

Memo

To:	Katsky Venter, TMAC Resources John Roberts, TMAC Resources	Client:	TMAC Resources
From:	Eduardo Marquez, SRK Lisa Barazzuol, SRK	Project No:	1CT022.009.100
Cc:		Date:	March 24, 2016
Subject:	Boston Ephemeral Stream Monitoring 2015		

1 Introduction

1.1 Project Background

At the Boston site, ore and waste rock were generated as part of a 1996/1997 BHP Billiton underground exploration program. The ore was placed in a number of stockpiles on the camp pad and the waste rock was used to construct a camp pad, roads and an airstrip at Boston. The ore/waste rock and associated runoff are managed as part of Water License 2BB-BOS1217 (Nunavut Water Board (NWB) 2012), and the Water and Ore/Waste Rock Management Plan for the Boston Site (SRK 2009).

As recommended in the management plan (SRK 2009), ephemeral streams downgradient of the waste rock pile have been monitored during spring freshet since 2009 to monitor the attenuation capacity of the tundra and to provide an indication of whether contaminants from the ore and waste rock piles are reaching the shoreline of Aimaokatalok Lake. This memo presents the results of the 2015 monitoring program.

1.2 Brief Summary

The results indicate that over the period from 2009 to 2015, concentrations of potential contaminants of concern have been low, and trends over time are stable in the ephemeral streams downstream of the Boston ore stockpiles and camp. The results suggest that the tundra continues to effectively attenuate these constituents, ensuring that there is no impact along the shore line of Aimaokatalok Lake.

2 Methods

2.1 Sample Collection

Five ephemeral streams have been identified in previous surveys at the site, as shown in Figure 1. Each of these sites was surveyed for flow by TMAC Resources (TMAC) in June 2015.

