep Creek	1995	0.3
Stream C3	1999	0.25

CRITERIA

CCME criteria for sediments are based on the Interim Sediment Quality Guideline (ISQD) and Probable Effects Level (PEL). Criteria are listed in Table 2-7.

Table 2-7: Canadian Environmental Quality Guidelines for Freshwater Sediment

Parameter	ISQG (ug/g)	PEL (ug/g)
Arsenic	5.800	17.000
Cadmium	0.600	3.500
Chromium	37.300	90.000
Copper	35.700	197.000
Lead	35.000	91.300
Mercury	0.170	0.486
Zinc	123.000	315.000
ISQG Interim sediment quality guideline		
PEL Probable effect level		

SEDIMENT QUALITY

Sediment quality results are appended for each year of sampling. Ranges of concentrations found are shown in Table 2-8 for 1995 and 1996 and in Table 2-9 for 1999 and 2000, since

methodology differed in 1995 and 1996 from that in 1999 and 2000. In Table 2-8, Key, Pocket, Lynne, Ash and Contwoyto were collected in 1996; the others in 1995. In the tables, **bold** numbers are above CCME ISQG and shaded cells are above PEL.

Table 2-8: 1995-96 Sediment Quality

Constituent	01 Cigar L	03 Carat W	04 Carat C	06 Jericho L	07 Jericho R Middle	08 Jericho R North	09 Kathawachaga W	10 Kathawachaga C	12-1 Tailings L	12-2 Tailings L	13 Seep Crk	14 Key L	15 Pocket L	16 Lynne L	17 Ash L	18 Contwoyto NW
Moisture (%)	27.4	27.9	42.8	34.8	27.1	24.2	25.	71.9	61.4	59.2	71.2	51.1	54.7	72.1	64.9	58.6
Aluminum	15800	11800	17100	6900	6440	10500	10000	8990	12300	35400	29500	22200	16200	23700	23800	10300
Antimony	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	3.7	3.1	6.3	2.2	1.8	1.2	0.95	1.7	10	4.8	**9.3**	4.2	3.7	21	**10**	3
Barium	92	52	84	36	24	47	50	70	57	200	187	106	68	103	118	46
Beryllium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Boron	17	12	18	7.1	7.8	1111	13	7.6	15	33	30	20	13	24	23	9
Cadmium	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Calcium	2780	3710	4270	1860	1750	3050	2740	1520	2460	5880	4650	5020	3280	4140	3840	2900
Chromium	35	29	**40**	16	12	24	24	20	27	94	**38**	**58**	**40**	**56**	**60**	29
Cobalt	9	7	11	4	3	6	7	5	10	22	31	11	9	14	11	5
Copper	29	216	**39**	16	6	12	10	27	**78**	**81**	**90**	**52**	34	**111**	**89**	25
Iron	24400	19100	25200	10100	9880	15900	15100	10100	24400	53300	41400	28800	20400	40200	41100	13700
Lead	3	2	3	2	1		1	1	3	4	56	3	2	5	3	2
Magnesium	7510	6370	8420	3430	3330	5400	4860	3600	5020	18600	7520	9700	6520	8410	10000	4720
Manganese	382	296	284	112	97	172	183	171	235	565	4260	329	282	607	344	190
Mercury	0.008	0.004	0.015	0.004	0.004	0.006	0.008	0.017	0.03	0.015	0.14	0.037	0.04	0.11	0.039	0.004
Molybdenum	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Nickel	25	19	29	14	10	17	16	19	27	56	36	30	24	37	33	23
Phosphorus	1630	1990	2310	1440	1090	1300	1750	870	1880	2860	3050					
Selenium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	<0.5	<0.5
Silver	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sodium	299	319	403	118	127	227	226	133	2070	706	272	933	382	398	753	232

