TECHNICAL MEMORANDUM

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REVIEWED BY:	Steve Atkin and Don Chorley		

RE: **ASSESSMENT OF THE ACID ROCK DRAINAGE AND METAL LEACHING POTENTIAL OF ROCK SAMPLES COLLECTED FROM AN ESKER ALONG THE TEHEK LAKE ACCESS ROAD MEADOWBANK PROJECT, NUNAVUT**

1.0 INTRODUCTION

This memorandum presents an assessment of the acid rock drainage (ARD) and metal leaching (ML) potential of gravel samples collected from an esker along the alignment of the Tehek Lake Access Road to the Meadowbank Gold Project (Meadowbank), in Nunavut. The esker is located approximately 7 km from Baker Lake (Cumberland, 2006a). The esker material is to be used as-is for road topping and in the construction of the starter road from Prince River road (Cumberland, 2006b). The purpose of conducting ARD/ML tests on these samples was to evaluate the potential for the excavated till to produce acidic drainage and leach metals to the receiving environment.

2.0 METHODOLOGY

2.1 Sample Collection

Meadowbank Mining Corp. (MMC) formerly Cumberland Resources Ltd. (Cumberland) collected seven gravel samples from the esker along the Tehek Lake Access Road. Figure 2-1 shows the locations along the road alignment where the esker samples were taken. The samples were sent by MMC to Golder Associates Ltd. (Golder), who then described them in terms of mineralogic characteristics visible in hand specimen. The seven samples were labelled, bagged and submitted to Canadian Environmental and Metallurgical Inc. (CEMI) for chemical analyses.

2.2 Analyses

The suite of chemical analyses performed by CEMI included whole rock and elemental solid phase chemistry, acid-base accounting (ABA), and analysis of metal leaching potential via shake flask extraction (SFE). These analyses are described in the following sections.

2.2.1 Rock Chemistry

The chemical composition of each of the seven samples was determined by a) whole rock analysis (via lithium metaborate fusion and nitric acid digestion) and by b) multi-acid digestion. Arsenic, mercury, selenium, and thallium were analyzed by a separate assay. All analyses were completed through ICP-OES scans of the digested solutions.

Whole rock analysis provides total elemental weight percent compositions as oxides of major rock-forming elements (*e.g.*, Na_2O, CaO, SiO_2, etc.) and is used to determine the general characteristics of different lithologies.

Multi-acid digestion provides elemental concentrations of trace metals. Although multi-acid digestion of samples prior to ICP analysis is aggressive, the process may leave trace amounts of solids undissolved and therefore not analyzed. Whole rock analytical results are thus considered to be more representative of the actual concentration of major elements.

2.2.2 Acid Base Accounting

ABA tests were performed on each of the seven samples to evaluate the ARD potential of the rock, following guideline analytical protocol per INAC (1992). These tests included determination of the following parameters: paste pH; acid potential (AP) through sulphur species analysis (analysis of total sulphur, sulphate sulphur and sulphide sulphur by difference); bulk neutralization potential (bulk NP) by the Modified Sobek Method; and carbonate neutralization potential (CaNP) through total inorganic carbon (TIC) analysis. CaNP is used to assess the amount of acid neutralization that can be attributed to reactive carbonate minerals, compared to the amount of acid neutralization from other sources such as aluminosilicate minerals.

2.2.3 Metal Leaching

SFE tests (INAC, 1992) were performed on each of the seven samples to evaluate the amount of readily soluble metals that can leach from the rock in concentrations exceeding the Canadian Council of Ministers of the Environment's (CCME) Canadian Environmental Quality Guidelines (CEQG) (updated 2003) for the protection of freshwater aquatic life. The seven samples were tested as-is (not crushed) so that the leachate results would be more representative of the material as it will be placed. The samples were subjected to a 24-hour shake flask extraction using de-ionized water at a liquid to solid ratio of 3 to 1 (*i.e.*, 750 ml distilled water to 250 g of sample). The resulting leachate was filtered and analyzed for pH, conductivity, acidity, alkalinity, sulphate, and low-level metals (by ICP-MS).

2.3 Comparative Guidelines

2.3.1 ARD Potential

The ARD potential of the seven samples was evaluated using the Indian and Northern Affairs Canada (INAC) guidelines for northern minesites (INAC, 1992). The potential of a geologic material to generate ARD is described by comparing the buffering capacity of the rock provided by neutralizing minerals, expressed as neutralization potential (bulk NP in units of equivalent kg of calcium carbonate per tonne of rock), to the amount of acidity that can be generated by the oxidation of sulphide minerals, expressed as the maximum acid potential (AP in the same units as NP), present in the rock. This ratio is referred to as the net potential ratio (NPR). The suggested guidelines are as follows:

TABLE 2-1: Acid Rock Drainage Screening Criteria for Rock (INAC, 1992)

Initial Screening Criteria	ARD Potential
NPR < 1	Likely Acid Generating (PAG)
1 < NPR < 3	Uncertain
3 < NPR	Acid Consuming Not Potentially Acid Generating (NPAG)

The relationship between paste pH and sulphide sulphur content was also considered based upon recommendations by Price (1997). Materials with a sulphide sulphur content of less than 0.3 wt.% and a paste pH greater than 5.5 may be classified as non-acid generating except where the rock matrix consists of base poor minerals (*e.g.*, quartz), or where the sulphide minerals contain metals that may leach under weakly acidic to alkaline conditions. This criterion was considered as a screening tool rather than a definite indicator of the potential for acidification.

Bulk NP measures the maximum potential buffering capacity including that, which comes from less reactive silicate minerals such as micas and feldspars. For samples having a low carbonate mineral content, the bulk NP measurement can overestimate the effective NP of a sample. For samples with low carbonate content CaNP may provide a better measure of available NP and NPR (ARD potential).