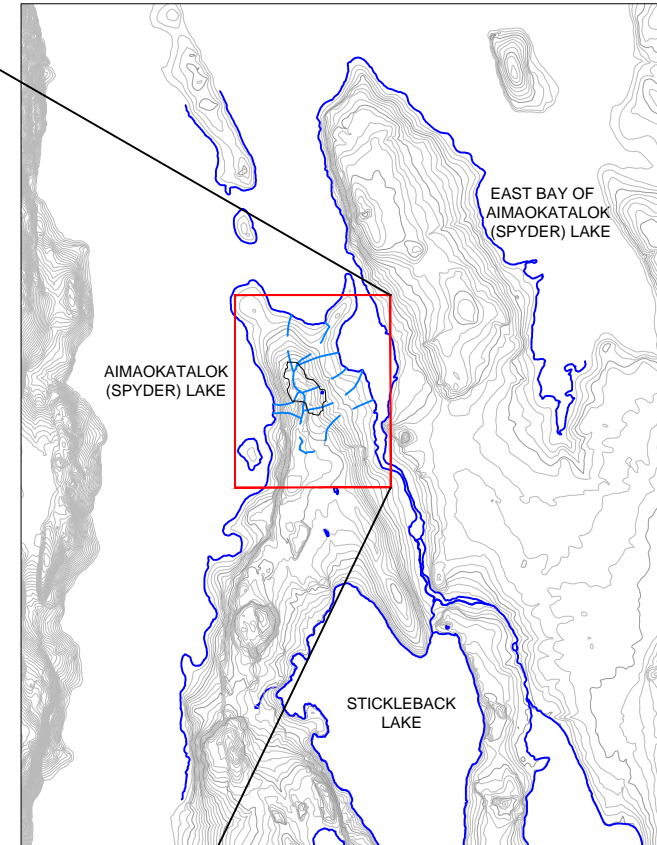
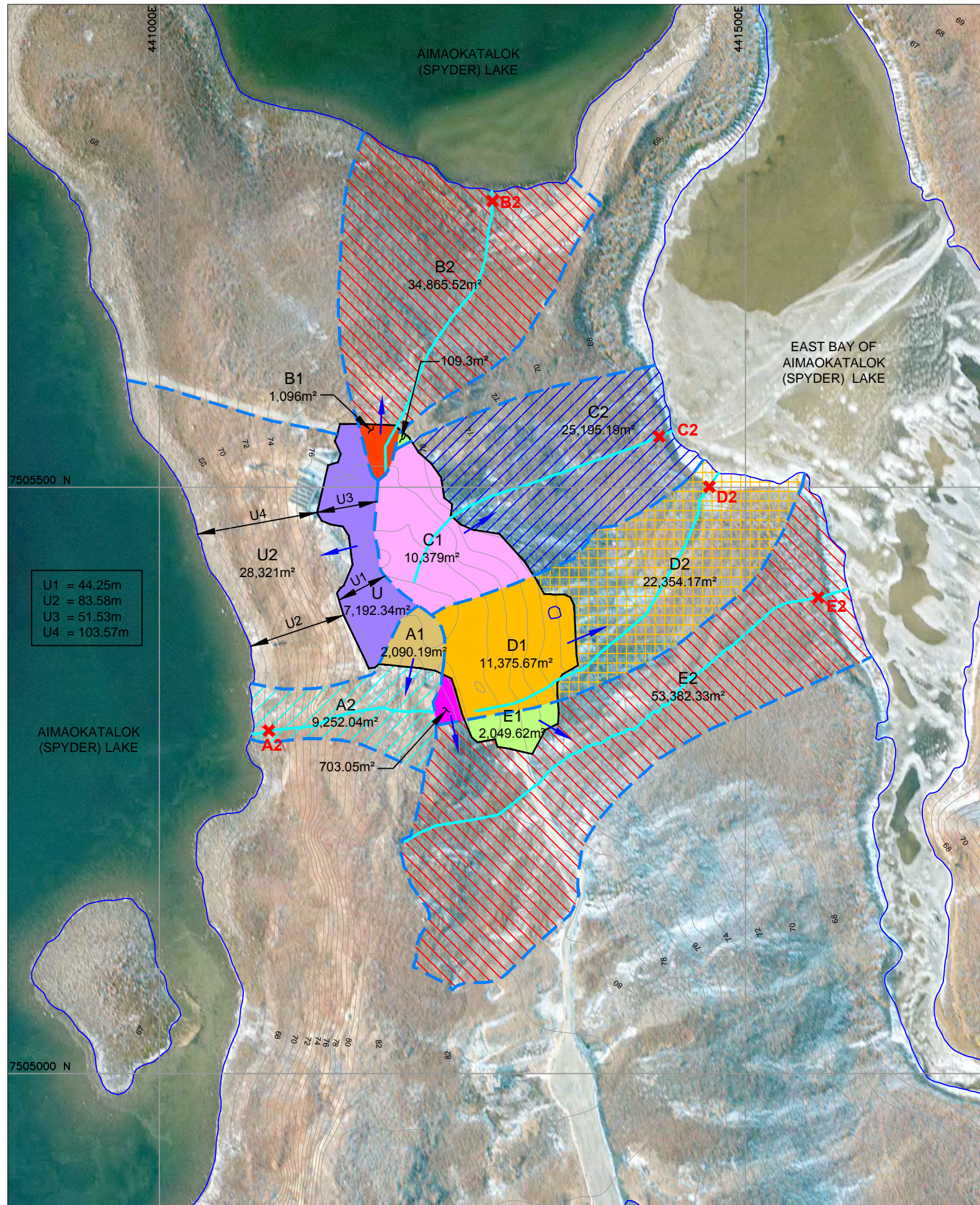
Flow was observed at and samples collected from stations A2, C2, D2 and E2. Field measurements included pH, conductivity, ORP and temperature. The water quality samples were submitted by TMAC for laboratory testing at ALS Environmental in Burnaby, British Columbia for pH, hardness, conductivity, total dissolved solids, alkalinity and species, anions, nutrients and dissolved metals (field filtered).

2.2 Quality Assurance and Control

One field duplicate, one field blank and one travel blank were collected as part of QA/QC program recommended by SRK. QA/QC review of all data was conducted by SRK and deemed acceptable.

Four parameters (barium, calcium, sodium and strontium) were detected in concentrations above two times the detection limit in the field blank. These concentrations were low and did not indicate a significant bias in the data. The remaining parameters in the field blank were below detection limits indicating appropriate field filtration and sampling methods were employed. Parameters were below the detection limits for the travel blank.

The field duplicate results were within $\pm 10\%$ relative percent difference (RPD) for all parameters with concentrations above 10 times the detection limit.



