ECCC-7

Appendix ECCC-7-1 Threespine Stickleback Toxicity Testing

Appendix ECCC-7-2 Groundwater Results QA/QC

Appendix ECCC-7-3 Groundwater Analytical Results

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FILE:GOLDER/1011034.STB

DATE: 15 November 2010

TO:
Peter Chapman
Golder Associates Ltd.
500-4260 Still Creek Drive
Burnaby, B.C.
V5C 6C6

REPORT ON: THREESPINE STICKLEBACK TOXICITY TESTING

SAMPLE DESCRIPTION:

IRC Sample ID No.:	1011034
Sample Name:	**10WBW001 Zone 6**
Date collected:	31 October 2010; 1400 hrs
Date received:	2 November 2010; 1630 hrs
Amount, Container:	4 x 20L plastic containers
Physical description:	Opaque, yellow-orange liquid
Date, time tested:	3 November 2010; 0945 hrs

96 HR TEST RESULTS:
The 96 hour (static) LC_{50} was greater than 100% (v/v sample).
30% stickleback mortality in 100% concentration.

The LC_{50} is defined as the median lethal concentration or the concentration at which there is 50% fish mortality. Results are calculated using the method described by Stephan (Methods for calculating an LC_{50} in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The method used for this test was as per the "Biological Test Method: Acute Lethality Test Using Threespine Stickleback (*Gasterosteus aculeatus*)" EPS 1/RM/10, July 1990. Test volume was 20 litres with 10 fish exposed in each test vessel. Aeration was by forced air through airstones at a rate of approximately 6.5 ± 1 ml/L/min. The sample was not pH adjusted or filtered prior to testing.

The initial dissolved oxygen level was 8.5 mg/L at 14.5°C, the conductivity was 49.0 mS/cm and the initial pH was 7.5. Sample salinity was 31.3 ppt. After pre-aerating the sample for 30 minutes, the dissolved oxygen level was 8.8 mg/L. As the dissolved oxygen level was greater than 70% saturation and less than 100% saturation the test was initiated at this time. The test set up technician was KA.

Please call should you have any questions.

IRC Integrated Resource Consultants Inc.

Carolyn Wilson
Laboratory Biologist
enclosure

RAW DATA:

TEST CONCENTRATION	HOURS	0	24	48	72	96
100%	Percent Survival	100%	100%	80%	70%	70%
	Dissolved Oxygen (mg/L)	8.8	8.4	8.2	8.3	8.3
	Temperature (°C)	14.5	14.5	15.0	15.0	15.0
	pH	7.6	7.7	7.8	7.8	7.8
	Conductivity (mS/cm)	49.1				50.0
	Salinity (ppt)	31.4	31.5	31.6	31.9	31.9
	Symptoms	1	2	2	2	2
	Loading Density (g/L)	0.30	0.30	0.24	0.21	0.21
50%	Percent Survival	100%	100%	90%	90%	90%
	Dissolved Oxygen (mg/L)	8.9	8.3	8.2	8.3	8.2
	Temperature (°C)	14.5	14.5	15.0	15.0	15.0
	pH	8.0	7.9	7.9	7.9	7.9
	Conductivity (mS/cm)	48.2				49.1
	Salinity (ppt)	30.7	30.9	31.1	31.1	31.3
	Symptoms	1	2	2	2	2
	Loading Density (g/L)	0.30	0.30	0.27	0.27	0.27
25%	Percent Survival	100%	100%	80%	80%	80%
	Dissolved Oxygen (mg/L)	8.9	8.3	8.3	8.4	8.4
	Temperature (°C)	14.5	15.0	15.0	15.0	15.0
	pH	8.2	8.0	8.0	8.0	8.0
	Conductivity (mS/cm)	47.9				48.3
	Salinity (ppt)	30.5	30.7	30.7	30.9	31.0
	Symptoms	1	1,2	1,2	1,2	1,2
	Loading Density (g/L)	0.30	0.30	0.24	0.24	0.24
12.5%	Percent Survival	100%	100%	100%	100%	100%
	Dissolved Oxygen (mg/L)	8.8	8.4	8.5	8.4	8.3
	Temperature (°C)	14.5	15.0	15.0	15.0	15.0
	pH	8.4	8.2	8.2	8.2	8.2
	Conductivity (mS/cm)	47.7				48.2
	Salinity (ppt)	30.3	30.4	30.6	30.7	30.8
	Symptoms	1	1,2	1,2	1,2	1,2
	Loading Density (g/L)	0.30	0.30	0.30	0.30	0.30
6.2%	Percent Survival	100%	100%	100%	100%	100%
	Dissolved Oxygen (mg/L)	8.9	8.3	8.3	8.3	8.2
	Temperature (°C)	14.5	15.0	15.0	15.0	14.5
	pH	8.3	8.2	8.1	8.1	8.1
	Conductivity (mS/cm)	47.5				47.5
	Salinity (ppt)	30.2	30.3	30.3	30.4	30.4
	Symptoms	1	1,2	1,2	1,2	1,2
	Loading Density (g/L)	0.30	0.30	0.30	0.30	0.30
CONTROL	Percent Survival	100%	100%	100%	100%	100%
	Dissolved Oxygen (mg/L)	8.9	8.1	8.0	8.0	7.9
	Temperature (°C)	14.5	15.0	14.5	15.0	15.0
	pH	8.4	8.2	8.1	8.1	8.1
	Conductivity (mS/cm)	47.3				47.6
	Salinity (ppt)	30.1	30.1	30.2	30.1	30.2
	Symptoms	1	1	1	1	1
	Loading Density (g/L)	0.30	0.30	0.30	0.30	0.30
	Technician	KA	LH	LH	LH	LH

KEY TO SYMPTOMS:	
	1 = no apparent effect
	2 = fish showing signs of stress
	3 = loss of equilibrium

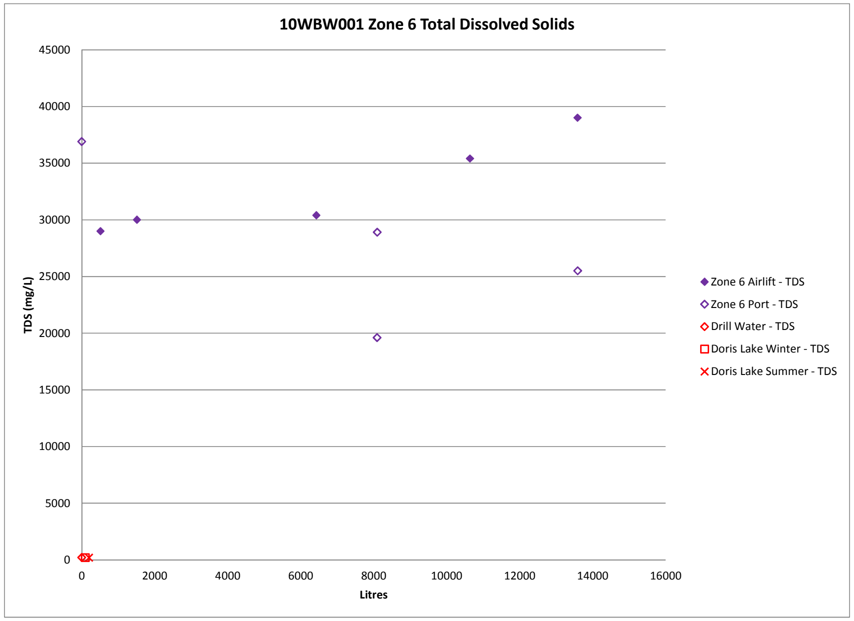
TEST FISH STOCK INFORMATION

Date received:	20 October 2010	
Source:	Ladner Trunk Road	
Species:	*Gasterosteus aculeatus* (Threespine Stickleback)	
Fork Length:	Mean:	38.4 mm ± 5.8 mm
	Range:	30.0 mm – 45.0 mm
Wet weight:	Mean:	0.59 g ± 0.17 g
	Range:	0.29 g – 0.80 g
Condition Factor (100xWt/length^{3}cm):	1.04	

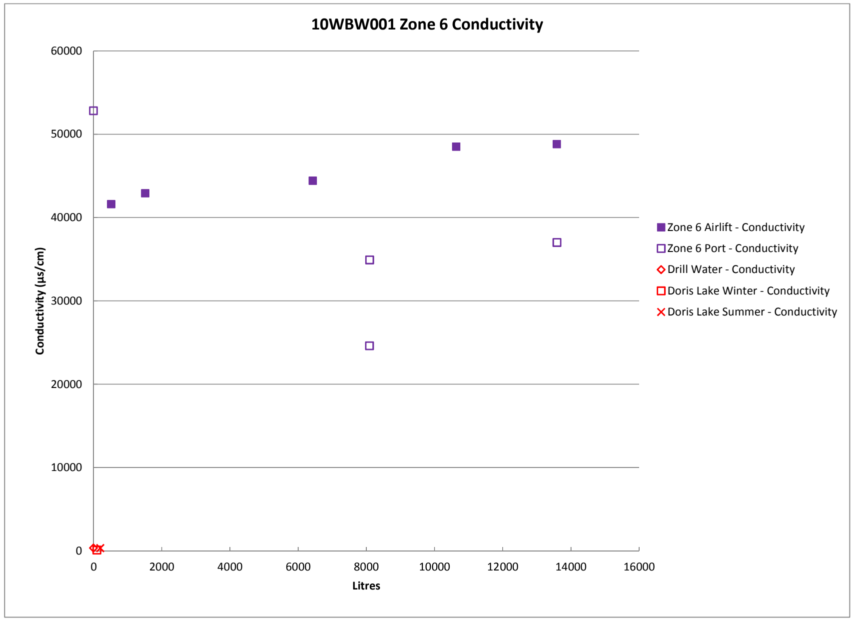
Acclimation History	
Acclimation temperature:	14.0 to 15.0 ° CELSIUS
Treatments:	None
Water:	Dechlorinated tap water, adjusted to 30.0ppt using dry ocean salts
Feeding:	Freeze-dried brine shrimp
Salinity:	1.0 to 26.1 ppt
Mortality:	0.92% in week prior to testing

THREESPINE STICKLEBACK REFERENCE TOXICANT DATA

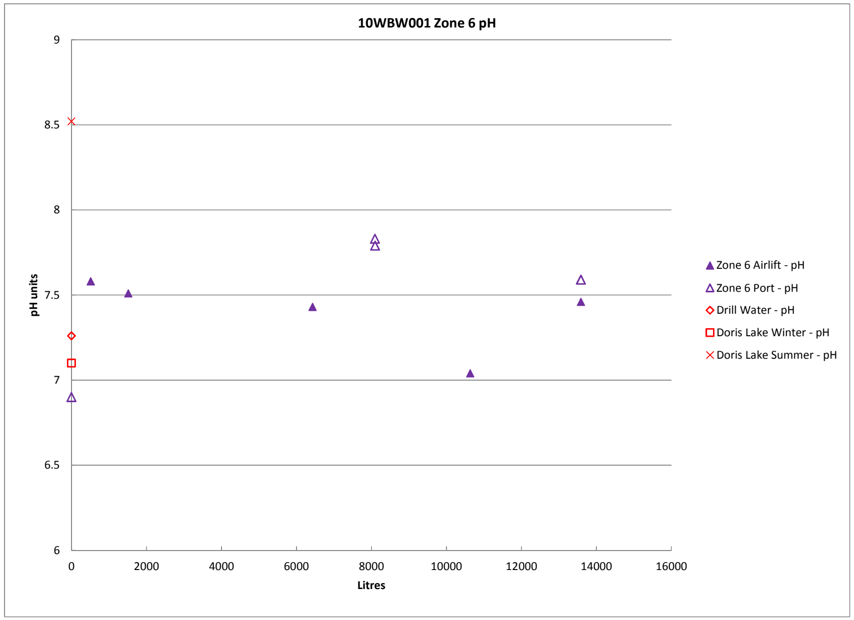
Stock Arrival Date (y/m/d)	Test Date (y/m/d)	Toxicant	Log LC$_{50}$ (mg/L)
05.03.01	05.03.30	Phenol	1.33
05.06.02	05.06.17	"	1.26
05.08.16	05.09.07	"	1.21
05.11.10	05.12.02	"	1.30
06.02.22	06.03.15	"	1.16
06.06.02	06.06.26	"	1.36
06.08.18	06.08.31	"	1.10
06.12.08	06.12.20	"	1.03
07.02.14	07.02.14	"	1.02
07.04.24	07.05.16	"	1.14
07.07.17	07.08.08	"	1.23
07.11.02	07.11.16	"	1.11
08.01.23	08.02.08	"	1.13
08.05.10	08.05.24	"	1.22
08.08.19	08.09.05	"	1.16
08.12.04	08.12.16	"	1.29
09.03.04	09.03.19	"	1.10
09.06.05	09.06.18	"	1.30
09.09.21	09.09.30	"	1.29
10.02.27	10.03.19	"	1.10
10.06.03	10.07.06	"	1.28
10.09.09	10.09.24	"	1.19
10.10.20	10.11.09	"	1.11
LAB GEOMETRIC MEAN (LOG) ± 2 standard deviations:			1.19 mg/L ± 0.19
Warning Limits (Log Values):			1.01 mg/L to 1.38 mg/L