2.3.2 Metal Leaching Potential

Metal concentrations in leachate generated by SFE tests are compared to the CEQG (updated 2003) for the protection of freshwater aquatic life.

This set of criteria is used for screening purposes only, since true drainage and run-off quality generated by exposure of fresh rock surfaces to water depends on factors that cannot be simulated in static laboratory tests (*e.g.*, grain size distribution, frequency and volume of precipitation, rate of sulphide oxidation, etc.). Guideline exceedances of constituents in SFE leachate do not necessarily imply water quality exceedances on site; rather they provide an indication of potential constituents of environmental concern.

3.0 RESULTS

3.1 Geology

The following table summarizes the lithologies of the gravel samples collected for ARD/ML analyses.

TABLE 3-1: Geological Sample Descriptions

Sample	Lithology	Gravel Description
Sample 1	IV	chloritized/hematized **intermediate volcanic** (feldspar phyric) no visible sulphides
Sample 2	IV	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides
Sample 3	IV	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides
Sample 4	IV + Phyllite (<5%)	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides, and **phyllite** particles with trace disseminated sulphides (pyrite)
Sample 5	IV	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides
Sample 6	IV	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides
Sample 7	IV + Granite (<5%)	chloritized/hematized **intermediate volcanic** (feldspar phyric), feldspar/quartz veining, no visible sulphides and **granitic** particles

The seven samples collected consisted of mostly gravel with some sand and finer particles. Sample 1, 2, 3, 5, and 6 were fairly clean gravel samples with less that 5% sand and fines. Sample 4 and 7 were gravel samples with approximately 10% sand and fines. In general, the seven gravel samples collected were composed of chloritized/hematized intermediate volcanic (IV) material with no visible sulphides. Sample 4 was composed of mostly IV material but contained a few phyllite particles (<5%) with trace sulphides (pyrite). Sample 7 was composed of mostly IV material but contained a few granite particles (<5%).

The presence of iron-bearing sulphides, particularly pyrite, is noteworthy since their oxidation results in acid production. The following equation represents the oxidation of pyrite and generation of proton acidity:

$$FeS_2\,(s) + (7/2)\,H_2O + (15/4)\,O_2\,(g) \rightarrow Fe(OH)_3\,(s) + 2SO_4^{2-}\,(aq) + 4H^+\,(aq)$$

This equation shows that pyrite in contact with water and air will produce rust ($Fe(OH)_3$), sulphate (SO_4^{2-}) and acid (H+). Under acidic conditions, with a lack of buffering, the mobility of most metals in water is enhanced. Common acid buffering minerals include calcium-rich carbonates, such as calcite and dolomite, as well as aluminosilicate minerals, such as chlorite and feldspar noted in the sample descriptions in Table 3-1. These minerals dissolve at different rates to buffer the acidity generated by sulphide minerals; silicate minerals are less reactive than carbonate minerals (Blowes and Ptacek, 1994).

3.2 Rock Chemistry

Results of whole rock and elemental analyses are shown at the end of this report in Tables 3-2 and 3-3, respectively.

The major rock type described for each of the seven gravel samples was intermediate volcanic, with a few samples containing minor amounts of granite or phyllite rock particles (<5%). As shown in the results from the whole rock analysis, the samples report silica and aluminium as major rock forming elements. The calculated average weight percents of SiO_2 and Al_2O_3 for the seven samples are 62.1 wt %, and 16.4 wt %, respectively.

The concentration ranges of the CEQG-regulated constituents from the multi-acid digestion analyses for trace element concentrations in the seven samples are as follows: aluminium (7.76 to 8.73 %); arsenic (<1 to 1 ppm); chromium (134 to 161 ppm); copper (3 to 15 ppm); iron (2.84 to 3.97 %); lead (<2 to 4 ppm); mercury (<5 to 8 ppb); molybdenum (<2 to 4 ppm); nickel (16 to 26 ppm); thallium (0.4 to 0.9 ppm); and zinc (54 to 77 ppm).

The following CEQG-regulated constituents were below laboratory detection limits in all seven samples: cadmium (<1 ppm); selenium (<0.1 ppm); and silver (<1 ppm).

3.3 ARD Potential

Results of ABA analyses are shown in Table 3-4 at the end of this report. Table 3-5 (below) summarizes the ARD potential of the seven samples by comparing the bulk NPR of the samples compared to the INAC (1992) criteria.

TABLE 3-5: Summary of ARD Potentials of Esker Samples

Potential for ARD	Initial Screening Criteria	Number of Results	NPR Range
PAG	NPR < 1	-	-
Uncertain	1 < NPR < 3	-	-
NPAG	NPR > 3	7	6.24 – 19.5

Based on the INAC guidelines for northern minesites (1992), none of the samples are considered to be potentially acid generating (NPAG). The NPR values range from 6.24 to 19.5 and sulphide sulphur contents are very low, ranging from 0.02 to 0.04 %. Sulphate sulphur concentrations that are below the method detection limit (<0.01 wt %)

The bulk NP values range from 3.9 to 12.2 kg $CaCO_3$/tonne of rock and AP values range from 0.63 to 1.25 kg $CaCO_3$/tonne of rock. The seven samples report alkaline paste pH values ranging from 8.96 to 9.26; which indicates that the samples have readily available buffering capacity.

Samples 1 and 2 report CaNPR values of 3.56 and 14.67, respectively. As compared to the bulk NPR values of these samples (6.51 and 18.4 respectively), these CaNPR values suggest that a significant proportion of the neutralization potential of these samples is provided by reactive carbonate minerals, with some proportion attributed to slower-reacting aluminosilicate minerals.

Samples 3, 4, 5, 6 and 7 report CaNPR values that range from 0.64 to 6.67. As compared to the bulk NPR values of these samples, which range from 6.2 to 19.5, these CaNPR values suggest that a significant proportion of the neutralization potential of these samples is provided by slower-reacting aluminosilicate minerals, with a smaller proportion attributed to reactive carbonate minerals.