Legend

- | | | | |
|--|--|--|---|
| | Contours (1m) | | Catchment Boundary |
| | Ephemeral streams | | Flow direction |
| | Camp pad perimeter | | 25,195.19m ² Catchment Areas |
| | A2, B2, C2, D2, E2, U2 Dilution Zone (Hatch) | | Ephemeral Stream Sampling Station |

1:4000 0 50 100 150 200 Metres



TMAC Resources

Boston Ephemeral Stream Monitoring

Ephemeral Stream Monitoring Locations

Hope Bay Project

SRK JOB NO.: 1CT022.009.100

FILE NAME: Boston_Catchments_20160324.dwg

DATE: March 2016

APPROVED:

FIGURE: 1

3 Results

3.1 Field Observations

Field parameters are presented in Table 1. Field conductivity in stream A2 has been progressively decreasing since 2013. Field conductivity in streams C2 and D2 have increased since 2011 but are within historical ranges. Stream E2 showed an increase since 2014 with equivalent levels to the 2013 and 2010 samples. All values remain within one order of magnitude from the 2014 reported values. Field pH values were neutral to alkaline, consistent with the 2014 results.

Table 1: 2015 Field Observations

Sample ID	Field pH	Field Conductivity	ORP	Temperature	Flow	Comments
Units	s.u.	µS/cm	mV	°C	L/s	
A2	7.8	246	215	4.1	Overland flow, shallow and dispersed across a wide area.	Same approximate location as 2010-2014
C2	7.3	912	266	6.2	Approx. 1L/s.	Same approximate location as 2010-2014
D2	6.8	1455	325	2.9	Trace flow.	Same approximate location as 2010-2014
E2	7.6	634	324	3.7	Approx. 0.5 L/s.	Same approximate location as 2010-2014

Source: \\van-svr0.van.na.srk.ad\projects\01_SITES\Hope.Bay\1CH008.022 Boston WR Management Plan\Boston Ephemeral Streams\2015\Working File\Hope_Bay_EphemeralStreams_2015_JEM_Rev01.xlsx

3.2 Laboratory Results

A summary of water quality results for 2015 is provided in Table 2. Full results of the 2015 water quality data are presented in Attachment A. A summary of the water quality data is as follows:

- The sulphate concentration in stream A2 was similar to that of 2014 and below the historical average. Chloride decreased by over 50% in 2015, relative to 2014. Nitrate remained low, over an order of magnitude below the historical average. Arsenic has shown a slight continuous increase since 2012. Ammonia increased relative to 2014 and remained around historical values.
- In stream C2, sulphate was slightly above the 2014 value and above the historical average. The chloride and nitrate concentrations were similar to those of 2014. Ammonia increased by 70% relative to 2014 but remained below the historical average.
- No flow was recorded for stream D2 in 2014. Stream D2 reported a sulphate concentration above the 2013 value and the historical average. Chloride was about 50% lower than the

2013 value. Ammonia and nitrate increased by around 150% relative to 2013 values but remained below the historical averages.

- Sulphate in stream E2 was slightly above the 2014 value and above the historical average. Ammonia increased by 100% relative to 2014 and remained slightly below the historical average. Nitrate remained below the detection limit.
- Alkalinity remained stable from 2014 to 2015 for all samples.
- Concentrations of dissolved metals, unless otherwise specified, remained consistent between 2014 and 2015 with any small fluctuations within the same order of magnitude.

Table 2: Summary of Water Quality Results for Stations A2, C2, D2, and E2, 2009 – 2015