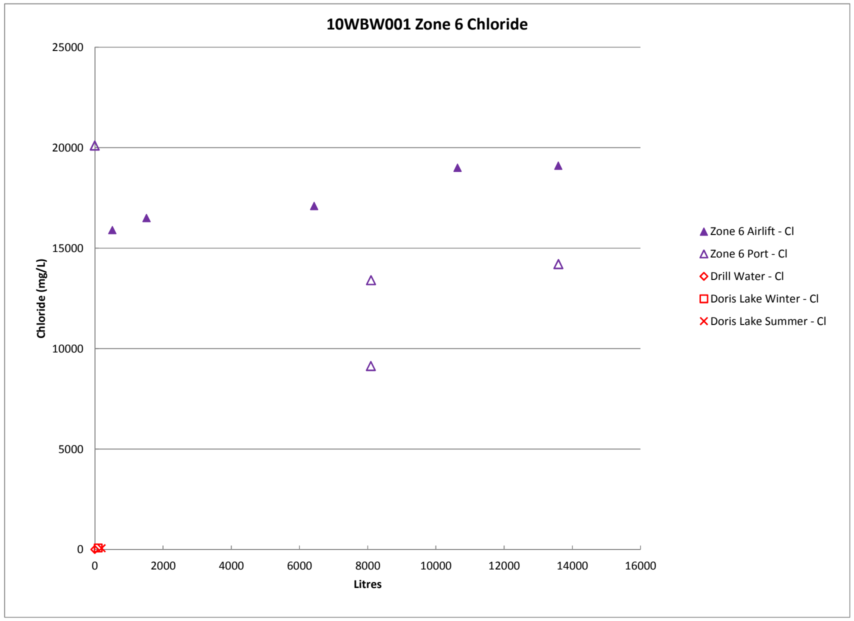
10WBW001 Zone 6 Total Dissolved Solids



10WBW001 Zone 6 Conductivity



10WBW001 Zone 6 pH



10WBW001 Zone 6 Chloride

Data file reference:
J:\01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\020_Project_Data\SRK\07_Water Chemisty Results\Working Files\20110201 Doris Central Purge Graphs.xlsx

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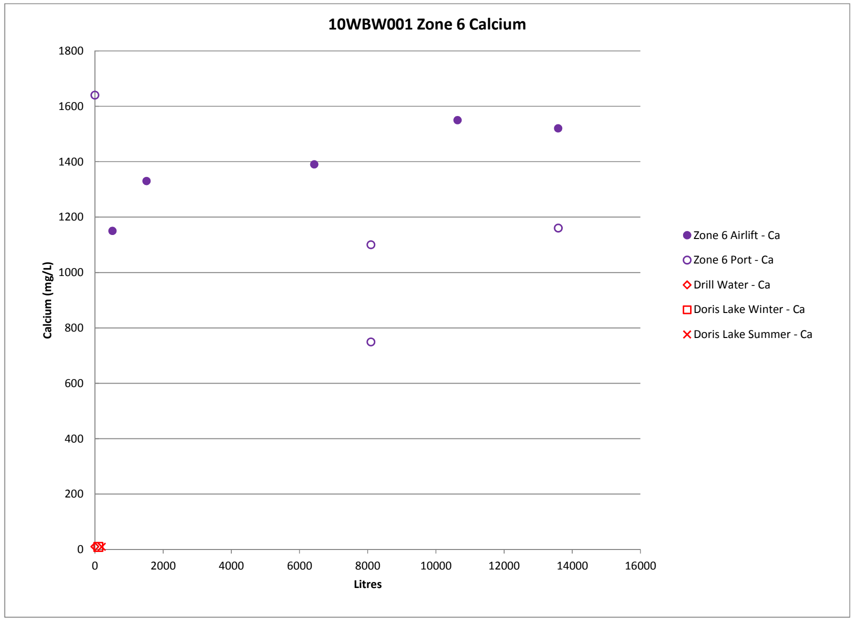
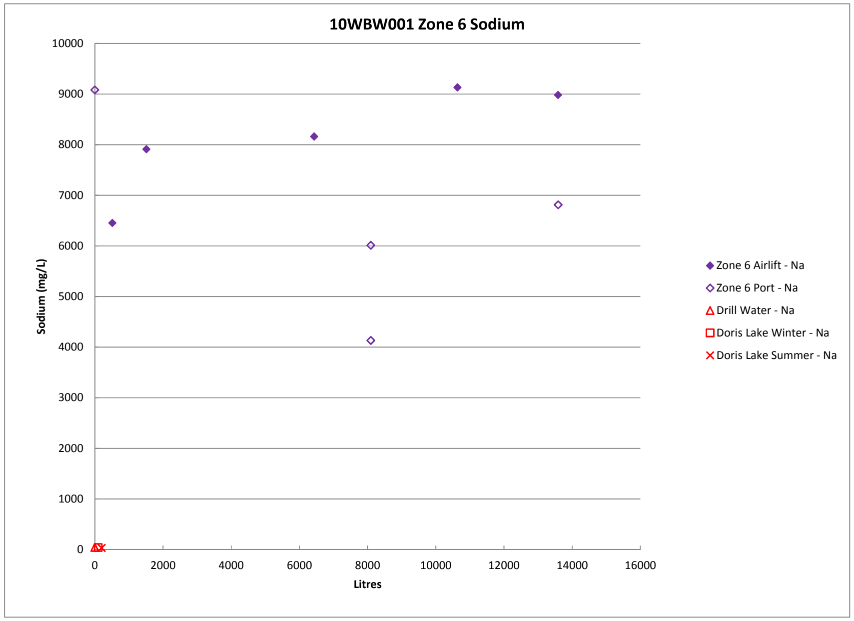
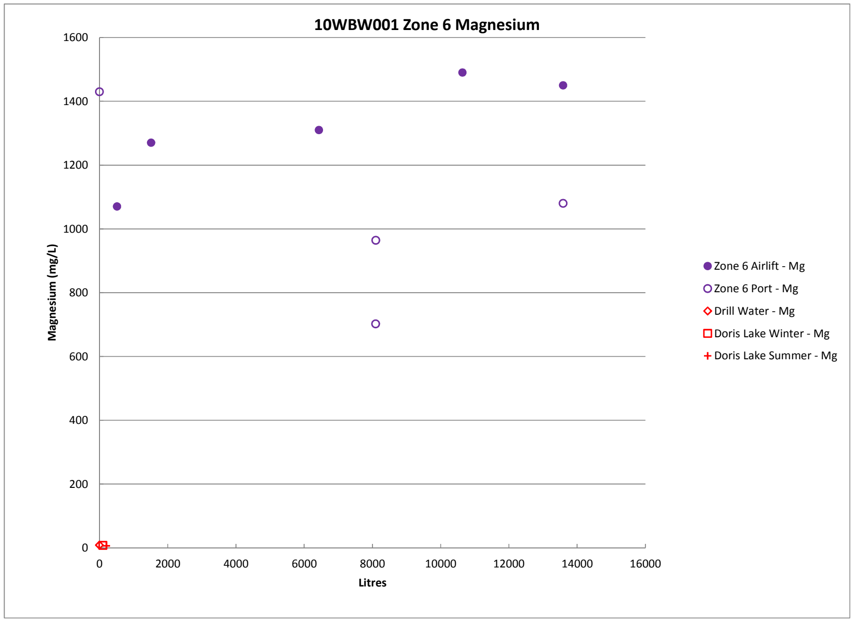
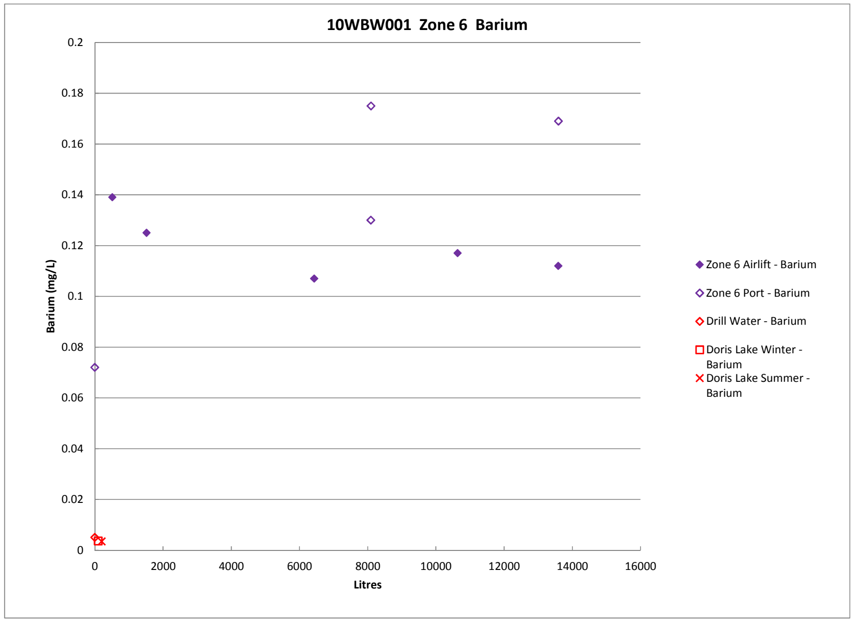
Doris Central 10WBW001
Zone 6

Date: February 2011
Approved: JH
Figure: **M.4**


10WBW001 Zone 6 Calcium


10WBW001 Zone 6 Sodium


10WBW001 Zone 6 Magnesium


10WBW001 Zone 6 Barium

Data file reference:
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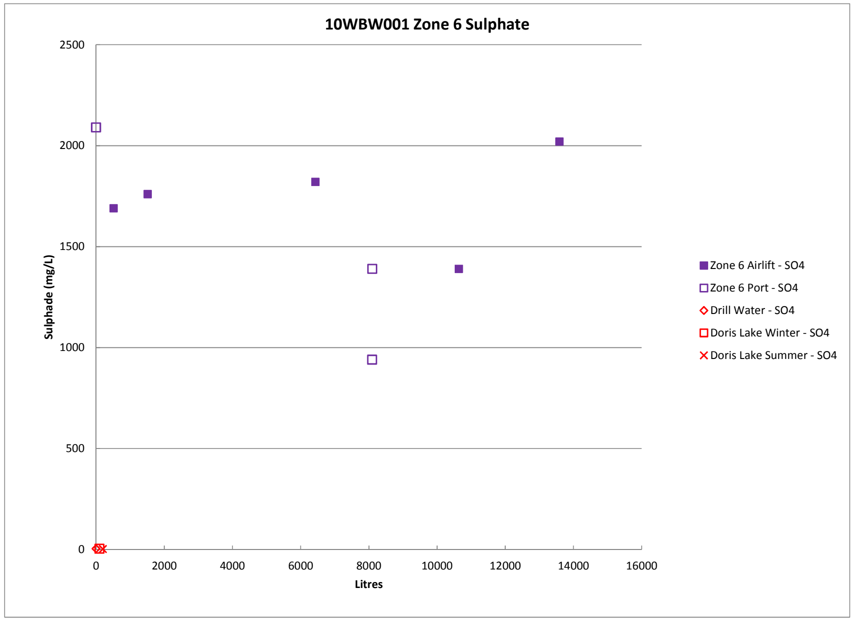
2010 West Bay Data Report - Appendix M

Doris Central 10WBW001
Zone 6

Date: February 2011
Approved: JH
Figure: **M.5**



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Job No: 1CH008.013	HOPE BAY MINING LTD.	2010 West Bay Data Report - Appendix M	
Filename: Figures M1-9_DorisCentral_20110202.pptx		Doris Central 10WBW001 Zone 6	
		Date: February 2011	Approved: JH
		Figure: M.6	