3.4 Metal Leaching

Results of static metal leaching tests are shown in Table 3-6 at the end of this report and are compared to the CEQG for freshwater aquatic life. Table 3-7 summarizes guideline exceedances noted in the leachates (shown in bold) from the seven samples.

TABLE 3-7: Summary of CEQG Exceedances

Sample ID	CEQG Exceedance(s)
Sample 1	Cr
Sample 2	pH, Al, Cd
Sample 3	-
Sample 4	Cu
Sample 5	pH, Al, Cu
Sample 6	pH, Al, Cd, Cu
Sample 7	pH, Al, As, Cu

As noted in section 2.2.3 uncrushed samples were tested to be more representative of the potential to leach metals of the material as it is used.

The SFE leachates from Samples 1, 3, and 4 report neutral pH values (7.11, 7.15, and 6.86 respectively). The SFE leachates from Samples 2, 5, 6, and 7 report slightly acidic pH values (6.27, 5.92, 6.37, and 6.46 respectively), which are below the CEQG guideline range (6.5 – 9.0) and indicate that the SFE leachate for these samples have no readily available buffering capacity. These leachates also report aluminium concentrations (0.0067 mg/L, 0.021 mg/L, 0.0096 mg/L, and 0.0097 mg/L respectively) that exceed the CEQG for aluminium (0.005 mg/L). The CEQG guideline for aluminium is pH dependant (if pH >= 6.5, the aluminium criteria is 0.1mg/L; if pH< 6.5, the aluminium criteria is 0.005 mg/L). Sample 7 also reports a leachate arsenic concentration (0.0075 mg/L) that exceeds the CEQG for arsenic (0.005 mg/L). For Samples 2 and 6 the SFE leachate cadmium concentrations (0.00002 mg/L and 0.00001 mg/L, respectively) are greater than CEQG for cadmium (0.000001 – 0.000003 mg/L). However in this case, the method detection limit for the analysis of cadmium (0.00001mg/L) also exceeds the CEQG guideline and the reported concentrations of Samples 2 and 6 are at or near the method detection limit at which accuracy is very low. Sample 1 reports a leachate chromium concentration (0.0015 mg/L) that exceeds CEQG for chromium (0.001 mg/L). Samples 4, 5, 6, and 7 report leachate copper concentrations (0.0046 mg/L, 0.0037 mg/L, 0.0051mg/L, and 0.0038 mg/L respectively) that exceed CEQG for copper (0.002 mg/L).

Constituent concentrations not discussed in this section are below the CEQG.

The aluminium leaching exhibited by each of the samples is likely due to partial dissolution of the naturally occurring and abundant aluminosilicate minerals. The source mineral for the arsenic, cadmium, chromium, and copper leaching is unknown. The material is not expected to be a large contributor of these constituents in time since the solid-phase concentrations of arsenic and cadmium are at or below their respective detection limits in the samples. The average concentrations of chromium and copper (144 and 7 ppm respectively) are not anomalously high compared to average basic igneous rock according to Price, 1997 (170 and 87 ppm, respectively). As the samples are all non-acid generating and have very low sulphide to oxidize, constituent concentrations are expected to attenuate over time, as fine particles are washed from the material.

4.0 SUMMARY OF RESULTS

The objective of this assessment was to evaluate the ARD/ML potential of rock collected from an esker along the alignment of the Tehek Lake Access Road to the Meadowbank Gold Project. The esker material is to be used for road topping and in the construction of the starter road from Prince River road. Seven samples of the esker material were collected by MMC personnel for ARD/ML testing.

The seven samples were composed of mostly chloritized/hematized, intermediate volcanic rocks. Sample 4 and Sample 7 also contained a small amount (<5%) of other rock types (phyllite and granite respectively). The phyllite in Sample 4 contained trace disseminated pyrite.

The whole rock analysis reports an abundance of aluminosilicate minerals for the seven samples. Aluminosilicate minerals, such as the feldspar and chlorite, noted in the sample descriptions, provide some amount of acid neutralizing potential, although they are typically slower to react (slower reaction kinetics and lower buffering pH) than carbonate minerals such as calcite or dolomite.

All seven samples are considered to be NPAG, based on their NPR values compared to the INAC (1992) screening criteria. The seven samples also report low sulphide sulphur concentrations, indicating a low potential to generate acid, and alkaline paste pH values, indicating immediately available buffering capacity. For samples 1 and 2 the comparison of bulk NPR and CaNPR suggests that a significant proportion of the neutralization potential is provided by reactive carbonate minerals, with a lesser proportion attributed to slowly-reacting aluminosilicate minerals. For samples 3, 4, 5, 6 and 7 the comparison of bulk NPR and CaNPR suggests that a significant proportion of the neutralization potential is provided by slowly-reacting aluminosilicate minerals, with a lesser proportion attributed to reactive carbonate minerals.

For the SFE leachable metals analysis the seven esker samples were tested as-is to provide a more representative estimate of the potential for the material to leach metals as it will be placed. The CEQG for pH, aluminium, arsenic, cadmium, chromium, and copper concentrations were exceeded in some of the samples. Four samples reported leachate pH values that were below the CEQG guideline range, these samples also reported aluminium concentrations that exceeded the CEQG for aluminium. The arsenic and chromium CEQG were each exceeded for one sample. The cadmium CEQG was exceeded for two samples, although in this case the method detection limit for cadmium also exceeds the guideline. The copper CEQG was exceeded for four samples.

Aluminium leaching from the samples is likely due to partial dissolution of the exposed aluminosilicate minerals, which are naturally occurring and abundant in the rock. The source for arsenic, cadmium, chromium, and copper leaching unknown but likely to be trace elements associated with readily soluble minerals. Trace metal leaching is likely to attenuate over time, due to the non-acid generating potential of the samples, as fine particles are washed from the material.