Strontium	17	21	25	9.1	11	15	15	9	12	33	27	28	17	23	21	15
Tin	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Titanium	1030	876	737	389	441	528	719	487	546	2040	961	66	711	679	1010	536
Uranium	3.8	2.3	5.7	2.1	1.2	2	1.5	3.6	28	22	43	1.05	1.03	3.87	3.75	1.36
Vanadium	40	34	47	20	16	29	26	21	37	93	62	54	40	65	60	28
Zinc	49	36	60	29	25	51	43	49	57	97	71	66	56	96	72	56
TOC (%)	0.32	0.13	0.38	0.17	0.54	0.47	0.54	1.85	2.84	1.37	3.71	1.07	2.03	1.75	1.49	0.69
Total Kjeldahl Nitrogen (%)	0.06	0.03	0.07	0.04	0.06	0.07	0.06	0.42	0.37	0.41	0.9	0.14	0.19	0.33	0.24	0.14
Phosphorus (PO_4)	1770	2070	2680	1730	1230	1560	1710	1880	2840	1950	2730	2700	2660	5740	2650	2140

All concentrations are μg/g unless specified.

Table 2-9: 1999-2000 1999
(ug/g, or as indicated)

	Control Lake			Control	Stream TC3			Stream	Lake C3			Lake C3
	Rep #1	Rep #2	Rep #3	Lake	Rep #1	Rep #2	Rep #3	TC3	Rep #1	Rep #2	Rep #3	
Physical Tests				Mean				Mean				Mean
Moisture %	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Metals												
Aluminum T-Al	25000	23500	23500	24000	8400	8850	7950	8400	19700	19100	19000	19267
Antimony T-Sb	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<40	<20
Arsenic T-As	64	78	80	74	4.2	2.6	2.8	3.2	**10**	**10**	**7.5**	**9.2**
Barium T-Ba	160	151	181	164	32	26	19	26	101	92	93	95
Beryllium T-Be	0.9	0.8	0.8	0.8	<0.5	<0.5	<0.5	<0.5	0.8	0.7	<1	0.75
Boron T-B	15	12	10	12	<10	<10	<10	<10	14	<10	<20	14
Cadmium T-Cd	0.3	0.3	0.5	0.4	<0.1	<0.1	<0.1	<0.1	0.3	0.3	0.3	0.3
Calcium T-Ca	2690	2520	2590	2600	1530	2070	1960	1853	2690	2410	2590	2563
Chromium T-Cr	**58**	**52**	**50**	**53**	23	21	16	20	**42**	**41**	**46**	**43**
Cobalt T-Co	28	35	50	38	4	5	4	4	9	10	9	9
Copper T-Cu	**88**	**89**	**92**	**90**	5	6	6	6	**62**	**63**	**60**	**62**
Iron T-Fe	108000	112000	142000	120667	15100	15000	13200	14433	26700	25700	23700	25367
Lead T-Pb	26	22	17	22	3	6	3	4	**39**	25	**52**	**39**
Magnesium T-Mg	6370	6190	5840	6133	4710	5020	4280	4670	5110	5130	4980	5073
Manganese T-Mn	5600	7210	11600	8137	108	112	99	106	298	332	303	311
Mercury T-Hg	0.168	0.16	0.161	0.163	0.009	0.008	0.009	0.009	0.058	0.055	0.054	0.056
Molybdenum T-Mo	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<8	<4
Nickel T-Ni	39	41	46	42	11	13	11	12	28	29	28	28
Phosphorus T-P	1960	2030	2070	2020	327	436	397	387	1260	1280	1370	1303
Selenium T-Se	0.8	0.8	0.9	0.8	<0.1	<0.1	<0.1	<0.1	0.4	0.4	0.4	0.4
Silver T-Ag	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<4	<2
Sodium T-Na	489	385	398	424	98	117	165	127	469	398	446	438
Strontium T-Sr	22.3	20.2	21.1	21.2	8.1	10.6	10.3	9.7	20.6	19.3	21	20.3
Tin T-Sn	6	<5	<5	6	<5	<5	<5	<5	<5	<5	<10	<5
Titanium T-Ti	825	714	747	762	431	423	380	411	708	707	803	739
Vanadium T-V	52	49	46	49	22	23	18	21	42	42	43	42
Zinc T-Zn	94	93	99	95	22	22	20	21	75	77	79	77
Organic Parameters												
Tot Organic Carbon C	5.67	5.37	5.67	5.57	0.15	<0.05	<0.05	0.15	3.78	3.05	3.24	3.36
Particle Size in 1999 <70 um except Stream C3: whole sample analysis												
Gravel (>2.00mm) (%)												
Sand (2.00mm - 0.063mm) (%)												
Silt (0.063mm - 4um) (%)												
Clay (<4um) (%)												