Table N1: Comparison of Repeated Samples from the Same Port, Over Time

		Repeated port samples over time		RPD	Repeated port samples over time		RPD	Repeated port samples over time		RPD	Repeated port samples over time		RPD	Repeated port samples over time		RPD	Repeated port samples over time		RPD
Field Sample ID / Unique ID	**Units**	**10WBW001-35**	**10WBW001-100**		**10WBW001-100**	**10WBW001-106**		**10WBW001-36**	**10WBW001-101**		**10WBW001-101**	**10WBW001-108**		**10WBW001-37**	**10WBW001-102**		**10WBW001-102**	**10WBW001-105**	
Sample From		**Westbay Port**	**Westbay Port**		**Westbay Port**	**Westbay Port**		**Westbay Port**	**Westbay Port**		**Westbay Port**	**Westbay Port**		**Westbay Port**	**Westbay Port**		**Westbay Port**	**Westbay Port**	
Sample label for graph		10WBW001-Zone 1-Port Final-S35	10WBW001-Zone 1-Port after 2mths-S100		10WBW001-Zone 1-Port after 2mths-S100	10WBW001-Zone 1-Port after bulk-S106		10WBW001-Zone 6-Port Final-S36	10WBW001-Zone 6-Port after 2mths-S101		10WBW001-Zone 6-Port after 2mths-S101	10WBW001-Zone 6-Port after bulk-S108		10WBW001-Zone 10-Port Final-S37	10WBW001-Zone 10-Port after 2mths-S102		10WBW001-Zone 10-Port after 2mths-S102	10WBW001-Zone 10-Port after bulk-S105	
Sample Zone		1	1		1	1		6	6		6	6		10	10		10	10	
Location of port in zone		Top	Top		Top	Top		Top	Top		Top	Top		Top	Top		Top	Top	
Zone port drillhole depth		548.0	548.0		548.0	548.0		246.0	246.0		246.0	246.0		63.5	63.5		63.5	63.5	
Total Litres purged from zone before sample was taken		3186	3189		3189	3192		8096	8099		8099	13592		3008	3011		3011	3014	
Zone volumes purged before sample was taken		27.4	27.4		27.4	27.5		46.6	46.6		46.6	79.3		11.0	11.0		11.0	11.0	
ALS DATA																			
ALS Date Sampled		04-AUG-10	19-OCT-10		19-OCT-10	30-OCT-10		05-AUG-10	19-OCT-10		19-OCT-10	01-NOV-10		05-AUG-10	20-OCT-10		20-OCT-10	29-OCT-10	
ALS Time Sampled		13:42	12:00		12:00	13:00		09:00	15:00		15:00	15:00		11:40	11:00		11:00	15:00	
Matrix		Seawater	Seawater		Seawater	Seawater		Seawater	Seawater		Seawater	BOTH		Seawater	Seawater		Seawater	Seawater	
Physical Tests																			
Conductivity (EC)	uS/cm	46600	46700	0%	46700	46900	0%	24600	34900	-35%	34900	37000	-6%	30300	33800	-11%	33800	43300	-25%
Density			1.01		1.01	1.03	-2%		1.01		1.01	1.03	-2%		1.01		1.01	1.01	0%
Hardness (as CaCO3)	mg/L	12700	12600	1%	12600	12100	4%	4760	6720	-34%	6720	7340	-9%	6030	6360	-5%	6360	8900	-33%
pH	pH	7.43	7.38	1%	7.38	7.69	-4%	7.83	7.79	1%	7.79	7.59	3%	7.47	7.46	0%	7.46	7.44	0%
Salinity (EC)	g/L		30.50		30.50	31.2	-2%		22.10		22.10	23.5	-6%					28.5	
Total Dissolved Solids	mg/L	47800	42300	12%	42300	47500	-12%	19600	28900	-38%	28900	25500	13%	23100	28300	-20%	28300	34500	-20%
Anions and Nutrients																			
Alkalinity, Bicarbonate (as CaCO3)	mg/L	<2	<2		<2	<2			44.2		44.2	43.7	1%		77.3		77.3	106	-31%
Alkalinity, Carbonate (as CaCO3)	mg/L		<2		<2	<2			<2		<2	<2			<1		<1	<2	
Alkalinity, Hydroxide (as CaCO3)	mg/L		<2		<2	<2			<2		<2	<2			<1		<1	<2	
Alkalinity, Total (as CaCO3)	mg/L		<2		<2	<2		44.2	44.2	0%	44.2	43.7	1%	49.7	77.3	-43%	77.3	106	-31%
Ammonia as N	mg/L					0.0631						2.32						3.46	
Bromide (Br)	mg/L	100	101	-1%	101	101	0%	21.2	38.1	-57%	38.1	41.3	-8%	27.6	36.4	-28%	36.4	41	-12%
Chloride (Cl)	mg/L	19000	19000	0%	19000	18400	3%	09130	13400	-38%	13400	14200	-6%	11500	13100	-13%	13100	16500	-23%
Fluoride (F)	mg/L	<0.75	<0.75		<0.75	<0.75		<0.75	<0.75		<0.75	<0.75		<0.75	<0.75		<0.75	<0.75	
Nitrate (as N)	mg/L	<0.5	0.96		0.96	<0.5		<0.5	<0.5		<0.5	<0.5		<0.5	<0.5		<0.5	<1	
Nitrite (as N)	mg/L	<0.1	<0.1		<0.1	<0.1		<0.1	<0.1		<0.1	<0.1		<0.1	<0.1		<0.1	<0.2	
Ortho Phosphate as P	mg/L		0.0264		0.0264	0.0086	102%		0.0017		0.0017	<0.001			<0.001		<0.001	<0.001	
Total Phosphate as P	mg/L					0.0163						0.0162						0.0389	
Silicate (as SIO2)	mg/L		7.8		7.8	<10			5.0		5.0	5.8	-15%		3.8		3.8	7.5	-65%
Sulfate (SO4)	mg/L	0981	980	0%	980	935	5%	0940	1390	-39%	1390	1500	-8%	1160	1230	-6%	1230	1580	-25%
Total Metals																			
Aluminum (Al)-Total	mg/L	0.0992	0.0136	152%	0.0136	0.0086	45%	0.0281	0.0052	138%	0.0052	0.0059	-13%	0.0146	<0.005		<0.005	<0.005	
Antimony (Sb)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		0.00745	0.005	39%	0.005	0.00461	8%	0.00349	0.00099	112%	0.00099	0.00054	59%
Arsenic (As)-Total	mg/L	<0.002	<0.002		<0.002	<0.002		0.003	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002	
Barium (Ba)-Total	mg/L	0.051	0.053	-3%	0.053	0.0521	1%	0.130	0.175	-30%	0.175	0.169	3%	0.179	0.177	1%	0.177	0.129	31%
Beryllium (Be)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Bismuth (Bi)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Boron (B)-Total	mg/L	2.93	2.89	1%	2.89	3.25	-12%	1.04	1.38	-28%	1.38	1.50	-8%	1.51	1.53	-1%	1.53	2.8	-59%
Cadmium (Cd)-Total	mg/L	<0.00012	0.000066		0.000066	0.000085	-25%	<0.00012	<0.00005		<0.00005	<0.00005		<0.00012	<0.00005		<0.00005	<0.00005	
Calcium (Ca)-Total	mg/L	5070	4960	2%	4960	4700	5%	0805	1140	-34%	1140	1170	-3%	1020	1080	-6%	1080	1540	-35%
Cesium (Cs)-Total	mg/L	0000	0.00102	3%	0.00102	0.0011	-8%	0000	0000	-23%	0000	0.00095	-4%	0.00097	0.001	-3%	0.001	0.00151	-41%
Chromium (Cr)-Total	mg/L	0.01	0.0006	160%	0.0006	0.0002	104%	0.00	0.00	139%	0.00	<0.0005		0.0030	0.00011	186%	0.00011	0.00016	-37%
Cobalt (Co)-Total	mg/L	<0.0005	0.000073		0.000073	0.000051	35%	<0.0005	0.000092		0.000092	0.000103	-11%	<0.0005	0.000084		0.000084	0.000132	-44%
Copper (Cu)-Total	mg/L	0.0018	0.00059	101%	0.00059	0.00102	-53%	<0.001	<0.0005		<0.0005	0.00061		<0.001	<0.0005		<0.0005	<0.0005	
Gallium (Ga)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Iron (Fe)-Total	mg/L	0.46	0.24	62%	0.24	0.197	20%	1.60	2.94	-59%	2.94	2.28	25%	3.95	4.31	-9%	4.31	11	-87%
Lead (Pb)-Total	mg/L	0.0013	<0.0003		<0.0003	<0.0003		<0.001	0.00035		0.00035	<0.0003		<0.001	<0.0003		<0.0003	<0.0003	
Lithium (Li)-Total	mg/L	0.37	0.346	7%	0.346	0.381	-10%	0.093	0.117	-23%	0.117	0.131	-11%	0.128	0.128	0%	0.128	0.2	-44%
Magnesium (Mg)-Total	mg/L	0071	064	10%	064	67.8	-5%	0739	1010	-31%	1010	1080	-7%	867	797	8%	797	1230	-43%
Manganese (Mn)-Total	mg/L	0.72	0.72	-1%	0.72	0.712	1%	0.56	0.95	-52%	0.95	0.892	6%	1.09	1.15	-5%	1.15	1.73	-40%
Mercury (Hg)-Total	mg/L		<0.00001		<0.00001	<0.00001			<0.00001		<0.00001				<0.00001		<0.00001	<0.00001	
Molybdenum (Mo)-Total	mg/L	0.0136	0.0089	42%	0.0089	0.0088	1%	0.0403	0.037	9%	0.037	0.0361	2%	0.0225	0.0244	-8%	0.0244	0.0072	109%
Nickel (Ni)-Total	mg/L	0.00437	0.00075	141%	0.00075	0.00265	-112%	0.00159	0.00059	92%	0.00059	0.00120	-68%	0.00237	<0.0005		<0.0005	<0.0005	
Phosphorus (P)-Total	mg/L	<1	<1		<1	<1		<1	<1		<1	<1		<1	<1		<1	<1	
Potassium (K)-Total	mg/L	040	040	0%	040	39	3%	125	171	-31%	171	172	-1%	166	166	0%	166	262	-45%
Rhenium (Re)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Rubidium (Rb)-Total	mg/L	000	0.0526	-5%	0.0526	0.0531	-1%	000	000	-30%	000	0.102	2%	0.0816	0.0842	-3%	0.0842	0.104	-21%
Selenium (Se)-Total	mg/L	<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002	
Silicon (Si)-Total	mg/L	2.61	2.79	-7%	2.79	2.47	12%	2.88	3.5	-19%	3.5	3.82	-9%	2.12	2.42	-13%	2.42	3.51	-37%
Silver (Ag)-Total	mg/L	<0.0002	<0.0001		<0.0001	<0.0001		<0.0002	<0.0001		<0.0001	0.00018		<0.0002	<0.0001		<0.0001	<0.0001	
Sodium (Na)-Total	mg/L	7470	7200	4%	7200	6850	5%	4460	6410	-36%	6410	6790	-6%	5590	5530	1%	5530	8990	-48%
Strontium (Sr)-Total	mg/L	0060	57.2	5%	57.2	54.6	5%	0010	0014	-35%	0014	14.6	-5%	11.7	11.1	5%	11.1	16.4	-39%
Tellurium (Te)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Thallium (Tl)-Total	mg/L	<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	<0.00005	
Thorium (Th)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Tin (Sn)-Total	mg/L	<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001	
Titanium (Ti)-Total	mg/L	0.0082	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005	
Tungsten (W)-Total	mg/L	<0.001	0.0014		0.0014	0.0016	-13%	0.0334	0.0247	30%	0.0247	0.0227	8%	0.0067	0.0051	27%	0.0051	0.0059	-15%
Uranium (U)-Total	mg/L	<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	0.000059		<0.0005	0.000057		0.000057	<0.00005	
Vanadium (V)-Total	mg/L	0.00	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Yttrium (Y)-Total	mg/L	<0.0005	0.00052		0.00052	0.00057	-9%	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Zinc (Zn)-Total	mg/L	0.503	0.279	57%	0.279	0.285	-2%	0.195	0.236	-19%	0.236	0.115	69%	0.261	0.173	41%	0.173	0.107	47%
Zirconium (Zr)-Total	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Dissolved Metals																			
Aluminum (Al)-Dissolved	mg/L	<0.005	<0.005		<0.005	0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005	
Antimony (Sb)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		0.00703	0.0048	38%	0.0048	0.00393	20%	0.00306	0.00097	104%	0.00097	0.00053	59%
Arsenic (As)-Dissolved	mg/L	<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002	
Barium (Ba)-Dissolved	mg/L	0.052	0.053	-2%	0.053	0.0526	1%	0.120	0.178	-39%	0.178	0.169	5%	0.169	0.178	-5%	0.178	0.122	37%
Beryllium (Be)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Bismuth (Bi)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Boron (B)-Dissolved	mg/L	2.99	2.92	2%	2.92	3.3	-12%	0.94	1.38	-38%	1.38	1.48	-7%	1.42	1.54	-8%	1.54	2.86	-60%
Cadmium (Cd)-Dissolved	mg/L	<0.00012	0.000083		0.000083	0.000097	-16%	<0.00012	<0.00005		<0.00005	<0.00005		<0.00012	<0.00005		<0.00005	<0.00005	
Calcium (Ca)-Dissolved	mg/L	4960	4920	1%	4920	4730	4%	0749	1100	-38%	1100	1160	-5%	1010	1110	-9%	1110	1560	-34%
Cesium (Cs)-Dissolved	mg/L	0000	0.00102	3%	0.00102	0.0011	-8%	0000	0000	-31%	0000	0.00097	-3%	0.00092	0.00104	-12%	0.00104	0.00148	-35%
Chromium (Cr)-Dissolved	mg/L	<0.001	<0.0001		<0.0001	<0.0001		<0.001	<0.0001		<0.0001	<0.0005		<0.001	<0.0001		<0.0001	<0.0001	
Cobalt (Co)-Dissolved	mg/L	<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	0.000087		0.000087	0.000091	-4%	<0.0005	0.000102		0.000102	0.000187	-59%
Copper (Cu)-Dissolved	mg/L	<0.001	<0.0005		<0.0005	0.00067		<0.001	<0.0005		<0.0005	<0.0005		<0.001	<0.0005		<0.0005	0.00296	
Gallium (Ga)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Iron (Fe)-Dissolved	mg/L	<0.05	0.06		0.06	0.075	-29%	0.06	0.13	-73%	0.13	0.503	-119%	2.68	3.15	-16%	3.15	8.94	-96%
Lead (Pb)-Dissolved	mg/L	<0.001	<0.0003		<0.0003	<0.0003		<0.001	<0.0003		<0.0003	<0.0003		<0.001	<0.0003		<0.0003	<0.0003	
Lithium (Li)-Dissolved	mg/L	0.37	0.350	6%	0.350	0.39	-11%	0.087	0.12	-32%	0.12	0.127	-6%	0.121	0.13	-7%	0.13	0.201	-43%
Magnesium (Mg)-Dissolved	mg/L	0070	064	8%	064	68.1	-6%	0702	0964	-31%	0964	1080	-11%	849	869	-2%	869	1250	-36%
Manganese (Mn)-Dissolved	mg/L	0.69	0.71	-2%	0.71	0.725	-2%	0.53	0.94	-57%	0.94	0.888	6%	1.04	1.17	-12%	1.17	1.69	-36%
Mercury (Hg)-Dissolved	mg/L	<	<0.00001		<0.00001	<0.00001		<	<0.00001		<0.00001			<	<0.00001		<0.00001	<0.00001	
Molybdenum (Mo)-Dissolved	mg/L	0.0128	0.0092	33%	0.0092	0.009	2%	0.0379	0.037	2%	0.037	0.0345	7%	0.0211	0.0259	-20%	0.0259	0.0044	142%
Nickel (Ni)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	0.00237		0.00076	<0.0005		<0.0005	0.00158		<0.0005	<0.0005		<0.0005	0.0006	
Phosphorus (P)-Dissolved	mg/L	<1	<1		<1	<1		<1	<1		<1	<1		<1	<1		<1	<1	
Potassium (K)-Dissolved	mg/L	039	039	0%	039	40	-3%	117	160	-31%	160	172	-7%	160	173	-8%	173	249	-36%
Rhenium (Re)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Rubidium (Rb)-Dissolved	mg/L	000	0.0528	-5%	0.0528	0.0532	-1%	000	000	-40%	000	0.106	3%	0.0766	0.085	-10%	0.085	0.107	-23%
Selenium (Se)-Dissolved	mg/L	<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002		<0.002	<0.002	
Silicon (Si)-Dissolved	mg/L	2.3	2.42	-5%	2.42	2.43	0%	2.48	2.88	-15%	2.88	3.33	-14%	1.99	2.38	-18%	2.38	3.3	-32%
Silver (Ag)-Dissolved	mg/L	<0.0002	<0.0001		<0.0001	<0.0001		<0.0002	<0.0001		<0.0001	<0.0001		<0.0002	<0.0001		<0.0001	<0.0001	
Sodium (Na)-Dissolved	mg/L	7290	7200	1%	7200	6910	4%	4130	6010	-37%	6010	6810	-12%	5400	5780	-7%	5780	8700	-40%
Strontium (Sr)-Dissolved	mg/L	0059	56.7	4%	56.7	55.1	3%	0009	0013	-37%	0013	14.6	-11%	11.3	11.7	-3%	11.7	16.8	-36%
Tellurium (Te)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Thallium (Tl)-Dissolved	mg/L	<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	<0.00005	
Thorium (Th)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Tin (Sn)-Dissolved	mg/L	<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001		<0.001	<0.001	
Titanium (Ti)-Dissolved	mg/L	<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005		<0.005	<0.005	
Tungsten (W)-Dissolved	mg/L	<0.001	0.0014		0.0014	0.0015	-7%	0.0316	0.0246	25%	0.0246	0.0231	6%	0.0059	0.005	17%	0.005	0.006	-18%
Uranium (U)-Dissolved	mg/L	<0.0005	<0.00005		<0.00005	<0.00005		<0.0005	<0.00005		<0.00005	0.000058		<0.0005	0.000059		0.000059	<0.00005	
Vanadium (V)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Yttrium (Y)-Dissolved	mg/L	<0.0005	0.00051		0.00051	0.00054	-6%	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	
Zinc (Zn)-Dissolved	mg/L	0.0897	0.1130	-23%	0.1130	0.137	-19%	0.02	0.0705	-116%	0.0705	0.0295	82%	0.0504	0.061	-19%	0.061	0.0851	-33%
Zirconium (Zr)-Dissolved	mg/L	<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005		<0.0005	<0.0005	