As noted above (refer to Section 2.3.2), results of the SFE are not directly applicable to field conditions, and exceedances in SFE analytes do not necessarily directly correlate to exceedances of the same analytes when the esker material is used for road construction. The exceedance in pH and other metals from the SFE tests suggest that if the esker material is used for construction, that the quality of runoff contacting the esker material, for the Tehek Lake Access Road or the starter road should be monitored during construction, to document the effect that the exposed rock will have on receiving water quality.

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TABLE 3-2:
Whole Rock Analysis Results
Esker Samples
Meadowbank, Nunavut

Sample ID	Location		Rock Type	SiO2	Al2O3	Fe2O3	CaO	MgO	Na2O	K2O	TiO2	P2O5	MnO	BaO	Cr2O3	LOI	Total	C	S
	Easting	Northing		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Sample 1	644692	7139831	IV	62.24	16.58	4.88	2.77	2.06	4.67	2.81	0.51	0.20	0.08	0.11	0.03	2.00	98.93	0.07	0.03
Sample 2	355402	7140268	IV	63.69	16.08	4.16	2.62	1.77	4.76	2.48	0.50	0.20	0.07	0.13	0.04	2.11	98.60	0.18	0.02
Sample 3	355379	7140161	IV	62.54	16.33	5.04	3.29	2.43	4.63	1.71	0.57	0.25	0.07	0.08	0.03	2.19	99.18	0.08	0.04
Sample 4	355374	7140106	IV + Phylite	63.22	15.93	5.23	3.49	2.05	4.32	1.99	0.61	0.20	0.08	0.09	0.03	2.20	99.45	0.11	0.02
Sample 5	355185	7140035	IV	62.06	16.42	5.21	3.35	2.53	4.40	2.11	0.59	0.27	0.07	0.09	0.03	2.36	99.51	0.10	0.03
Sample 6	355279	7139957	IV	60.30	16.35	5.84	3.36	2.39	4.29	2.51	0.66	0.30	0.08	0.10	0.03	2.20	98.40	0.10	0.02
Sample 7	355281	7139953	IV + Granitic	60.94	17.01	5.10	3.32	1.99	4.45	3.12	0.55	0.22	0.07	0.11	0.03	2.05	98.97	0.04	0.02
			min	*60.30*	*15.93*	*4.16*	*2.62*	*1.77*	*4.29*	*1.71*	*0.50*	*0.20*	*0.07*	*0.08*	*0.03*	*2.00*	*98.40*	*0.04*	*0.02*
			max	*63.69*	*17.01*	*5.84*	*3.49*	*2.53*	*4.76*	*3.12*	*0.66*	*0.30*	*0.08*	*0.13*	*0.04*	*2.36*	*99.51*	*0.18*	*0.04*
			average	*62.14*	*16.39*	*5.07*	*3.17*	*2.17*	*4.50*	*2.39*	*0.57*	*0.23*	*0.07*	*0.10*	*0.03*	*2.16*	*99.01*	*0.10*	*0.03*
			median	*62.24*	*16.35*	*5.10*	*3.32*	*2.06*	*4.45*	*2.48*	*0.57*	*0.22*	*0.07*	*0.10*	*0.03*	*2.19*	*98.97*	*0.10*	*0.02*
			standard deviation	*1.20*	*0.35*	*0.50*	*0.33*	*0.28*	*0.18*	*0.49*	*0.06*	*0.04*	*0.01*	*0.02*	*0.00*	*0.12*	*0.41*	*0.04*	*0.01*

Notes:
< = less than detection limit
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE 3-3:
Trace Element Analysis Results
Esker Samples
Meadowbank, Nunavut

Sample ID	Location		Rock Type	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Co	Cr	Cu	Fe	Hg	K
	Easting	Northing		ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppb	%
Sample 1	644692	7139831	IV	<1	8.08	<1	978	1.6	<5	1.87	<1	14	134	15	3.39	<5	2.26
Sample 2	355402	7140268	IV	<1	7.78	<1	1080	1.4	<5	1.74	<1	14	134	5	2.84	<5	1.95
Sample 3	355379	7140161	IV	<1	8.29	<1	741	1.4	<5	2.31	<1	19	147	7	3.71	<5	1.5
Sample 4	355374	7140106	IV + Phylite	<1	8.21	<1	824	1.7	<5	2.49	<1	18	161	3	3.91	<5	1.74
Sample 5	355185	7140035	IV	<1	8.73	<1	818	1.6	<5	2.44	<1	20	157	5	3.97	8	1.89
Sample 6	355279	7139957	IV	<1	7.76	<1	847	1.4	<5	2.21	<1	20	138	10	3.9	<5	1.92
Sample 7	355281	7139953	IV + Granitic	<1	8.42	1	983	1.7	<5	2.3	<1	16	136	6	3.71	<5	2.46
			min	*<1*	*7.76*	*<1*	*741*	*1.4*	*<5*	*1.74*	*<1*	*14*	*134*	*3*	*2.84*	*<5*	*1.50*
			max	*<1*	*8.73*	*1*	*1080*	*1.7*	*<5*	*2.49*	*<1*	*20*	*161*	*15*	*3.97*	*8*	*2.46*
			average	*<1*	*8.18*	*1*	*896*	*1.5*	*<5*	*2.19*	*<1*	*17*	*144*	*7*	*3.63*	*3*	*1.96*
			median	*<1*	*8.21*	*1*	*847*	*1.6*	*<5*	*2.30*	*<1*	*18*	*138*	*6*	*3.71*	*3*	*1.92*
			standard deviation	*n/a*	*0.35*	*0*	*120*	*0.1*	*n/a*	*0.28*	*n/a*	*3*	*11*	*4*	*0.40*	*2*	*0.32*