Table 2-9: 1999-2000 **2000**
(ug/g, or as indicated)

	Carat L NE			Carat L NE	Jericho Lake			Jericho Lake	Lake C1			Lake C1	Key Lake			Key Lake
	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean
Physical Tests																
Moisture %	81.4	81.3	81.5	81.4	82.9	82.8	83	82.9	82.1	81.9	82	82.0	77.8	77.8	77.5	77.7
Total Metals																
Aluminum T-Al	21800	22300	22400	22167	14300	15600	15300	15067	23700	23300	25100	24033	24900	24700	22500	24033
Antimony T-Sb	<20	<20	<20	<20	<20	<20	<20	<20	<40	<40	<20	<20	<20	<20	<20	<20
Arsenic T-As	28	24	29	27	<4	4	4	4	**13**	**12**	**12**	**12**	27	29	16	24
Barium T-Ba	106	106	108	107	70	78	74	74	111	110	123	115	208	198	197	201
Beryllium T-Be	1	1	1	1	0.7	0.7	0.6	0.7	<1	1	1.1	1.1	0.8	0.8	0.7	0.8
Boron T-B	20	14	14	16	18	22	20	20	<20	<20	20	20	13	19	14	15
Cadmium T-Cd	0.5	0.5	0.4	0.5	0.3	0.3	0.3	0.3	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.3	0.2
Calcium T-Ca	3320	3630	3440	3463	3280	3590	3450	3440	3290	3250	3460	3333	3730	3700	3390	3607
Chromium T-Cr	**45**	**47**	**47**	**46**	33	34	35	34	**46**	**45**	**48**	**46**	**55**	**55**	**50**	**53**
Cobalt T-Co	12	13	13	13	6	5	6	6	15	14	15	15	26	23	21	23
Copper T-Cu	**68**	**69**	**71**	**69**	**60**	**61**	**60**	**60**	**92**	**92**	**95**	**93**	**84**	**88**	**80**	**84**
Iron T-Fe	42200	44700	44300	43733	16700	17600	17800	17367	68000	66600	70800	68467	83300	75800	58600	72567
Lead T-Pb	6	6	6	6	5	6	6	6	10	10	10	10	8	7	6	7
Magnesium T-Mg	6710	7020	7080	6937	4970	5260	5320	5183	6700	6590	6950	6747	8850	8720	8080	8550
Manganese T-Mn	437	465	466	456	182	202	196	193	1360	1430	1520	1437	8770	7760	7850	8127
Mercury T-Hg	0.032	0.031	0.033	0.032	0.029	0.033	0.031	0.031	0.094	0.114	0.118	0.109	0.069	0.07	0.068	0.069
Molybdenum T-Mo	<4	<4	<4	<4	<4	<4	<4	<4	<8	<8	<4	<4	<4	<4	<4	<4
Nickel T-Ni	30	32	33	32	21	20	21	21	23	24	25	24	45	46	44	45
Phosphorus T-P	1210	1270	1290	1257	958	989	984	977	1280	1270	1350	1300	1230	1290	1070	1197
Selenium T-Se	0.4	0.3	0.4	0.4	0.3	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.5	0.5	0.4	0.5
Silver T-Ag	<2	<2	<2	<2	<2	<2	<2	<2	<4	<4	<2	<2	<2	<2	<2	<2
Sodium T-Na	307	273	308	296	290	257	204	250	272	285	349	302	358	355	387	367
Strontium T-Sr	22.7	23.2	23.2	23	18.9	21.5	19.9	20	21	21	22.6	22	24.3	24.1	22.1	24
Tin T-Sn	<5	<5	<5	<5	<5	<5	<5	<5	<10	<10	<5	<5	<5	<5	<5	<5
Titanium T-Ti	1220	1150	1270	1213	743	1030	909	894	1020	999	1100	1040	1490	1440	1340	1423
Vanadium T-V	60	59	65	61	43	43	44	43	57	56	65	59	70	74	65	70
Zinc T-Zn	102	109	107	106	63	64	66	64	66	66	69	67	86	88	81	85
Organic Parameters																
Tot Organic Carbon C	4.62	4.84	4.58	4.68	6.8	6.77	6.78	6.78	4.16	-	-	4.16	3.29	-	-	3.29
Particle Size in 1999 <70 um																
Gravel (>2.00mm) (%	<0.1	-	-	<0.1	<0.1	-	-	<0.1	<0.1	-	-	<0.1	<0.1	-	-	<0.1
Sand (2.00mm - 0.063mm)	5.9	-	-	5.9	20	-	-	20	2.7	-	-	2.7	3.9	-	-	3.9
Silt (0.063mm - 4um) (%	49.7	-	-	49.7	50.3	-	-	50.3	54	-	-	54	51	-	-	51
Clay (<4um) (%)	44.4	-	-	44.4	29.7	-	-	29.7	43.3	-	-	43.3	45.1	-	-	45.1