RPDs greater than 20% are highlighted, to show parameters with the greatest variation between samples.

Table N2: Comparison of Duplicate Samples

		Duplicate		RPD	Duplicate		RPD	Duplicate		RPD	Duplicate		RPD
Field Sample ID / Unique ID	**Units**	**10WBW001-03b**	**10WBW001-04b**		**10WBW001-15**	**10WBW001-16**		**10WBW001-25**	**10WBW001-26**		**10WBW001-02a**	**10WBW001-04a**	
Sample From		**Westbay Port**	**Westbay Port**		**Westbay airlift**	**Westbay airlift**		**Westbay airlift**	**Westbay airlift**		**Other**	**Other**	
Sample Label		10WBW001-Zone 10-Port Initial-S03b	10WBW001-Zone 10-Port InitialD-S04b		10WBW001-Zone 10-Airlift Purge-S15	10WBW001-Zone 10-Airlift Final-S16D		10WBW001-Zone 1-Airlift Final-S25	10WBW001-Zone 1-Airlift Final-S26D		10WBW001 Drill Tank	10WBW001 Drill Tank Dup	
Sample Zone		10	10		10	10		1	1		n/a	n/a	
Location of port in zone		Top	Top		Bottom	Bottom		Middle	Middle		n/a	n/a	
Zone port drillhole depth		63.5	63.5		107.50	107.50		554.00	554.00		n/a	n/a	
Total Litres purged from zone before sample was taken		0	2		3008	3008		3065	3065		n/a	n/a	
Zone volumes purged before sample was taken		0.0	0.3		11.0	11.0		26.2	26.2		n/a	n/a	
ALS DATA													
ALS Date Sampled		09-JUL-10	09-JUL-10		21-JUL-10	21-JUL-10		25-JUL-10	25-JUL-10		25-APR-10	25-APR-10	
ALS Time Sampled		14:00	14:00		16:28	17:28		12:37	12:37		16:00	16:00	
Matrix		Water	Water		Water	Water		Water	Water		Water	Water	
Physical Tests													
Conductivity (EC)	uS/cm	27600	27500	0%	46500	46600	0%	47600	47600	0%	335	339	-1%
Density		1.00	1.01	-1%									
Hardness (as CaCO3)	mg/L	4960	5060	-2%	8360	9250	-10%	11500	11100	4%	57.8	59.8	-3%
pH	pH	7.37	7.42	-1%	7.35	7.39	-1%	7.65	7.72	-1%	7.20	7.26	-1%
Total Dissolved Solids	mg/L	18700	18500	1%	32200	32700	-2%	33300	32400	3%	197	202	-3%
Anions and Nutrients													
Alkalinity, Total (as CaCO3)	mg/L	66.3	64.8	2%	82.3	81.7	1%				35.6	35.2	1%
Chloride (Cl)	mg/L	9650	9610	0%	17700	18200	-3%	18700	18800	-1%	83.4	82.5	1%
Fluoride (F)	mg/L	<5	<5		<1	<1		<1	<1		0.069	0.069	0%
Nitrate (as N)	mg/L	<5	<5		<1	<1		<1	<1		0.053	<0.050	
Nitrite (as N)	mg/L	<5	<5		<1	<1		<1	<1		<0.050	<0.050	
Sulfate (SO4)	mg/L	995	991	0%	1750	1790	-2%	0960	0964	0%	4.05	3.70	9%
Additional Anions and Nutrients													
Bicarbonate (HCO3)	mg/L	80.9	79.0	2%	100	99.6	0%	010	010	5%	43.4	43.0	1%
Carbonate (CO3)	mg/L	<5	<5		<5	<5		<5	<5		<5.0	<5.0	
Hydroxide (OH)	mg/L	<5	<5		<5	<5		<5	<5		<5.0	<5.0	
Ion Balance	%	101	103	-2%	96.6	109	-12%	95.5	89.8	6%	93.7	99.3	-6%
Nitrate and Nitrite as N	mg/L	<7.1	<7.1		<1.4	<1.4		<1.4	<1.4		<0.071	<0.071	
TDS (Calculated)	mg/L	16800	16900	-1%	30300	32600	-7%	31000	30500	2%	170	171	-1%
Total Metals													
Aluminum (Al)-Total	mg/L	<0.2	<0.2		<2	<2		<2	<2		0.014	0.021	-40%
Antimony (Sb)-Total	mg/L	<0.008	<0.008		<0.08	<0.08		<0.08	<0.08		<0.00040	<0.00040	
Arsenic (As)-Total	mg/L	<0.08	<0.08		0.083	0.090	-8%	0.296	0.101	98%	0.00076	0.00067	13%
Barium (Ba)-Total	mg/L	0.187	0.185	1%	0.102	0.113	-10%	0.054	0.059	-9%	0.0050	0.0057	-13%
Beryllium (Be)-Total	mg/L	<0.02	<0.02		<0.2	<0.2		<0.2	<0.2		<0.0010	<0.0010	
Boron (B)-Total	mg/L	1.34	1.37	-2%	2.32	2.31	0%	2.56	2.50	2%	<0.050	<0.050	
Cadmium (Cd)-Total	mg/L	<0.001	<0.001		<0.01	<0.01		<0.01	<0.01		<0.000050	<0.000050	
Calcium (Ca)-Total	mg/L	851	867	-2%	1590	1580	1%	4430	4380	1%	10.5	10.8	-3%
Chromium (Cr)-Total	mg/L	<0.016	0.024		0.61	0.66	-8%	0.62	0.74	-18%	<0.0050	<0.0050	
Cobalt (Co)-Total	mg/L	<0.004	<0.004		<0.04	<0.04		<0.04	<0.04		<0.0020	<0.0020	
Copper (Cu)-Total	mg/L	<0.02	<0.02		<0.2	<0.2		<0.2	<0.2		0.0040	0.0054	-30%
Iron (Fe)-Total	mg/L	3.53	3.65	-3%	7.15	7.14	0%	0.15	0.16	-6%	0.118	0.149	-23%
Lead (Pb)-Total	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		0.00063	0.00018	111%
Lithium (Li)-Total	mg/L	0.13	0.14	-7%	<1.2	<1.2		<1.2	<1.2		<0.010	<0.010	
Magnesium (Mg)-Total	mg/L	726	736	-1%	1290	1290	0%	0051	0053	-4%	8.59	8.73	-2%
Manganese (Mn)-Total	mg/L	1.04	1.06	-2%	1.73	1.76	-2%	0.62	0.64	-4%	0.0066	0.0072	-9%
Mercury (Hg)-Total	mg/L	<0.0001	<0.0001		<0.0001	<0.0001		<0.0001	<0.0001		<0.00010	<0.00010	
Molybdenum (Mo)-Total	mg/L	0.0244	0.0237	3%	<0.02	<0.02		<0.02	<0.02		<0.0050	<0.0050	
Nickel (Ni)-Total	mg/L	0.0138	0.0144	-4%	<0.04	<0.04		0.068	0.074	-8%	<0.0020	<0.0020	
Potassium (K)-Total	mg/L	114	116	-2%	294	292	1%	044	045	-3%	3.13	3.14	0%
Selenium (Se)-Total	mg/L	<0.4	<0.4		<0.4	<0.4		<0.4	<0.4		0.00058	0.00057	2%
Silver (Ag)-Total	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.00050	<0.00050	
Sodium (Na)-Total	mg/L	4860	4930	-1%	9260	9580	-3%	7420	7870	-6%	43.0	43.9	-2%
Thallium (Tl)-Total	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.00010	<0.00010	
Tin (Sn)-Total	mg/L	<0.05	<0.05		<0.08	<0.08		<0.08	<0.08		<0.050	<0.050	
Titanium (Ti)-Total	mg/L	<0.012	<0.012		<0.12	<0.12		<0.12	<0.12		<0.0010	<0.0010	
Uranium (U)-Total	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.00010	<0.00010	
Vanadium (V)-Total	mg/L	<0.1	<0.1		0.20	0.22	-10%	0.21	0.23	-9%	<0.0010	<0.0010	
Zinc (Zn)-Total	mg/L	<0.08	<0.08		<0.8	<0.8		<0.8	<0.8		0.0131	0.0252	-63%
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	0.13	<0.1		<1	<1		<1	<1		<0.010	<0.010	
Antimony (Sb)-Dissolved	mg/L	<0.008	<0.008		<0.08	<0.08		<0.08	<0.08		<0.00040	<0.00040	
Arsenic (As)-Dissolved	mg/L	<0.08	<0.08		0.091	0.097	-6%	<0.08	0.090		0.00066	0.00068	-3%
Barium (Ba)-Dissolved	mg/L	0.186	0.188	-1%	0.100	0.097	3%	0.051	0.052	-2%	0.0040	0.0042	-5%
Beryllium (Be)-Dissolved	mg/L	<0.01	<0.01		<0.1	<0.1		<0.1	<0.1		<0.0010	<0.0010	
Boron (B)-Dissolved	mg/L	1.31	1.38	-5%	2.23	2.32	-4%	2.87	2.74	5%	<0.050	<0.050	
Cadmium (Cd)-Dissolved	mg/L	<0.001	<0.001		<0.01	<0.01		<0.01	<0.01		<0.000050	<0.000050	
Calcium (Ca)-Dissolved	mg/L	822	837	-2%	1420	1560	-9%	4520	4360	4%	10.1	10.3	-2%
Chromium (Cr)-Dissolved	mg/L	0.0178	0.0264	-39%	0.747	0.874	-16%	0.351	0.532	-41%	<0.0050	<0.0050	
Cobalt (Co)-Dissolved	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.0020	<0.0020	
Copper (Cu)-Dissolved	mg/L	<0.012	<0.012		0.19	<0.12		<0.12	<0.12		0.0028	0.0028	0%
Iron (Fe)-Dissolved	mg/L	1.88	1.63	14%	5.77	6.25	-8%	<0.15	<0.15		0.072	0.075	-4%
Lead (Pb)-Dissolved	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		0.00015	0.00012	22%
Lithium (Li)-Dissolved	mg/L	0.128	0.136	-6%	<0.6	<0.6		<0.6	<0.6		0.0034	<0.0030	
Magnesium (Mg)-Dissolved	mg/L	707	721	-2%	1170	1300	-11%	0046	0045	2%	7.90	8.28	-5%
Manganese (Mn)-Dissolved	mg/L	1.01	1.01	0%	1.56	1.72	-10%	0.544	0.53	2%	0.0054	0.0056	-4%
Mercury (Hg)-Dissolved	mg/L	<0.0001	<0.0001		<0.0001	<0.0001		<0.0001	<0.0001		<0.00010	<0.00010	
Molybdenum (Mo)-Dissolved	mg/L	0.0240	0.0239	0%	<0.02	<0.02		<0.02	<0.02		<0.0050	<0.0050	
Nickel (Ni)-Dissolved	mg/L	0.0146	0.0159	-9%	<0.02	<0.02		0.061	0.066	-8%	<0.0020	<0.0020	
Potassium (K)-Dissolved	mg/L	129	131	-2%	206	294	-35%	039	037	4%	2.47	2.67	-8%
Selenium (Se)-Dissolved	mg/L	<0.4	<0.4		<0.4	<0.4		<0.4	<0.4		0.00044	0.00060	-31%
Silver (Ag)-Dissolved	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.00010	<0.00010	
Sodium (Na)-Dissolved	mg/L	4470	4540	-2%	7970	9450	-17%	6730	6260	7%	40.0	42.0	-5%
Thallium (Tl)-Dissolved	mg/L	<0.001	<0.001		<0.01	0.010		<0.01	<0.01		<0.00010	<0.00010	
Tin (Sn)-Dissolved	mg/L	<0.05	<0.05		<0.05	<0.05		<0.05	<0.05		<0.050	<0.050	
Titanium (Ti)-Dissolved	mg/L	0.0135	0.0081	50%	<0.06	<0.06		<0.06	<0.06		<0.0010	<0.0010	
Uranium (U)-Dissolved	mg/L	<0.002	<0.002		<0.02	<0.02		<0.02	<0.02		<0.00010	<0.00010	
Vanadium (V)-Dissolved	mg/L	0.077	0.099	-25%	0.259	0.292	-12%	0.122	0.174	-35%	<0.0010	<0.0010	
Zinc (Zn)-Dissolved	mg/L	0.026	0.022	17%	0.22	<0.2		<0.2	<0.2		0.0032	0.0038	-17%
Isotope Chemistry											?	?	
Delta 2H x 1000		-110.12	-109.57	1%	-77.72	-77.67	0%	-138.13	-138.57	0%	-19.16	-19.25	0%
Delta 18O x 1000		-14	-13.96	0%	-10	-10.18	-2%	-19.06	-19.07	0%			