Sample ID	Year	Anions and Nutrients						Dissolved Metals								
		Alkalinity, Total (as CaCO ₃)	Ammonia	Chloride	Nitrate	Ortho Phosphate	Sulphate	Aluminum	Arsenic	Cadmium	Copper	Iron	Lead	Nickel	Selenium	Zinc
		mg/L as CaCO ₃	mg/L as N	mg/L	mg/L as N	mg/L as P	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
A2	2012	44	0.0077	180	0.31	--	43	0.0045	0.018	<0.00001	0.0009	<0.01	0.0001	0.004	<0.0001	0.0029
	2013	33	0.013	130	0.052	--	57	0.02	0.021	<0.00001	0.0014	0.052	0.000068	0.0047	<0.0001	0.0018
	2014	38	<0.005	58	<0.005	--	27	0.0027	0.036	<0.00001	0.0013	<0.01	<0.00005	0.018	<0.0001	0.0022
	2015	44	0.011	22	0.0083	0	24	0.0071	0.075	<0.000005	0.00099	<0.01	<0.00005	0.0039	<0.00005	0.0023
C2	2009	42	<0.02	170	<0.005	<0.001	48	0.014	<0.0015	<0.000017	0.0017	<0.03	<0.00005	0.003	<0.001	0.0014
	2010	44	0.083	200	3	<0.001	220	0.011	0.0021	<0.00005	0.002	0.071	0.0002	0.0084	0.0018	0.0071
	2011	29	0.05	42	1.2	--	85	0.02	0.006	<0.00005	0.001	<0.03	<0.00005	0.0049	<0.001	<0.003
	2012	44	0.01	110	1.4	--	220	0.012	0.0017	0.000012	0.0016	0.033	<0.00005	0.006	0.00038	0.0021
	2013	64	0.0093	140	1.5	--	300	0.014	0.0026	0.00002	0.002	0.035	<0.00005	0.0076	0.0004	0.0028
	2014	61	0.0078	66	0.46	--	230	0.016	0.0038	0.000013	0.0025	0.012	<0.00005	0.0097	0.00033	0.0025
	2015	53	0.014	61	0.42	0	270	0.014	0.0023	0.0000056	0.002	0.027	<0.00005	0.0079	0.00035	0.0022
D2	2009	25	0.024	460	4	0.001	200	0.012	<0.002	<0.000085	0.0016	<0.03	<0.00025	0.0053	<0.006	<0.005
	2010	30	0.03	550	2.1	0.0011	220	0.0057	<0.003	<0.00025	0.0014	<0.03	<0.00025	0.0083	<0.005	<0.005
	2011	29	0.12	190	1	--	63	0.0063	0.0024	<0.000050	0.00076	<0.030	<0.000050	0.0058	0.0015	<0.0030
	2012	31	0.0065	370	0.3	--	160	0.0067	0.00093	0.000016	0.001	<0.010	<0.000050	0.006	0.00077	0.0025
	2013	35	0.0069	420	0.12	--	190	0.0066	0.0012	0.000026	0.00092	0.021	<0.000050	0.0069	0.00056	0.0034
	2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	2015	42	0.018	250	0.31	--	250	0.0031	0.0014	0.0000094	0.0011	0.011	<0.00005	0.0085	0.00062	0.0043
E2	2009	43	0.022	210	2.2	<0.001	140	0.016	<0.002	0.000063	0.003	<0.03	0.000068	0.006	<0.001	0.0055
	2010	59	<0.005	140	<0.005	<0.001	50	0.0076	0.0016	<0.00005	0.001	<0.03	<0.00005	0.0029	<0.001	<0.001
	2011	36	0.023	48	0.02	--	34	0.01	0.002	<0.00005	0.001	<0.03	<0.00005	0.0018	<0.001	<0.003
	2012	43	<0.005	59	<0.005	--	50	0.013	0.00099	<0.00001	0.0018	0.014	<0.00005	0.003	<0.0001	0.0015
	2013	47	0.0055	120	<0.005	--	110	0.0075	0.0013	<0.00001	0.0012	0.01	<0.00005	0.0028	<0.0001	0.0011
	2014	46	0.0051	62	<0.005	--	83	0.0089	0.0013	<0.00001	0.0013	0.012	<0.00005	0.0026	<0.0001	0.0037
	2015	49	0.01	77	<0.005	0	110	0.013	0.00095	<0.000005	0.0014	0.016	<0.00005	0.0029	0.000072	0.0019

Y:\01_SITES\Hope.Bay\1CH008.022 Boston WR Management Plan\Boston Ephemeral Streams\2015\Working File\[Hope_Bay_EphemeralStreams_2015_JEM_Rev02.xlsx]

4 Discussion

Seepage chemistry predictions were made as part of the Water and Ore/Waste Rock Management Plan (SRK 2009). The report calculated predicted and maximum predicted concentrations of sulphate, chloride, nitrate, arsenic, copper, iron, nickel and selenium that were expected to discharge from the ore stockpile. Table 3 presents these model predictions compared to the 2015 reported concentrations of these parameters. A comparison of the 2015 data with the model predictions is summarized as follows:

- Sulphate was below the predicted concentrations for stream A2, and exceeded the maximum predictions for C2, D2, and E2 (but remained within the same order of magnitude).
- Chloride was below the predicted concentrations for streams A2 and C2, whereas concentrations in streams D2 and E2 exceeded the predicted concentrations but remained below the maximum predicted.
- Nitrate concentrations for all samples were below predicted levels.
- The arsenic concentration in stream A2 exceeded the predicted maximum. Concentrations in the other streams were below predicted concentrations.
- Concentrations of copper, iron, nickel and selenium in all of the samples were below predicted values.