Table 2-9: 1999-2000 **2000**
(ug/g, or as indicated)

	Ash Lake			Ash Lake	Lynne Lake			Lynne Lake	Contwoyto Lake			Contwoyto Lake
	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean
Physical Tests												
Moisture %	85.6	85.4	85.6	85.5	75.9	76	76.1	76	80.2	80.2	80.3	80.2
Total Metals												
Aluminum T-Al	30900	29100	34000	31333	24000	27700	28500	26733	18900	18500	19200	18867
Antimony T-Sb	<40	<40	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Arsenic T-As	**9**	**9**	**9**	**9**	**13**	**18**	**17**	**16**	35	40	41	39
Barium T-Ba	172	153	190	172	103	116	120	113	94	95	97	95
Beryllium T-Be	1	<1	1.3	1.2	0.7	1	0.9	0.9	0.6	0.6	0.7	0.6
Boron T-B	24	<20	24	24	11	14	14	13	14	15	17	15
Cadmium T-Cd	<0.1	<0.1	<0.1	<0.1	0.5	0.5	0.4	0.5	0.4	0.6	0.5	0.5
Calcium T-Ca	3780	3740	4250	3923	4300	4890	5080	4757	3380	3290	3430	3367
Chromium T-Cr	**65**	**64**	**72**	**67**	**50**	**58**	**59**	**56**	**41**	**40**	**42**	**41**
Cobalt T-Co	12	12	14	13	15	17	18	17	22	21	23	22
Copper T-Cu	**117**	**118**	**131**	**122**	**79**	**95**	**96**	**90**	**56**	**54**	**58**	**56**
Iron T-Fe	58300	57300	64400	60000	45100	57700	55100	52633	47300	46600	49900	47933
Lead T-Pb	8	10	10	9	9	9	8	9	6	7	6	6
Magnesium T-Mg	10100	9950	11000	10350	7370	8390	8770	8177	6450	6310	6600	6453
Manganese T-Mn	381	386	438	402	521	633	824	659	1290	1470	1380	1380
Mercury T-Hg	0.103	0.106	0.115	0.108	0.141	0.134	0.133	0.136	0.012	0.013	0.014	0.013
Molybdenum T-Mo	<8	<8	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Nickel T-Ni	36	35	42	38	31	33	36	33	48	47	49	48
Phosphorus T-P	1580	1560	1780	1640	1580	1910	1880	1790	1740	1720	1840	1767
Selenium T-Se	0.8	0.8	0.8	0.8	0.4	0.5	0.6	0.5	0.4	0.4	0.4	0.4
Silver T-Ag	<4	<4	<2	<2	<2	<2	<2	<2	<2	<2	4	4
Sodium T-Na	369	271	496	379	401	408	419	409	314	302	329	315
Strontium T-Sr	20	19	23.4	21	26.5	29.3	30.6	29	26.2	25.5	26.5	26
Tin T-Sn	<10	<10	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Titanium T-Ti	1410	1230	1580	1407	1520	1670	1820	1670	1330	1310	1380	1340
Vanadium T-V	83	88	100	90	74	92	85	84	52	53	52	52
Zinc T-Zn	84	85	94	88	84	95	96	92	92	91	95	93
Organic Parameters												
Tot Organic Carbon C	8.26	-	-	8.26	4.2	-	-	4.20	3.25	-	-	3.25
Particle Size in 1999 <70 um												
Gravel (>2.00mm) (%	<0.1	-	-	<0.1	<0.1	-	-	<0.1	<0.1	-	-	<0.1
Sand (2.00mm - 0.063mm)	4.5	-	-	4.5	1.6	-	-	1.6	3.5	-	-	3.5
Silt (0.063mm - 4um) (%	37.2	-	-	37.2	50.5	-	-	50.5	61	-	-	61
Clay (<4um) (%)	58.3	-	-	58.3	47.9	-	-	47.9	35.5	-	-	35.5