RPDs greater than 20% are highlighted, to show parameters above the recommended duplicate limits.

Table N3: Ion Balance Assessment

Sample label	Alkalinity, Total (as CaCO3)	Chloride (Cl)	Sulfate (SO4)	Calcium (Ca)-Dissolved	Magnesium (Mg)-Dissolved	Potassium (K)-Dissolved	Sodium (Na)-Dissolved	Cation Balance	Anion Balance	Ion Balance
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	**% diff**
Doris Lake Winter	34.4	76.6	3.44	9.3	7.37	2.31	38	2.78	2.92	**2.38**
10WBW001 Drill Tank	35.6	83.4	4.05	10.1	7.9	2.47	40	2.96	3.15	**3.10**
10WBW001 Casing Flow	52.9	1960	195	111	140	34.2	1110	66.19	60.33	**4.63**
10WBW001 Drill Tank Dup	35.2	82.5	3.7	10.3	8.28	2.67	42	3.09	3.10	**0.25**
equipment blank DI										
10WBW001-Zone 1-Port Initial-S01b		18200	1020	4390	172	54	6840	531.98	533.91	**0.18**
10WBW001-Zone 6-Port Initial-S02b	87.3	20100	2090	1640	1430	251	9080	600.69	611.46	**0.89**
10WBW001-Zone 10-Port Initial-S03b	66.3	9650	995	822	707	129	4470	296.83	293.87	**0.50**
10WBW001-Zone 10-Port InitialD-S04b	64.8	9610	991	837	721	131	4540	301.83	292.63	**1.55**
Doris Lake Summer	31.8	60.3	2.42	9.7	5.96	2.11	29.6	2.32	2.38	**1.48**
10WBW001-Zone 10-Airlift Purge-S12	90.6	15200	1490	1230	990	225	7130	458.58	461.00	**0.26**
10WBW001-Zone 10-Airlift Purge-S14	83.3	17100	1700	1340	1070	245	7840	502.03	518.75	**1.64**
10WBW001-Zone 10-Airlift Purge-S15	82.3	17700	1750	1420	1170	206	7970	518.91	536.67	**1.68**
10WBW001-Zone 10-Airlift Final-S16D	81.7	18200	1790	1560	1300	294	9450	603.18	551.58	**4.47**
10WBW001-Zone 1-Port Purge-S17		19100	1010	4480	80.3	42.5	6810	527.33	559.06	**2.92**
10WBW001-Zone 1-Airlift Purge - S20		19000	997	4260	65.6	39.1	6480	500.71	555.97	**5.23**
RO Water	<5	0.65	<0.5	0.75	0.12	<0.5	1.4			
10WBW001-Zone 1-Airlift Final-S25		18700	960	4520	46.1	38.5	6730	522.93	546.75	**2.23**
10WBW001-Zone 1-Airlift Final-S26D		18800	964	4360	45	37	6260	494.39	549.65	**5.29**
10WBW001-Zone 6-Airlift Purge -S28	63.4	15900	1690	1150	1070	170	6450	430.20	484.34	**5.92**
10WBW001-Zone 6-Airlift Purge-S31	67.7	16500	1760	1330	1270	186	7910	519.52	502.79	**1.64**
10WBW001-Zone 6-Airlift Final-S33	70.8	17100	1820	1390	1310	194	8160	536.88	521.00	**1.50**
Westbay Sampler Bottles Equipment blank	<5	7.03	<0.5	<0.5	0.24	<0.5	1.4			
10WBW001-Zone 1-Port Final-S35		19000	981	4960	69.5	39	7290	571.18	555.64	**1.38**
10WBW001-Zone 6-Port Final-S36	44.2	9130	940	749	702	117	4130	277.69	277.64	**0.01**
10WBW001-Zone 10-Port Final-S37	49.7	11500	1160	1010	849	160	5400	359.12	349.09	**1.42**
10WBW001-Zone 1-Port after 2mths-S100	<2	19000	980	4920	64.1	39	7200			
10WBW001-Zone 6-Port after 2mths-S101	44.2	13400	1390	1100	964	160	6010	399.60	407.29	**0.95**
10WBW001-Zone 10-Port after 2mths-S102	77.3	13100	1230	1110	869	173	5780	382.61	396.17	**1.74**
10WBW001-Zone 6-Airlift 160L sample-S103	72.4	19000	2020	1550	1490	233	9130	602.84	578.72	**2.04**
Gas Can Rinsate blank	<2	<0.5	<0.5	0.224	<0.1	<2	<2			
10WBW001-Zone 10-Port after bulk-S105	106	16500	1580	1560	1250	249	8700	565.31	499.80	**6.15**
10WBW001-Zone 1-Port after bulk-S106	<2	18400	935	4730	68.1	40	6910			
10WBW001-Zone 6-Airlift 80L sample-S107	76.5	19100	2000	1520	1450	229	8980	591.43	581.20	**0.87**
10WBW001-Zone 6-Port after bulk-S108	43.7	14200	1500	1160	1080	172	6810	447.22	432.10	**1.72**
10WBW002-Zone 1-Port Initial-S01	56	114000	<100	72100	113	39	655			
10WBW002-Zone 1-Port Purge-S02	59.5	123000	<100	79800	124	52	300			
10WBW002-Zone 1-Port Purge-S109a				74700	110	<200	1680			
10WBW002-Zone 1-Port Purge-S109b										
Glycol & water mix from inside Westbay 10WBW00	42.8	46800	<500	29400	65	<200	<200			
10WBW002-Zone 1-Port Purge-S121	59	133000	<2500	73100	113	<200	490			
Glycol & water mix prepared at camp	46.1	53	<50	8.55	5.9	31	30			
Spyder Lake	7.9	7.58	1.63	3	1.42	0.72	3.8	0.45	0.41	**5.23**
10WBW004 -Drill Tank Beginning	41.9	16400	50	8320	84.7	83	439	443.35	463.85	**2.26**
10WBW004 - Drill Tank End	13	7530	5.28	4330	18.7	12.6	62.7	220.65	212.48	**1.89**
10WBW004 - Zone 6-Port Initial-S123	35.8	12100	244	5050	311	47	1820	357.91	346.64	**1.60**
10WBW004 - Zone 6-Port Purge-S124	35.5	12400	264	4630	312	47	1820	337.04	355.50	**2.67**
10WBW004 - Zone 6-Port Purge-S125	35.3	12400	260	4580	309	47	1790	332.99	355.41	**3.26**
10WBW004 - Zone 6-Port Purge-S126	40	13700	336	4180	404	48	2410	347.83	393.71	**6.19**
10WBW004 - Zone 6-Port Purge-S128	48.7	12600	322	4230	365	48	2200	337.99	362.61	**3.51**
10WBW004 - Zone 6-Port Purge-S129	50.5	13400	349	4350	425	50	2510	362.44	385.74	**3.11**
10WBW004 - Zone 6-Port Purge-S130	53	13400	347	4620	432	53	2600	380.48	385.75	**0.69**
10WBW004 - Zone 6-Port Purge Final Dec-S131	53.5	12800	330	4080	387	49	2330	337.99	368.50	**4.32**