Overall, concentrations of sulphate, chloride, nitrate, copper, iron, nickel and selenium have oscillated from year to year, but do not show definitive increasing trends over time. Only arsenic shows a slight increasing trend over time in stream A2.

It should be noted that there are old drill sites upstream of all sampling locations that may also influence results in this area, particularly for chloride.

5 Conclusions and Recommendations

Monitoring of the ephemeral streams A2, B2, C2, D2 and E2 (Figure 1) was initiated in 2009. In 2015, flow was observed and samples collected from A2, C2, D2, and E2.

The analysis of the water quality trends for ephemeral streams A2, C2, D2 and E2 indicated that concentrations of potential contaminants of concern (nitrate, aluminum, arsenic, cadmium, copper, iron, nickel and selenium) are stable in the ephemeral streams downstream of the Boston ore stockpiles and camp area. Only stream A2 has shown a slight increasing trend in arsenic concentrations since 2012.

The low variation in concentrations indicates that the tundra continues to effectively attenuate contaminants of concern and breakthrough of the effectiveness of the attenuation process has not occurred. Sulphate and chloride levels have fluctuated but have not exhibited increasing trends. These parameters are not attenuated by the tundra and the stable levels validate the

2009 water and load balance. Overall, the water quality from the ephemeral streams is stable. Ongoing monitoring is recommended for the routine ephemeral stream sampling sites.

Table 3: Comparison of 2015 Water Quality Results to Model Predictions (SRK 2009)

Parameter	Unit	Predicted Value				Max Predicted Value				2015			
		A2	C2	D2	E2	A2	C2	D2	E2	A2	C2	D2	E2
Chloride	mg/L	95	140	160	27	360	560	640	79	22	61	250	77
Nitrate (as N)	mg/L	3.4	5.4	6.3	0.68	9.2	15	17	2	0.0083	0.42	0.31	<0.005
Sulphate	mg/L	70	110	130	15	120	190	220	25	24	270	250	110
Arsenic	mg/L	0.03	0.048	0.056	0.0063	0.063	0.1	0.1	0.013	0.075	0.0023	0.0014	0.00095
Copper	mg/L	0.0026	0.0026	0.0028	0.0017	0.0033	0.004	0.005	0.002	0.00099	0.002	0.0011	0.0014
Iron	mg/L	0.41	0.43	0.44	0.37	0.89	1.2	1.3	0.46	<0.01	0.027	0.011	0.016
Nickel	mg/L	0.095	0.15	0.17	0.02	0.32	0.51	0.59	0.065	0.0039	0.0079	0.0085	0.0029
Selenium	mg/L	0.0015	0.0021	0.0024	0.0007	0.0035	0.0053	0.0061	0.0011	<0.00005	0.00035	0.00062	0.000072

Y:\01_SITES\Hope.Bay\1CH008.022 Boston WR Management Plan\Boston Ephemeral Streams\2015\Working File\Hope_Bay_EphemeralStreams_2015_JEM_Rev02.xlsx]

6 References

Nunavut Water Board, 2012. Water Licence No: 2BB-BOS1217. August 7, 2012.

SRK Consulting (Canada) Inc., 2009. Water and Ore/Waste Rock Management Plan for the Boston Site Hope Bay Project, Nunavut. Report 1CH008.022 for Hope Bay Mining Ltd. July 2009.

Disclaimer—SRK Consulting (Canada) Inc. has prepared this document for TMAC Resources. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this report by a third party.