Table 2-9: 1999-2000 **2000**
(ug/g, or as indicated)

	Control Lake			Control Lake	Lake C3			Lake C3	Carat L SE			Carat L SE
	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean	Rep 1	Rep 2	Rep 3	Mean
Physical Tests												
Moisture %	81.3	81.6	81.5	81.5	81.7	81.6	81.7	81.7	72.7	72.2	72.8	72.6
Total Metals												
Aluminum T-Al	32700	34700	33300	33567	23200	23600	24900	23900	17700	20100	21000	19600
Antimony T-Sb	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Arsenic T-As	46	44	47	46	4	5	5	5	39	43	123	68
Barium T-Ba	152	166	160	159	101	107	113	107	75	93	92	87
Beryllium T-Be	1.2	1.1	1.1	1.1	0.9	0.8	1	0.9	0.7	0.7	0.8	0.7
Boron T-B	20	19	24	21	15	13	13	14	<10	11	11	11
Cadmium T-Cd	<0.1	<0.1	<0.1	<0.1	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.2
Calcium T-Ca	3380	3570	3420	3457	3300	3350	3480	3377	2620	3070	3210	2967
Chromium T-Cr	**68**	**72**	**70**	**70**	**50**	**50**	**52**	**51**	**40**	**43**	**46**	**43**
Cobalt T-Co	46	45	43	45	8	8	8	8	22	24	24	23
Copper T-Cu	**103**	**108**	**101**	**104**	**68**	**64**	**67**	**66**	**49**	**53**	**58**	**53**
Iron T-Fe	94400	93500	90600	92833	24100	23300	24300	23900	52800	55200	58900	55633
Lead T-Pb	14	13	14	14	8	8	8	8	6	6	6	6
Magnesium T-Mg	9110	9440	9100	9217	6990	6930	7260	7060	6270	6440	7120	6610
Manganese T-Mn	2850	2830	2770	2817	255	254	270	260	1950	2310	2080	2113
Mercury T-Hg	0.139	0.141	0.142	0.141	0.072	0.064	0.067	0.068	0.029	0.028	0.03	0.029
Molybdenum T-Mo	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Nickel T-Ni	33	35	35	34	27	25	26	26	25	28	30	28
Phosphorus T-P	1970	2040	1960	1990	1690	1660	1710	1687	1010	1040	1140	1063
Selenium T-Se	0.9	1	0.9	0.9	0.4	0.5	0.5	0.5	0.2	0.2	0.2	0.2
Silver T-Ag	<2	2	2	2	<2	<2	<2	<2	<2	<2	<2	<2
Sodium T-Na	373	369	350	364	268	287	278	278	224	287	302	271
Strontium T-Sr	26.2	28.2	27	27	21.4	22.6	23.6	23	18.1	22.5	23.1	21
Tin T-Sn	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Titanium T-Ti	1610	1690	1630	1643	1250	1340	1420	1337	1060	1270	1320	1217
Vanadium T-V	75	79	78	77	54	57	58	56	44	54	58	52
Zinc T-Zn	94	97	94	95	74	72	74	73	69	72	77	73
Organic Parameters												
Tot Organic Carbon C	4.75	4.58	4.69	4.67	4.94	-	-	4.94	2.26	-	-	2.26
Particle Size in 1999 <70 um												
Gravel (>2.00mm) (%	<0.1	-	-	<0.1	<0.1	-	-	<0.1	<0.1	-	-	<0.1
Sand (2.00mm - 0.063mm)	5.7	-	-	5.7	1.9	-	-	1.9	15.2	-	-	15.2
Silt (0.063mm - 4um) (%	44.8	-	-	44.8	48.2	-	-	48.2	56	-	-	56
Clay (<4um) (%)	49.5	-	-	49.5	49.9	-	-	49.9	28.8	-	-	28.8