Sample ID	Location		Rock Type	Mg	Mn	Mo	Na	Ni	P	Pb	Se	Sr	Ti	TI	V	W	Zn
	Easting	Northing		%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample 1	644692	7139831	IV	1.12	546	4	3.14	16	934	2	<0.1	474	0.27	0.9	73	<10	72
Sample 2	355402	7140268	IV	0.94	429	3	3.17	16	930	<2	<0.1	444	0.26	0.6	61	<10	54
Sample 3	355379	7140161	IV	1.37	538	4	3.29	24	1227	<2	<0.1	583	0.32	0.5	78	<10	68
Sample 4	355374	7140106	IV + Phylite	1.16	595	3	3.05	20	989	<2	<0.1	594	0.32	0.4	86	<10	77
Sample 5	355185	7140035	IV	1.48	581	<2	3.31	26	1334	<2	<0.1	642	0.34	0.4	89	<10	77
Sample 6	355279	7139957	IV	1.26	576	<2	2.74	23	1336	<2	<0.1	571	0.33	0.5	84	<10	76
Sample 7	355281	7139953	IV + Granitic	1.09	536	3	2.99	16	996	4	<0.1	525	0.30	0.5	74	<10	70
			min	*0.94*	*429*	*<2*	*2.74*	*16*	*930*	*<2*	*<0.1*	*444*	*0.26*	*0.4*	*61*	*<10*	*54*
			max	*1.48*	*595*	*4*	*3.31*	*26*	*1336*	*4*	*<0.1*	*642*	*0.34*	*0.9*	*89*	*<10*	*77*
			average	*1.20*	*543*	*3*	*3.10*	*20*	*1107*	*2*	*<0.1*	*548*	*0.31*	*0.5*	*78*	*<10*	*71*
			median	*1.16*	*546*	*3*	*3.14*	*20*	*996*	*1*	*<0.1*	*571*	*0.32*	*0.5*	*78*	*<10*	*72*
			standard deviation	*0.18*	*55*	*1*	*0.20*	*4*	*185*	*1*	*n/a*	*70*	*0.03*	*0.2*	*10*	*n/a*	*8*

Notes:
< = less than detection limit
Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE 3-4:
Acid Base Accounting Results
Esker Samples
Meadowbank, Nunavut

Sample ID	Location		Rock type	Paste pH	S(T) %	S(SO4) %	S(S-2) %	AP	NP	TIC %	CaCO3 NP	Net NP	NPR	CaNPR	ARD Potential
	Easting	Northing													
Sample 1	644692	7139831	IV	9.15	0.03	<0.01	0.03	0.938	6.1	0.04	3.3	5.2	6.51	3.56	NPAG
Sample 2	355402	7140268	IV	9.11	0.02	<0.01	0.02	0.625	11.5	0.11	9.2	10.9	18.40	14.67	NPAG
Sample 3	355379	7140161	IV	9.26	0.04	<0.01	0.04	1.250	10.2	0.03	2.5	9.0	8.16	2.00	NPAG
Sample 4	355374	7140106	IV + Phylite	9.20	0.02	<0.01	0.02	0.625	11.2	0.05	4.2	10.6	17.92	6.67	NPAG
Sample 5	355185	7140035	IV	8.96	0.03	<0.01	0.03	0.938	10.7	0.03	2.5	9.8	11.41	2.67	NPAG
Sample 6	355279	7139957	IV	9.12	0.02	<0.01	0.02	0.625	12.2	0.04	3.3	11.6	19.52	5.33	NPAG
Sample 7	355281	7139953	IV + Granitic	9.00	0.02	<0.01	0.02	0.625	3.9	<0.01	<0.8	3.3	6.24	0.64	NPAG
			min	*8.96*	*0.02*	*<0.01*	*0.02*	*0.63*	*3.9*	*0.03*	*2.5*	*3.3*	*6.24*	*0.64*	-
			max	*9.26*	*0.04*	*<0.01*	*0.04*	*1.25*	*12.2*	*0.11*	*9.2*	*11.6*	*19.52*	*14.67*	-
			average	*9.10*	*0.03*	*<0.01*	*0.03*	*0.80*	*9.4*	*0.05*	*4.2*	*8.6*	*12.59*	*5.08*	-
			median	*9.12*	*0.02*	*<0.01*	*0.02*	*0.63*	*10.7*	*0.04*	*3.3*	*9.8*	*11.41*	*3.56*	-
			standard deviation	*0.11*	*0.01*	*n/a*	*0.01*	*0.25*	*3.1*	*0.03*	*2.5*	*3.2*	*5.90*	*4.69*	-

Notes:

< = less than detection limit

* S(S2-) sulphide sulphur calculated as S(T)total suphur - S(SO4)sulphate sulphur

Where S(SO4) is reported as <0.01%, it is assumed to be zero for the AP calculation.

TIC = Total inorganic carbon, used in calculation of CaNP

AP = Acid potential in kg CaCO3 equivalent per tonne of rock. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4), assuming total conversion of sulphide to sulphate.

Bulk NP = Neutralization potential in kg CaCO3 equivalent per tonne of rock.

CaNP = Carbonate mineral neutralization potential in kg CaCO3 equivalent per tonne of rock

NET NP = Net neutralization potential in kg CaCO3 equivalent per tonne of rock. Calculated as the difference between NP and AP.