The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

Attachment A – 2015 Field Observations and Water Quality Results

Attachment A: Field Observations and Water Quality Results

Station	Date	Time	Sampled (y/n)	Description	Field pH	Field EC	ORP	Temperature	Flow	Conductivity	Hardness (as CaCO3)	pH	Total Suspended Solids	Total Dissolved Solids	Acidity (as CaCO3)	Alkalinity, Total (as CaCO3)	Ammonia, Total (as N)	Bromide (Br)	Chloride (Cl)	Fluoride (F)	Nitrate (as N)
						uS/cm	mV	°C	L/s	uS/cm	mg/L	pH	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
15-EPH-A2	6/20/2015		Y	Southwest drainage pathway from portal area.	7.8	246	215	4.1	Overland flow, shallow and dispersed across a wide area.	206	83.3	7.86	3.2	139	1.5	43.8	0.0108	<0.05	21.6	0.028	0.0083
15-EPH-B2	6/20/2015		N	North of Camp Area. SRK coordinates and approximately 100m surrounding.	-	-	-	-	Very small isolated pools, no flow.	-	-	-	-	-	-	-	-	-	-	-	-
15-EPH-C2	6/20/2015		Y	East drainage from ore piles.	7.3	912	266	6.2	Approx 1L/s.	806	352	7.84	<3	614	3.6	52.7	0.0136	<0.1	60.6	<0.04	0.416
15-EPH-D2	6/20/2015		Y	Drainage immediately east of ore piles.	6.8	1455	325	2.9	Trace flow.	1310	577	7.65	<3	1130	3.2	41.8	0.0176	0.35	245	<0.1	0.308
15-EPH-E2	6/20/2015		Y	Drainage southeast of ore piles.	7.6	634	324	3.7	Approx 0.5 L/s.	555	246	7.8	<3	452	2.1	49.1	0.0101	0.085	77	0.04	<0.005

Station	Nitrite (as N)	Phosphorus (P)-Total	Sulphate (SO4)	Aluminum (Al)-Dissolved	Antimony (Sb)-Dissolved	Arsenic (As)-Dissolved	Barium (Ba)-Dissolved	Beryllium (Be)-Dissolved	Bismuth (Bi)-Dissolved	Boron (B)-Dissolved	Cadmium (Cd)-Dissolved	Calcium (Ca)-Dissolved	Chromium (Cr)-Dissolved	Cobalt (Co)-Dissolved	Copper (Cu)-Dissolved	Iron (Fe)-Dissolved	Lead (Pb)-Dissolved	Lithium (Li)-Dissolved	Magnesium (Mg)-Dissolved
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
15-EPH-A2	<0.001	0.002	24.1	0.0071	0.00277	0.075	0.00682	<0.00002	<0.00005	0.026	<0.000005	24.3	<0.0001	0.00021	0.00099	<0.01	<0.00005	0.0058	5.5
15-EPH-B2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15-EPH-C2	<0.002	0.0021	268	0.0144	0.00089	0.00231	0.0283	<0.00002	<0.00005	0.045	0.0000056	79.5	0.00014	0.00041	0.00198	0.027	<0.00005	0.0015	37.2
15-EPH-D2	<0.005	0.0024	250	0.0073	0.00312	0.00143	0.0385	<0.00002	<0.00005	0.078	0.0000094	161	0.00016	0.00083	0.00107	0.011	<0.00005	0.0188	42.4
15-EPH-E2	<0.001	0.0027	109	0.0131	0.00054	0.00095	0.0275	<0.00002	<0.00005	0.024	<0.000005	67.1	0.00023	0.00021	0.00142	0.016	<0.00005	0.0068	19.2

Station	Manganese (Mn)- Dissolved	Mercury (Hg)- Dissolved	Molybdenum (Mo)- Dissolved	Nickel (Ni)- Dissolved	Phosphorus (P)- Dissolved	Potassium (K)- Dissolved	Selenium (Se)- Dissolved	Silicon (Si)- Dissolved	Silver (Ag)- Dissolved	Sodium (Na)- Dissolved	Strontium (Sr)- Dissolved	Sulfur (S)- Dissolved	Thallium (Tl)- Dissolved	Tin (Sn)- Dissolved	Titanium (Ti)- Dissolved	Uranium (U)- Dissolved	Vanadium (V)- Dissolved	Zinc (Zn)- Dissolved
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
15-EPH-A2	0.00099	<0.000005	0.000212	0.00387	<0.05	1.42	<0.00005	0.702	<0.00001	8.72	0.175	8.63	<0.00001	<0.0001	<0.0003	<0.00001	<0.0005	0.0023
15-EPH-B2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15-EPH-C2	0.00732	<0.000005	0.000354	0.00786	<0.05	6.56	0.000348	1.3	<0.00001	34.3	0.286	92.9	<0.00001	<0.0001	<0.0003	0.000033	<0.0005	0.0022
15-EPH-D2	0.00286	<0.000005	0.000849	0.00848	<0.05	7.76	0.000617	1.77	<0.00001	40.7	1.19	85.3	<0.00001	<0.0001	<0.0003	0.000014	<0.0005	0.0043
15-EPH-E2	0.0006	<0.000005	0.000413	0.00292	<0.05	2.01	0.000072	1.5	<0.00001	17.4	0.418	37.2	<0.00001	<0.0001	0.0004	0.000013	<0.0005	0.0019