For Jericho area lakes, arsenic, chromium and copper show up as above ISQG and, for arsenic especially, significantly above PEL. This pattern is consistent throughout the samples, despite the differing methods of collection and analyses. For chromium and copper analyses are the same order of magnitude throughout, whereas for arsenic, the 1995-96 core samples and total (aqua-regia) digestion produced lower arsenic results on average than the 1999-2000 Ekman grab, total extractable metals analyses. Despite these differences, general trends remain similar.

While arsenic appears to be at levels of concern, aquatic sampling of Jericho area lakes indicated populations of aquatic organisms were generally what would be expected for tundra lakes; no anomalies were noted. This suggests CCME guidelines for all of Canada may not adequately take into account areas with bedrock arsenic higher than crustal averages for Canada.

Control Lake had metals elevated above those of other sample sites. Other data were consistent with previously collected sediment samples. Most parameters measured in Control Lake were two to ten times higher than Lake C3, Cigar Lake, Carat Lake, and Jericho Lake. This may be due to glacial movement of Morel Sills (basic diabase bedrock) into the Control Lake basin. These rocks are high in aluminum, iron, and magnesium. In contrast, Lake C3 and Long Lake are located behind a topographic high consisting of granitoid bedrock and may have been protected from deposits from the Morel Sills. Lynne, Key, Ash, Pocket, and Contwoyto Lake bay are nearer to Control Lake in sediment quality, except for arsenic, which is generally lower in these latter lakes. Movement of Morel sills can be used to explain these latter similarities as well.

CONCLUSIONS

Results for all years are generally similar, despite differing methodologies, but cannot be quantitatively compared because of those confounding factors. Mercury in sediments is low and therefore the high background concentration in fish muscle from area lakes found during aquatic sampling is unlikely to have been caused by biomagification or bioaccumulation from sediments. Nickel is another metal of potential concern in areas where ultramafic bedrock is located but an ISQG for the metal has not been published by CCME. On average nickel concentrations were about half those of copper and chromium.

Results indicate that arsenic, chromium and copper are elevated in area lakes. It will be important to monitor lake sediment metals concentrations to determine whether increases occur over the life of mine. Of course, to determine whether an effect has occurred, aquatic effects monitoring will need to be conducted as well.

REFERENCES

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