Table N4: Evaluation of Blank Samples

Sample label	Units	10WBW001-Zone 6-Port Final-S36	equipment blank DI	% of ground water sample	RO Water	% of ground water sample	Westbay Sampler Bottles Equipment blank	% of ground water sample	Gas Can Rinsate blank	% of ground water sample	10WBW004 Rinsate blank	% of ground water sample
Field Sample ID		**10WBW001-36**	**10WBW001-05**		**10WBW001-22**		**10WBW001-34**		**10WBW001-104**		**10WBW004-127**	
Sample Comments		Groundwater sample for comparison with blank samples	Equipment blank DI water		RO blank		Rinse blank of Westbay sampler probe bottles		DI water rinsate of gas cans used in bulk samples.		Rinsate blank of Westbay sample probe	
ALS DATA												
ALS File No.		L917645	L880950		L915201		L915201		L948685		L960194	
Date Lab Received		09-Aug-10 09:10	27-Apr-10 15:23		01-Aug-10 11:24		01-Aug-10 11:24		29-Oct-10 10:28		03-Dec-10 17:00	
ALS Report Date		20-Aug-10	06-May-10		13-Aug-10		13-Aug-10		22-Nov-10		22-Dec-10	
RESULTS OF ANALYSIS												
ALS SRK Sample ID		10WBW001-36	10WBW001-05		10WBW001-22		10WBW001-34		10WBW001-104		10WBW004-127	
ALS Date Sampled		05-AUG-10	25-APR-10		26-JUL-10		28-JUL-10		25-OCT-10		26-NOV-10	
ALS Time Sampled		09:00	00:00		09:10		11:00		00:00		18:00	
ALS Sample ID		L917645-2	L880950-5		L915201-8		L915201-22		L948685-1		L960194-8	
Matrix		Seawater	Water		Water		Water		Water		Water	
Physical Tests												
Conductivity (EC)	uS/cm	24600			5.97	0.0%	24.7	0.1%	<2		28.3	0.1%
Density									1.00		1.01	
Hardness (as CaCO3)	mg/L	4760			2.4	0.1%	<1		0.56	0.0%		
pH	pH	7.83			6.38		6.11		7.29		6.34	
Salinity (EC)	g/L											
Total Dissolved Solids	mg/L	19600			10.0	0.1%	18.0	0.1%	<10		12	0.1%
Anions and Nutrients												
Alkalinity, Bicarbonate (as CaCO3)	mg/L								<2		<1.0	
Alkalinity, Carbonate (as CaCO3)	mg/L								<2		<1.0	
Alkalinity, Hydroxide (as CaCO3)	mg/L								<2		<1.0	
Alkalinity, Total (as CaCO3)	mg/L	44.2			<5		<5		<2		<1.0	
Ammonia as N	mg/L								<0.005			
Bromide (Br)	mg/L	21.2							<0.05		<0.050	
Chloride (Cl)	mg/L	9130			0.65	0.0%	7.03	0.1%	<0.5		6.33	0.1%
Fluoride (F)	mg/L	<0.75			<0.05		<0.05		<0.02		<0.020	
Nitrate (as N)	mg/L	<0.5			<0.05		<0.05		<0.005		<0.0050	
Nitrite (as N)	mg/L	<0.1			<0.05		<0.05		<0.001		<0.0010	
Ortho Phosphate as P	mg/L											
Total Phosphate as P	mg/L								0.0052			
Silicate (as SIO2)	mg/L								<1			
Sulfate (SO4)	mg/L	940			<0.5		<0.5		<0.5		<0.50	
Additional Anions and Nutrients												
Bicarbonate (HCO3)	mg/L				<5		<5					
Carbonate (CO3)	mg/L				<5		<5					
Hydroxide (OH)	mg/L				<5		<5					
Ion Balance	%				Low EC		Low EC					
Nitrate and Nitrite as N	mg/L				<0.071		<0.071					
TDS (Calculated)	mg/L				2.9		8.7					
Total Metals												
Aluminum (Al)-Total	mg/L	0.0281	<0.010		<0.01		<0.01		0.0086	30.6%		
Antimony (Sb)-Total	mg/L	0.00745	<0.00040		<0.0004		<0.0004		<0.00001			
Arsenic (As)-Total	mg/L	0.003	<0.00040		<0.0004		<0.0004		<0.00005			
Barium (Ba)-Total	mg/L	0.130	<0.0030		<0.003		<0.003		0.00017	0.1%		
Beryllium (Be)-Total	mg/L	<0.0005	<0.0010		<0.001		<0.001		<0.000005			
Bismuth (Bi)-Total	mg/L	<0.0005							<0.00005			
Boron (B)-Total	mg/L	1.04	<0.050		<0.05		<0.05		0.0097	0.9%		
Cadmium (Cd)-Total	mg/L	<0.00012	<0.000050		<0.00005		0.000190		<0.000005			
Calcium (Ca)-Total	mg/L	0805	<0.50		<0.5		<0.5		<0.05			
Cesium (Cs)-Total	mg/L	0000							<0.000005			
Chromium (Cr)-Total	mg/L	0.00	<0.0050		<0.005		<0.005		<0.0005			
Cobalt (Co)-Total	mg/L	<0.0005	<0.0020		<0.002		<0.002		<0.00005			
Copper (Cu)-Total	mg/L	<0.001	<0.0010		0.0807		<0.001		0.0161			
Gallium (Ga)-Total	mg/L	<0.0005							<0.00005			
Iron (Fe)-Total	mg/L	1.60	<0.010		<0.01		0.037	2.3%	<0.03			
Lead (Pb)-Total	mg/L	<0.001	<0.00010		0.00244		0.00067		0.00114			
Lithium (Li)-Total	mg/L	0.093	<0.010		<0.01		<0.01		<0.0002			
Magnesium (Mg)-Total	mg/L	0739	<0.10		<0.1		<0.1		<0.1			
Manganese (Mn)-Total	mg/L	0.56	<0.0020		<0.002		0.0023	0.4%	<0.0002			
Mercury (Hg)-Total	mg/L		<0.00010		<0.0001		<0.0001		<0.00005			
Molybdenum (Mo)-Total	mg/L	0.0403	<0.0050		<0.005		<0.005		<0.00005			
Nickel (Ni)-Total	mg/L	0.00159	<0.0020		<0.002		<0.002		<0.0002			
Phosphorus (P)-Total	mg/L	<1							<0.3			
Potassium (K)-Total	mg/L	125	<0.10		<0.1		<0.1		<2			
Rhenium (Re)-Total	mg/L	<0.0005							<0.000005			
Rubidium (Rb)-Total	mg/L	000							<0.00002			
Selenium (Se)-Total	mg/L	<0.002	<0.00040		<0.0004		<0.0004		<0.0002			
Silicon (Si)-Total	mg/L	2.88							<0.05			
Silver (Ag)-Total	mg/L	<0.0002	<0.00050		<0.0001		<0.0001		0.0000058			
Sodium (Na)-Total	mg/L	4460	<1.0		<1		<1		<2			
Strontium (Sr)-Total	mg/L	0010							<0.005			
Tellurium (Te)-Total	mg/L	<0.0005							<0.00001			
Thallium (Tl)-Total	mg/L	<0.0005	<0.00010		<0.0001		<0.0001		<0.000002			
Thorium (Th)-Total	mg/L	<0.0005							<0.000005			
Tin (Sn)-Total	mg/L	<0.001	<0.050		<0.05		<0.05		<0.0002			
Titanium (Ti)-Total	mg/L	<0.005	<0.0010		<0.001		<0.001		<0.0002			
Tungsten (W)-Total	mg/L	0.0334							<0.00001			
Uranium (U)-Total	mg/L	<0.0005	<0.00010		<0.0001		<0.0001		0.0000020			
Vanadium (V)-Total	mg/L	<0.0005	<0.0010		<0.001		<0.001		<0.00005			
Yttrium (Y)-Total	mg/L	<0.0005							<0.000005			
Zinc (Zn)-Total	mg/L	0.195	<0.0040		0.0408	20.9%	0.0300	15.4%	0.0056	2.9%		
Zirconium (Zr)-Total	mg/L	<0.0005							<0.00005			

Sample label	Units	10WBW001-Zone 6-Port Final-S36	equipment blank DI	% of ground water sample	RO Water	% of ground water sample	Westbay Sampler Bottles Equipment blank	% of ground water sample	Gas Can Rinsate blank	% of ground water sample	10WBW004 Rinsate blank	% of ground water sample
Field Sample ID		**10WBW001-36**	**10WBW001-05**		**10WBW001-22**		**10WBW001-34**		**10WBW001-104**		**10WBW004-127**	
Sample Comments		Groundwater sample for comparison with blank samples	Equipment blank DI water		RO blank		Rinse blank of Westbay sampler probe bottles		DI water rinsate of gas cans used in bulk samples.		Rinsate blank of Westbay sample probe	
Dissolved Metals												
Aluminum (Al)-Dissolved	mg/L	<0.005	<0.010		<0.01		<0.01		<0.003			
Antimony (Sb)-Dissolved	mg/L	0.00703	<0.00040		<0.0004		<0.0004		0.000021	0.3%		
Arsenic (As)-Dissolved	mg/L	<0.002	<0.00040		<0.0004		<0.0004		<0.00005			
Barium (Ba)-Dissolved	mg/L	0.120	<0.0030		<0.003		<0.003		0.00044	0.4%		
Beryllium (Be)-Dissolved	mg/L	<0.0005	<0.0010		<0.001		<0.001		<0.000005			
Bismuth (Bi)-Dissolved	mg/L	<0.0005							<0.00005			
Boron (B)-Dissolved	mg/L	0.94	<0.050		<0.05		<0.05		<0.005			
Cadmium (Cd)-Dissolved	mg/L	<0.00012	<0.000050		<0.00005		<0.00005		0.0000102			
Calcium (Ca)-Dissolved	mg/L	749			0.75	0.1%	<0.5		0.224	0.0%		
Cesium (Cs)-Dissolved	mg/L	0.00069							<0.000005			
Chromium (Cr)-Dissolved	mg/L	<0.001	<0.0050		<0.005		<0.005		<0.0005			
Cobalt (Co)-Dissolved	mg/L	<0.0005	<0.0020		<0.002		<0.002		<0.00005			
Copper (Cu)-Dissolved	mg/L	<0.001	<0.0010		0.0031		<0.001		0.0123			
Gallium (Ga)-Dissolved	mg/L	<0.0005							<0.00005			
Iron (Fe)-Dissolved	mg/L	0.06			<0.03		<0.03		<0.03			
Lead (Pb)-Dissolved	mg/L	<0.001	<0.00010		<0.0001		<0.0001		0.00114			
Lithium (Li)-Dissolved	mg/L	0.087	<0.0030		<0.003		<0.003		<0.0002			
Magnesium (Mg)-Dissolved	mg/L	702			0.12	0.0%	0.24	0.0%	<0.1			
Manganese (Mn)-Dissolved	mg/L	0.53			<0.005		<0.005		<0.0002			
Mercury (Hg)-Dissolved	mg/L	<	<0.00010		<0.0001		<0.0001		<0.00005			
Molybdenum (Mo)-Dissolved	mg/L	0.0379	<0.0050		<0.005		<0.005		<0.00005			
Nickel (Ni)-Dissolved	mg/L	0.00076	<0.0020		<0.002		<0.002		<0.0002			
Phosphorus (P)-Dissolved	mg/L	<1							<0.3			
Potassium (K)-Dissolved	mg/L	117			<0.5		<0.5		<2			
Rhenium (Re)-Dissolved	mg/L	<0.0005							<0.000005			
Rubidium (Rb)-Dissolved	mg/L	000							<0.00002			
Selenium (Se)-Dissolved	mg/L	<0.002	<0.00040		<0.0004		<0.0004		<0.0002			
Silicon (Si)-Dissolved	mg/L	2.48							<0.05			
Silver (Ag)-Dissolved	mg/L	<0.0002	<0.00010		<0.0001		<0.0001		<0.000005			
Sodium (Na)-Dissolved	mg/L	4130			1.4	0.0%	1.4	0.0%	<2			
Strontium (Sr)-Dissolved	mg/L	0009							<0.005			
Tellurium (Te)-Dissolved	mg/L	<0.0005							<0.00001			
Thallium (Tl)-Dissolved	mg/L	<0.0005	<0.00010		<0.0001		<0.0001		<0.000002			
Thorium (Th)-Dissolved	mg/L	<0.0005							<0.000005			
Tin (Sn)-Dissolved	mg/L	<0.001	<0.050		<0.05		<0.05		<0.0002			
Titanium (Ti)-Dissolved	mg/L	<0.005	<0.0010		<0.001		<0.001		<0.0002			
Tungsten (W)-Dissolved	mg/L	0.0316							<0.00001			
Uranium (U)-Dissolved	mg/L	<0.0005	<0.00010		<0.0001		<0.0001		<0.000002			
Vanadium (V)-Dissolved	mg/L	<0.0005	<0.0010		<0.001		<0.001		<0.00005			
Yttrium (Y)-Dissolved	mg/L	<0.0005							<0.000005			
Zinc (Zn)-Dissolved	mg/L	0.02	<0.0020		0.0030	16.1%	0.0031	16.7%	0.0109	58.6%		
Zirconium (Zr)-Dissolved	mg/L	<0.0005							<0.00005			
Delta 2H x 1000		-117.72	-144.31		-149.55							
Delta 18O x 1000		-15.00	-15.60		-18.97							
Parameters with detectable concentrations in blanks are higlighted.												