NPR = Neutralization potential ratio: NP/AP

CaNPR = Neutralization potential ratio calculated using CaNP: CaNP/AP

Non-detect values assumed to be equal to one half of the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE 3-6:
Shake Flask Extraction Results
Esker Samples
Meadowbank, Nunavut

CCME (CEQG) (freshwater aquatic life)* (mg/L)				6.5 - 9.0							0.005 - 0.1		0.005
Sample ID	**Location**		**Rock type**	**pH**	**REDOX**	**Conductivity**	**Acidity (pH 8.3)**	**Alkalinity**	**Hardness**	**Sulphate**	**Aluminum[2]**	**Antimony**	**Arsenic**
	Easting	**Northing**		**s.u.**	**mV**	**uS/cm**	**mg/L as CaCO3**	**mg/L as CaCO3**	**mg/L as CaCO3**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
Sample 1	644692	7139831	IV	7.11	338	18	2.2	7.0	6.9	<1	0.0167	<0.00005	0.0008
Sample 2	355402	7140268	IV	**6.27**	440	3	2.1	3.0	1	<1	**0.0067**	<0.00005	0.0011
Sample 3	355379	7140161	IV	7.15	409	14	4.8	2.9	7.1	<1	0.0165	<0.00005	0.0003
Sample 4	355374	7140106	IV + Phylite	6.86	358	10	1.9	4.9	5.2	<1	0.036	0.00011	0.0025
Sample 5	355185	7140035	IV	**5.92**	429	3	2.5	3.9	1.7	<1	**0.021**	0.00006	0.0025
Sample 6	355279	7139957	IV	**6.37**	210	14	5.0	<2	1.9	<1	**0.0096**	0.00008	0.0038
Sample 7	355281	7139953	IV + Granitic	**6.46**	420	11	6.7	4.2	4.5	<1	**0.0097**	0.00115	**0.0075**
		min		*5.92*	*210*	*3*	*1.9*	*2.9*	*1.0*	*<1*	*0.007*	*<0.00005*	*0.0003*
		max		*7.15*	*440*	*18*	*6.7*	*7.0*	*7.1*	*<1*	*0.036*	*0.00115*	*0.0075*
		average		*6.40*	*372*	*10*	*3.6*	*4.3*	*4.0*	*<1*	*0.017*	*0.00021*	*0.0026*
		median		*6.46*	*409*	*11*	*2.5*	*4.0*	*4.5*	*<1*	*0.017*	*0.00006*	*0.0025*
		standard deviation		*0.46*	*81*	*6*	*1.9*	*1.5*	*2.5*	*n/a*	*0.010*	*0.00042*	*0.0025*

CCME (CEQG) (freshwater aquatic life)* (mg/L)							0.000003-0.000001		0.001/0.0089		0.002 - 0.004	0.3	0.001 - 0.007
Sample ID	**Location**		**Rock type**	**Beryllium**	**Bismuth**	**Boron**	**Cadmium[4, 7]**	**Calcium**	**Chromium[3]**	**Cobalt**	**Copper[4]**	**Iron**	**Lead[4]**
	Easting	**Northing**		**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
Sample 1	644692	7139831	IV	<0.00005	<0.00005	<0.008	<0.00001	2.37	**0.0015**	<0.00002	0.0014	0.009	0.00003
Sample 2	355402	7140268	IV	<0.00005	<0.00005	<0.008	**0.00002**	0.24	<0.0002	0.00002	0.0017	<0.005	0.00002
Sample 3	355379	7140161	IV	<0.00005	<0.00005	<0.008	<0.00001	2.58	<0.0002	<0.00002	0.0014	0.006	0.00004
Sample 4	355374	7140106	IV + Phylite	<0.00005	<0.00005	<0.008	<0.00001	1.85	<0.0002	<0.00002	**0.0046**	0.016	0.00007
Sample 5	355185	7140035	IV	<0.00005	<0.00005	<0.008	<0.00001	0.44	<0.0002	0.00002	**0.0037**	0.008	0.00008
Sample 6	355279	7139957	IV	<0.00005	<0.00005	<0.008	**0.00001**	0.52	<0.0002	0.00006	**0.0051**	0.006	0.00008
Sample 7	355281	7139953	IV + Granitic	<0.00005	<0.00005	<0.008	<0.00001	1.45	<0.0002	<0.00002	**0.0038**	0.009	0.00006
		min		*<0.00005*	*<0.00005*	*<0.008*	*<0.00001*	*0.24*	*<0.0002*	*<0.00002*	*0.0014*	*<0.005*	*0.00002*
		max		*<0.00005*	*<0.00005*	*<0.008*	*0.00002*	*2.58*	*0.0015*	*0.00006*	*0.0051*	*0.016*	*0.00008*
		average		*<0.00005*	*<0.00005*	*<0.008*	*0.00001*	*1.35*	*0.0003*	*0.00002*	*0.0031*	*0.008*	*0.00005*
		median		*<0.00005*	*<0.00005*	*<0.008*	*0.00001*	*1.45*	*0.0001*	*0.00001*	*0.0037*	*0.008*	*0.00006*
		standard deviation		*n/a*	*n/a*	*n/a*	*0.00001*	*0.96*	*0.0005*	*0.00002*	*0.0016*	*0.004*	*0.00002*

Notes:

1. CEQG freshwater guidelines and criteria are based on **total** metal concentrations, except for aluminum (dissolved aluminum criterion).
2. Freshwater aquatic life criterion for aluminum depends on pH, [Ca2+] and DOC. In this table, only the pH criterion has been applied to highlight exceedances.
3. Freshwater aquatic life criteria for chromium depends on the valence of chromium ion. In the above table, the Cr(VI) criterion of 0.001 mg/L is shown.
4. Freshwater aquatic life criterion or guideline is hardness dependant.
5. Maximum authorized monthly mean concentration (based on **total** concentration).
6. < = less than the analytical detection limit.
7. Cadmium guideline = 10^(0.86*log(hardness)-3.2)

* December 2003

Non-detect values assumed to be equal to one half the detection limit in calculations of average, median and standard deviation, where applicable.

TABLE 3-6:
Shake Flask Extraction Results
Esker Samples
Meadowbank, Nunavut

Sample ID	Location: Easting	Location: Northing	Rock type	Lithium (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Molybdenum (mg/L)	Nickel[4] (mg/L)	Phosphorus (mg/L)	Potassium (mg/L)	Selenium (mg/L)	Silicon (mg/L)	Barium (mg/L)
CCME (CEQG) (freshwater aquatic life)* (mg/L)							**0.000026**	**0.073**	**0.025 - 0.15**			**0.001**		
Sample 1	644692	7139831	IV	<0.0002	0.24	0.00182	<0.05	0.00008	0.0008	<0.1	0.159	<0.0005	0.13	0.00346
Sample 2	355402	7140268	IV	<0.0002	0.10	0.00351	<0.05	<0.00002	<0.0005	<0.1	0.119	<0.0005	0.07	0.00058
Sample 3	355379	7140161	IV	0.0003	0.17	0.00214	<0.05	0.00004	<0.0005	<0.1	0.078	<0.0005	0.06	0.00126
Sample 4	355374	7140106	IV + Phylite	0.0004	0.15	0.00212	<0.05	0.00016	<0.0005	<0.1	0.352	<0.0005	0.43	0.0026
Sample 5	355185	7140035	IV	0.0004	0.13	0.00396	<0.05	0.00007	<0.0005	<0.1	0.253	<0.0005	0.16	0.00102
Sample 6	355279	7139957	IV	0.0002	0.14	0.00415	<0.05	0.00006	<0.0005	<0.1	0.189	<0.0005	0.15	0.00131
Sample 7	355281	7139953	IV + Granitic	0.0004	0.20	0.00373	<0.05	0.00027	<0.0005	<0.1	0.42	<0.0005	0.46	0.00056
		min		*<0.0002*	*0.10*	*0.00182*	*<0.05*	*<0.00002*	*<0.0005*	*<0.1*	*0.078*	*<0.0005*	*0.06*	*0.00056*
		max		*0.0004*	*0.24*	*0.00415*	*<0.05*	*0.00027*	*0.0008*	*<0.1*	*0.420*	*<0.0005*	*0.46*	*0.00346*
		average		*0.0003*	*0.16*	*0.00306*	*<0.05*	*0.00010*	*0.0003*	*<0.1*	*0.224*	*<0.0005*	*0.21*	*0.00154*
		median		*0.0003*	*0.15*	*0.00351*	*<0.05*	*0.00007*	*0.0003*	*<0.1*	*0.189*	*<0.0005*	*0.15*	*0.00126*
		standard deviation		*0.0001*	*0.05*	*0.00099*	*n/a*	*0.00009*	*0.0002*	*n/a*	*0.125*	*n/a*	*0.17*	*0.00109*

Sample ID	Location: Easting	Location: Northing	Rock type	Silver (mg/L)	Sodium (mg/L)	Strontium (mg/L)	Sulphur (mg/L)	Thallium (mg/L)	Tin (mg/L)	Titanium (mg/L)	Uranium (mg/L)	Vanadium (mg/L)	Zinc (mg/L)	Zirconium (mg/L)
CCME (CEQG) (freshwater aquatic life)* (mg/L)				**0.0001**				**0.0008**					**0.03**	
Sample 1	644692	7139831	IV	<0.00001	0.21	0.00734	<0.1	<0.00005	<0.00005	<0.0005	<0.00001	0.00012	0.0009	<0.005
Sample 2	355402	7140268	IV	<0.00001	0.13	0.00072	<0.1	<0.00005	<0.00005	<0.0005	<0.00001	<0.00005	0.0048	<0.005
Sample 3	355379	7140161	IV	<0.00001	0.16	0.00579	<0.1	<0.00005	<0.00005	<0.0005	<0.00001	0.0001	0.0009	<0.005
Sample 4	355374	7140106	IV + Phylite	<0.00001	0.29	0.00443	0.3	<0.00005	0.00005	<0.0005	0.00003	0.00036	0.0008	<0.005
Sample 5	355185	7140035	IV	<0.00001	0.23	0.00149	0.2	<0.00005	0.00008	<0.0005	<0.00001	0.00007	0.0021	<0.005
Sample 6	355279	7139957	IV	<0.00001	0.16	0.00164	0.2	<0.00005	<0.00005	<0.0005	<0.00001	<0.00005	0.0042	<0.005
Sample 7	355281	7139953	IV + Granitic	0.00002	0.33	0.00402	0.4	<0.00005	<0.00005	<0.0005	<0.00001	0.00013	0.0015	<0.005
		min		*<0.00001*	*0.13*	*0.00072*	*<0.1*	*<0.00005*	*<0.00005*	*<0.0005*	*<0.00001*	*<0.00005*	*0.0008*	*<0.005*
		max		*0.00002*	*0.33*	*0.00734*	*0.4*	*<0.00005*	*0.00008*	*<0.0005*	*0.00003*	*0.0004*	*0.0048*	*<0.005*
		average		*0.00001*	*0.22*	*0.00363*	*0.2*	*<0.00005*	*0.00004*	*<0.0005*	*0.00001*	*0.0001*	*0.0022*	*<0.005*
		median		*0.00001*	*0.21*	*0.00402*	*0.2*	*<0.00005*	*0.00003*	*<0.0005*	*0.00001*	*0.0001*	*0.0015*	*<0.005*
		standard deviation		*0.00001*	*0.07*	*0.00246*	*0.1*	*n/a*	*0.00002*	*n/a*	*0.00001*	*0.0001*	*0.0017*	*n/a*