Table N5: Comparison of Airlift and Port Samples

		Airlift vs Port		RPD	Airlift vs Port		RPD	Airlift vs Port		RPD	Airlift vs Port		RPD
Field Sample ID / Unique ID	Units	10WBW001-33	10WBW001-36		10WBW001-26	10WBW001-35		10WBW001-16	10WBW001-37		10WBW001-103	10WBW001-108	
Sample From		Westbay airlift	Westbay Port		Westbay airlift	Westbay Port		Westbay airlift	Westbay Port		Westbay airlift	Westbay Port	
Sample label for graph		10WBW001-Zone 6-Airlift Final-S33	10WBW001-Zone 6-Port Final-S36		10WBW001-Zone 1-Airlift Final-S26D	10WBW001-Zone 1-Port Final-S35		10WBW001-Zone 10-Airlift Final-S16D	10WBW001-Zone 10-Port Final-S37		10WBW001-Zone 6-Airlift 160L sample-S103	10WBW001-Zone 6-Port after bulk-S108	
Sample Zone		6	6		1	1		10	10		6	6	
Location of port in zone		Bottom	Top		Middle	Top		Bottom	Top		Bottom	Top	
Zone port drillhole depth		274.00	246.0		554.00	548.0		107.50	63.5		274.00	246.0	
Total Litres purged from zone before sample was taken		6433	8096		3065	3186		3008	3008		10639	13592	
Zone volumes purged before sample was taken		36.7	46.6		26.2	27.4		11.0	11.0		61.7	79.3	
ALS DATA													
ALS Date Sampled		27-JUL-10	05-AUG-10		25-JUL-10	04-AUG-10		21-JUL-10	05-AUG-10		25-OCT-10	01-NOV-10	
ALS Time Sampled		15:21	09:00		12:37	13:42		17:28	11:40		00:00	15:00	
Matrix		Water	Seawater		Water	Seawater		Water	Seawater		Water	BOTH	
Physical Tests													
Conductivity (EC)	uS/cm	44400	24600	57%	47600	46600	2%	46600	30300	42%	48500	37000	27%
Density												1.03	
Hardness (as CaCO3)	mg/L	8870	4760	60%	11100	12700	-13%	9250	6030	42%	10000	7340	31%
pH	pH	7.43	7.83	-5%	7.72	7.43	4%	7.39	7.47	-1%	7.04	7.59	-8%
Salinity (EC)	g/L										32.4	23.5	32%
Total Dissolved Solids	mg/L	30400	19600	43%	32400	47800	-38%	32700	23100	34%	35400	25500	33%
Anions and Nutrients													
Alkalinity, Total (as CaCO3)	mg/L	70.8	44.2	46%				81.7	49.7	49%	72.4	43.7	49%
Ammonia as N	mg/L										3.14	2.32	30%
Bromide (Br)	mg/L		21.2			100			27.6		49.1	41.3	17%
Chloride (Cl)	mg/L	17100	09130	61%	18800	19000	-1%	18200	11500	45%	19000	14200	29%
Fluoride (F)	mg/L	<1	<0.75		<1	<0.75		<1	<0.75		0.091	<0.75	
Nitrate (as N)	mg/L	<1	<0.5		<1	<0.5		<1	<0.5		<0.5	<0.5	
Nitrite (as N)	mg/L	<1	<0.1		<1	<0.1		<1	<0.1		<0.1	<0.1	
Total Phosphate as P	mg/L										0.0262	0.0162	47%
Silicate (as SIO2)	mg/L										6.1	5.8	5%
Sulfate (SO4)	mg/L	1820	0940	64%	0964	0981	-2%	1790	1160	43%	2020	1500	30%
Total Metals													
Aluminum (Al)-Total	mg/L	<2	0.0281		<2	0.0992		<2	0.0146		0.0318	0.0059	137%
Antimony (Sb)-Total	mg/L	<0.08	0.00745		<0.08	<0.0005		<0.08	0.00349		0.00127	0.00461	-114%
Arsenic (As)-Total	mg/L	0.121	0.003	192%	0.101	<0.002		0.090	<0.002		0.007	<0.002	
Barium (Ba)-Total	mg/L	0.107	0.130	-19%	0.059	0.051	14%	0.113	0.179	-45%	0.117	0.169	-36%
Beryllium (Be)-Total	mg/L	<0.2	<0.0005		<0.2	<0.0005		<0.2	<0.0005		<0.0005	<0.0005	
Bismuth (Bi)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Boron (B)-Total	mg/L	1.91	1.04	59%	2.50	2.93	-16%	2.31	1.51	42%	2.65	1.50	55%
Cadmium (Cd)-Total	mg/L	<0.01	<0.00012		<0.01	<0.00012		<0.01	<0.00012		<0.00005	<0.00005	
Calcium (Ca)-Total	mg/L	1280	805	46%	4380	5070	-15%	1580	1020	43%	1600	1170	31%
Cesium (Cs)-Total	mg/L		0.00072			0.00105			0.00097		0.00155	0.00095	48%
Chromium (Cr)-Total	mg/L	0.86	0.00	199%	0.74	0.01	197%	0.66	0.0030	198%	<0.0005	<0.0005	
Cobalt (Co)-Total	mg/L	<0.04	<0.0005		<0.04	<0.0005		<0.04	<0.0005		0.000381	0.000103	115%
Copper (Cu)-Total	mg/L	<0.2	<0.001		<0.2	0.0018		<0.2	<0.001		<0.0005	0.00061	
Gallium (Ga)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Iron (Fe)-Total	mg/L	3.54	1.60	75%	0.16	0.46	-96%	7.14	3.95	58%	4.53	2.28	66%
Lead (Pb)-Total	mg/L	<0.02	<0.001		<0.02	0.0013		<0.02	<0.001		<0.0003	<0.0003	
Lithium (Li)-Total	mg/L	<1.2	0.093		<1.2	0.37		<1.2	0.128		0.228	0.131	54%
Magnesium (Mg)-Total	mg/L	1210	739	48%	53	71	-29%	1290	867	39%	1510	1080	33%
Manganese (Mn)-Total	mg/L	1.81	0.56	106%	0.64	0.72	-11%	1.76	1.09	47%	2.08	0.892	80%
Mercury (Hg)-Total	mg/L	<0.0001			<0.0001			<0.0001			<0.00005		
Molybdenum (Mo)-Total	mg/L	<0.02	0.0403		<0.02	0.0136		<0.02	0.0225		0.0140	0.0361	-88%
Nickel (Ni)-Total	mg/L	<0.04	0.00159		0.074	0.00437	178%	<0.04	0.00237		0.00095	0.00120	-23%
Phosphorus (P)-Total	mg/L		<1			<1			<1		<1	<1	
Potassium (K)-Total	mg/L	203	125	48%	045	040	12%	292	166	55%	240	172	33%
Rhenium (Re)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Rubidium (Rb)-Total	mg/L		0.0765			0.0500			0.0816		0.1420	0.102	33%
Selenium (Se)-Total	mg/L	<0.4	<0.002		<0.4	<0.002		<0.4	<0.002		<0.002	<0.002	
Silicon (Si)-Total	mg/L		2.88			2.61			2.12		3.68	3.82	-4%
Silver (Ag)-Total	mg/L	<0.02	<0.0002		<0.02	<0.0002		<0.02	<0.0002		<0.0001	0.00018	
Sodium (Na)-Total	mg/L	7450	4460	50%	7870	7470	5%	9580	5590	53%	9350	6790	32%
Strontium (Sr)-Total	mg/L		10			60			11.7		21.2	14.6	37%
Tellurium (Te)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Thallium (Tl)-Total	mg/L	<0.02	<0.0005		<0.02	<0.0005		<0.02	<0.0005		<0.00005	<0.00005	
Thorium (Th)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Tin (Sn)-Total	mg/L	<0.08	<0.001		<0.08	<0.001		<0.08	<0.001		<0.001	<0.001	
Titanium (Ti)-Total	mg/L	<0.12	<0.005		<0.12	0.0082		<0.12	<0.005		<0.005	<0.005	
Tungsten (W)-Total	mg/L		0.0334			<0.001			0.0067		0.0056	0.0227	-121%
Uranium (U)-Total	mg/L	<0.02	<0.0005		<0.02	<0.0005		<0.02	<0.0005		0.00023	0.000059	118%
Vanadium (V)-Total	mg/L	0.27	<0.0005		0.23	0.001	199%	0.22	<0.0005		0.00054	<0.0005	
Yttrium (Y)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Zinc (Zn)-Total	mg/L	<0.8	0.195		<0.8	0.503		<0.8	0.261		0.046	0.115	-86%
Zirconium (Zr)-Total	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Dissolved Metals													
Aluminum (Al)-Dissolved	mg/L	<1	<0.005		<1	<0.005		<1	<0.005		<0.005	<0.005	
Antimony (Sb)-Dissolved	mg/L	<0.08	0.00703		<0.08	<0.0005		<0.08	0.00306		0.00121	0.00393	-106%
Arsenic (As)-Dissolved	mg/L	0.102	<0.002		0.090	<0.002		0.097	<0.002		0.0066	<0.002	
Barium (Ba)-Dissolved	mg/L	0.120	0.120	0%	0.052	0.052	0%	0.097	0.169	-54%	0.113	0.169	-40%
Beryllium (Be)-Dissolved	mg/L	<0.1	<0.0005		<0.1	<0.0005		<0.1	<0.0005		<0.0005	<0.0005	
Bismuth (Bi)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	

		Airlift vs Port		RPD	Airlift vs Port		RPD	Airlift vs Port		RPD	Airlift vs Port		RPD
Field Sample ID / Unique ID	**Units**	**10WBW001-33**	**10WBW001-36**		**10WBW001-26**	**10WBW001-35**		**10WBW001-16**	**10WBW001-37**		**10WBW001-103**	**10WBW001-108**	
Boron (B)-Dissolved	mg/L	1.97	0.94	71%	2.74	2.99	-9%	2.32	1.42	48%	2.64	1.48	56%
Cadmium (Cd)-Dissolved	mg/L	<0.01	<0.00012		<0.01	<0.00012		<0.01	<0.00012		<0.00005	<0.00005	
Calcium (Ca)-Dissolved	mg/L	1390	749	60%	4360	4960	-13%	1560	1010	43%	1550	1160	29%
Cesium (Cs)-Dissolved	mg/L		0.00069			0.00105			0.00092		0.00154	0.00097	45%
Chromium (Cr)-Dissolved	mg/L	0.682	<0.001		0.532	<0.001		0.874	<0.001		<0.0005	<0.0005	
Cobalt (Co)-Dissolved	mg/L	<0.02	<0.0005		<0.02	<0.0005		<0.02	<0.0005		0.000315	0.000091	110%
Copper (Cu)-Dissolved	mg/L	<0.12	<0.001		<0.12	<0.001		<0.12	<0.001		<0.0005	<0.0005	
Gallium (Ga)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Iron (Fe)-Dissolved	mg/L	3.32	0.06	193%	<0.15	<0.05		6.25	2.68	80%	4.31	0.503	158%
Lead (Pb)-Dissolved	mg/L	<0.02	<0.001		<0.02	<0.001		<0.02	<0.001		<0.003	<0.0003	
Lithium (Li)-Dissolved	mg/L	<0.6	0.087		<0.6	0.37		<0.6	0.121		0.223	0.127	55%
Magnesium (Mg)-Dissolved	mg/L	1310	0702	60%	0045	0070	-43%	1300	849	42%	1490	1080	32%
Manganese (Mn)-Dissolved	mg/L	1.96	0.53	115%	0.53	0.69	-26%	1.72	1.04	49%	2.03	0.888	78%
Mercury (Hg)-Dissolved	mg/L	<0.0001			<0.0001			<0.0001			<0.00005		
Molybdenum (Mo)-Dissolved	mg/L	<0.02	0.0379		<0.02	0.0128		<0.02	0.0211		0.0138	0.0345	-86%
Nickel (Ni)-Dissolved	mg/L	<0.02	0.00076		0.066	<0.0005		<0.02	<0.0005		0.00101	0.00158	-44%
Phosphorus (P)-Dissolved	mg/L		<1			<1			<1		<1	<1	
Potassium (K)-Dissolved	mg/L	194	117	50%	037	039	-5%	294	160	59%	233	172	30%
Rhenium (Re)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Rubidium (Rb)-Dissolved	mg/L		0.0725			0.0504			0.0766		0.1400	0.106	28%
Selenium (Se)-Dissolved	mg/L	<0.4	<0.002		<0.4	<0.002		<0.4	<0.002		<0.002	<0.002	
Silicon (Si)-Dissolved	mg/L		2.48			2.3			1.99		3.49	3.33	5%
Silver (Ag)-Dissolved	mg/L	<0.02	<0.0002		<0.02	<0.0002		<0.02	<0.0002		<0.0001	<0.0001	
Sodium (Na)-Dissolved	mg/L	8160	4130	66%	6260	7290	-15%	9450	5400	55%	9130	6810	29%
Strontium (Sr)-Dissolved	mg/L		9.0			58.9			11.3		21.1	14.6	36%
Tellurium (Te)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Thallium (Tl)-Dissolved	mg/L	<0.01	<0.0005		<0.01	<0.0005		0.010	<0.0005		<0.00005	<0.00005	
Thorium (Th)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Tin (Sn)-Dissolved	mg/L	<0.05	<0.001		<0.05	<0.001		<0.05	<0.001		<0.001	<0.001	
Titanium (Ti)-Dissolved	mg/L	<0.06	<0.005		<0.06	<0.005		<0.06	<0.005		<0.005	<0.005	
Tungsten (W)-Dissolved	mg/L		0.0316			<0.001			0.0059		0.0053	0.0231	-125%
Uranium (U)-Dissolved	mg/L	<0.02	<0.0005		<0.02	<0.0005		<0.02	<0.0005		0.000231	0.000058	120%
Vanadium (V)-Dissolved	mg/L	0.229	<0.0005		0.174	<0.0005		0.292	<0.0005		<0.0005	<0.0005	
Yttrium (Y)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Zinc (Zn)-Dissolved	mg/L	<0.2	0.02		<0.2	0.0897		<0.2	0.0504		0.0384	0.0295	26%
Zirconium (Zr)-Dissolved	mg/L		<0.0005			<0.0005			<0.0005		<0.0005	<0.0005	
Isotope Chemistry													
Delta 2H x 1000		-85.71	-117.72	-31%	-138.57	-138	0%	-77.67	-106.52	-31%			
Delta 18O x 1000		-10.9	-15	-32%	-19.07	-18.83	1%	-10.18	-13.49	-28%			