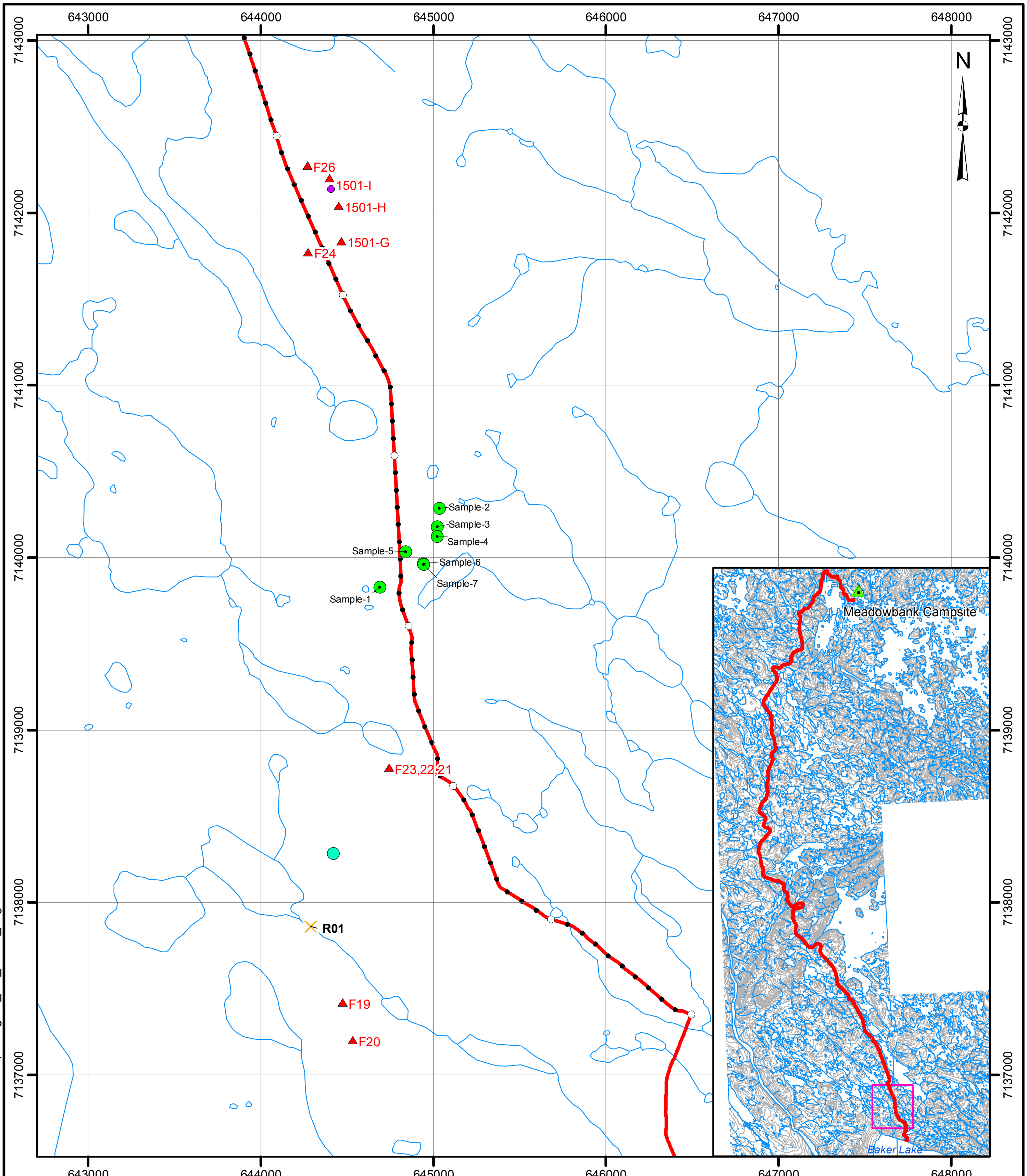
Notes:
1. CEQG freshwater guidelines and criteria
2. Freshwater aquatic life criterion for alum
3. Freshwater aquatic life criteria for chrom
4. Freshwater aquatic life criterion or guide
5. Maximum authorized monthly mean con
6. < = less than the analytical detection limi
7. Cadmium guideline = 10^(0.86*log(harc
* December 2003
Non-detect values assumed to be equal to or

Notes:

1. CEQG freshwater guidelines and criteria are based on **total** metal concentrations, except for aluminum (dissolved aluminum criterion).
2. Freshwater aquatic life criterion for aluminum depends on pH, [Ca2+] and DOC. In this table, only the pH criterion has been applied to highlight exceedances.
3. Freshwater aquatic life criteria for chromium depends on the valence of chromium ion. In the above table, the Cr(VI) criterion of 0.001 mg/L is shown.
4. Freshwater aquatic life criterion or guideline is hardness dependant.
5. Maximum authorized monthly mean concentration (based on **total** concentration).
6. < = less than the analytical detection limit.
7. Cadmium guideline = 10^(0.86*log(hardness)-3.2)

* December 2003

Non-detect values assumed to be equal to one half the detection limit in calculations of average, median and standard deviation, where applicable.



N:\Bur-Graphics\Projects\2006\1413\06-1413-034A\GIS\aprs\Figure_2.1_Route_Alignment.mxd

LEGEND

- Sample Location
- Archaeological Site
- Rock Pit (investigated)
- Rock Pit (to be quarried)
- Chainage Marker
- Route (Revised, 2006 Golder)
- Watercourse
- Waterbody
- Contour (10 m interval)
- Stream Crossing (30 m bridge)
- Stream Crossing (12 m bridge)
- Map Extent
- Meadowbank Campsite

600 300 0 600 Meters

Scale - 1:30,000

REFERENCE

Golder, 2006. Report on Field Assessment - Proposed Tehek Lake Access Rd. Dec 15, 2006.
Cumberland Resources Ltd. Datum: NAD 83 Projection: UTM Zone 14

PROJECT

CUMBERLAND RESOURCES LTD.

TITLE

ROUTE ALIGNMENT SHOWING ESKER SAMPLE LOCATIONS

Golder Associates
Burnaby, B.C.

PROJECT No. 06-1413-034A			SCALE AS SHOWN	REV. 0
DESIGN	KD	28 Dec. 2006	**FIGURE 2-1**	
GIS	BC	28 Dec. 2006		
CHECK				
REVIEW				