RPDs greater than 20% are highlighted, to show parameters with the greatest variation between samples.

SRK CONSULTING (CANADA) INC.
ATTN: MELISSA PITZ
SUITE 205
2100 AIRPORT DRIVE
SASKATOON SK S7L 6M6

Phone: 306-955-4732

Date Received:	29-OCT-10
Report Date:	22-NOV-10 09:12 (MT)
Version:	FINAL

Certificate of Analysis

Lab Work Order #:	L948685
Project P.O. #:	NOT SUBMITTED
Job Reference:	
Legal Site Desc:	
C of C Numbers:	

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L948685-1	L948685-2			
	Description	WATER	WATER			
	Sampled Date	25-OCT-10	25-OCT-10			
	Sampled Time					
	Client ID	10WBW001-104	10WBW001-103			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	<2.0	48500			
	Hardness (as CaCO3) (mg/L)	0.56	10000			
	pH (pH)	7.29	7.04			
	Total Dissolved Solids (mg/L)	<10	35400			
Leachable Anions & Nutrients	Anion Sum (meq/L)	<0.10	580			
	Cation Sum (meq/L)	<0.10	603			
	Cation - Anion Balance (%)	0.0	2.0			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	<2.0				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0				
	Alkalinity, Total (as CaCO3) (mg/L)	<2.0	72.4			
	Ammonia as N (mg/L)	<0.0050	3.14			
	Bromide (Br) (mg/L)	<0.050	49.1			
	Chloride (Cl) (mg/L)	<0.50	19000			
	Fluoride (F) (mg/L)	<0.020	0.091			
	Nitrate (as N) (mg/L)	<0.0050	<0.50			
	Nitrite (as N) (mg/L)	<0.0010	<0.10			
	Total Phosphate as P (mg/L)	0.0052	0.0262			
	Silicate (as SIO2) (mg/L)	<1.0	6.1			
	Sulfate (SO4) (mg/L)	<0.50	2020			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0086	0.0318			
	Antimony (Sb)-Total (mg/L)	<0.000010	0.00127			
	Arsenic (As)-Total (mg/L)	<0.000050	0.0070			
	Barium (Ba)-Total (mg/L)	0.00017	0.117			
	Beryllium (Be)-Total (mg/L)	<0.0000050	<0.00050			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.00050			
	Boron (B)-Total (mg/L)	0.0097	2.65			
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.000050			
	Calcium (Ca)-Total (mg/L)	<0.050	1600			
	Cesium (Cs)-Total (mg/L)	<0.0000050	0.00155			
	Chromium (Cr)-Total (mg/L)	<0.00050	<0.00050			
	Cobalt (Co)-Total (mg/L)	<0.000050	0.000381			
	Copper (Cu)-Total (mg/L)	0.0161	<0.00050			
	Gallium (Ga)-Total (mg/L)	<0.000050	<0.00050			
	Iron (Fe)-Total (mg/L)	<0.030	4.53			
	Lead (Pb)-Total (mg/L)	0.00114	<0.00030			

ALS LABORATORY GROUP ANALYTICAL REPORT

	Sample ID	L948685-1	L948685-2			
	Description	WATER	WATER			
	Sampled Date	25-OCT-10	25-OCT-10			
	Sampled Time					
	Client ID	10WBW001-104	10WBW001-103			
Grouping	**Analyte**					
WATER						
Total Metals	Lithium (Li)-Total (mg/L)	<0.00020	0.228			
	Magnesium (Mg)-Total (mg/L)	<0.10	1510			
	Manganese (Mn)-Total (mg/L)	<0.00020	2.08			
	Mercury (Hg)-Total (mg/L)	<0.000050	<0.000050			
	Molybdenum (Mo)-Total (mg/L)	<0.000050	0.0140			
	Nickel (Ni)-Total (mg/L)	<0.00020	0.00095			
	Phosphorus (P)-Total (mg/L)	<0.30	<1.0			
	Potassium (K)-Total (mg/L)	<2.0	240			
	Rhenium (Re)-Total (mg/L)	<0.0000050	<0.00050			
	Rubidium (Rb)-Total (mg/L)	<0.000020	0.142			
	Selenium (Se)-Total (mg/L)	<0.00020	<0.0020			
	Silicon (Si)-Total (mg/L)	<0.050	3.68			
	Silver (Ag)-Total (mg/L)	0.0000058	<0.00010			
	Sodium (Na)-Total (mg/L)	<2.0	9350			
	Strontium (Sr)-Total (mg/L)	<0.0050	21.2			
	Tellurium (Te)-Total (mg/L)	<0.000010	<0.00050			
	Thallium (Tl)-Total (mg/L)	<0.0000020	<0.000050			
	Thorium (Th)-Total (mg/L)	<0.0000050	<0.00050			
	Tin (Sn)-Total (mg/L)	<0.00020	<0.0010			
	Titanium (Ti)-Total (mg/L)	<0.00020	<0.0050			
	Tungsten (W)-Total (mg/L)	<0.000010	0.0056			
	Uranium (U)-Total (mg/L)	0.0000020	0.000230			
	Vanadium (V)-Total (mg/L)	<0.000050	0.00054			
	Yttrium (Y)-Total (mg/L)	<0.0000050	<0.00050			
	Zinc (Zn)-Total (mg/L)	0.0056	0.0456			
	Zirconium (Zr)-Total (mg/L)	<0.000050	<0.00050			
Dissolved Metals	Aluminum (Al)-Dissolved (mg/L)	<0.0030	<0.0050			
	Antimony (Sb)-Dissolved (mg/L)	0.000021	0.00121			
	Arsenic (As)-Dissolved (mg/L)	<0.000050	0.0066			
	Barium (Ba)-Dissolved (mg/L)	0.00044	0.113			
	Beryllium (Be)-Dissolved (mg/L)	<0.0000050	<0.00050			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00050			
	Boron (B)-Dissolved (mg/L)	<0.0050	2.64			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000102	<0.000050			
	Calcium (Ca)-Dissolved (mg/L)	0.224	1550			
	Cesium (Cs)-Dissolved (mg/L)	<0.0000050	0.00154			
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050			

	Sample ID	L948685-1	L948685-2
	Description	WATER	WATER
	Sampled Date	25-OCT-10	25-OCT-10
	Sampled Time		
	Client ID	10WBW001-104	10WBW001-103
Grouping	**Analyte**		
WATER			
Dissolved Metals	Cobalt (Co)-Dissolved (mg/L)	<0.000050	0.000315
	Copper (Cu)-Dissolved (mg/L)	0.0123	<0.00050
	Gallium (Ga)-Dissolved (mg/L)	<0.000050	<0.00050
	Iron (Fe)-Dissolved (mg/L)	<0.030	4.31
	Lead (Pb)-Dissolved (mg/L)	0.00114	<0.0030
	Lithium (Li)-Dissolved (mg/L)	<0.00020	0.223
	Lithium (Li)-Dissolved (mg/L)	<0.00020	0.223
	Magnesium (Mg)-Dissolved (mg/L)	<0.10	1490
	Manganese (Mn)-Dissolved (mg/L)	<0.00020	2.03
	Mercury (Hg)-Dissolved (mg/L)	<0.000050	<0.000050
	Molybdenum (Mo)-Dissolved (mg/L)	<0.000050	0.0138
	Nickel (Ni)-Dissolved (mg/L)	<0.00020	0.00101
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<1.0
	Potassium (K)-Dissolved (mg/L)	<2.0	233
	Rhenium (Re)-Dissolved (mg/L)	<0.0000050	<0.00050
	Rubidium (Rb)-Dissolved (mg/L)	<0.000020	0.140
	Selenium (Se)-Dissolved (mg/L)	<0.00020	<0.0020
	Silicon (Si)-Dissolved (mg/L)	<0.050	3.49
	Silicon (Si)-Dissolved (mg/L)	<0.050	3.49
	Silver (Ag)-Dissolved (mg/L)	<0.0000050	<0.00010
	Sodium (Na)-Dissolved (mg/L)	<2.0	9130
	Strontium (Sr)-Dissolved (mg/L)	<0.0050	21.1
	Tellurium (Te)-Dissolved (mg/L)	<0.000010	<0.00050
	Thallium (Tl)-Dissolved (mg/L)	<0.0000020	<0.000050
	Thorium (Th)-Dissolved (mg/L)	<0.0000050	<0.00050
	Thorium (Th)-Dissolved (mg/L)	<0.0000050	<0.00050
	Tin (Sn)-Dissolved (mg/L)	<0.00020	<0.0010
	Titanium (Ti)-Dissolved (mg/L)	<0.00020	<0.0050
	Tungsten (W)-Dissolved (mg/L)	<0.000010	0.0053
	Uranium (U)-Dissolved (mg/L)	<0.0000020	0.000231
	Vanadium (V)-Dissolved (mg/L)	<0.000050	<0.00050
	Yttrium (Y)-Dissolved (mg/L)	<0.0000050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0109	0.0384
	Zirconium (Zr)-Dissolved (mg/L)	<0.000050	<0.00050

Reference Information

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ALK-PCT-VA</td><td>Water</td><td>Alkalinity by Auto. Titration</td><td>APHA 2320 "Alkalinity"</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ALK-PCT-VA</td><td>Water</td><td>Alkalinity by Auto. Titration</td><td>APHA 2320 Alkalinity</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ALK-SCR-VA</td><td>Water</td><td>Alkalinity by colour or titration</td><td>EPA 310.2 OR APHA 2320</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.
OR
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ANIONS-BR-IC-VA</td><td>Water</td><td>Bromide by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>ANIONS-CL-IC-VA</td><td>Water</td><td>Chloride by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>ANIONS-F-IC-VA</td><td>Water</td><td>Fluoride by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>ANIONS-NO2-IC-VA</td><td>Water</td><td>Nitrite by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrite detection is by UV absorbance and not conductivity.</td></tr>
<tr><td>ANIONS-NO3-IC-VA</td><td>Water</td><td>Nitrate by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Specifically, the nitrate detection is by UV absorance and not conductivity.</td></tr>
<tr><td>ANIONS-SO4-IC-VA</td><td>Water</td><td>Sulfate by Ion Chromatography</td><td>APHA 4110 B.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".</td></tr>
<tr><td>EC-PCT-VA</td><td>Water</td><td>Conductivity (Automated)</td><td>APHA 2510 Auto. Conduc.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.</td></tr>
<tr><td>F-SIE-VA</td><td>Water</td><td>Fluoride by SIE</td><td>APHA 4500-F "Fluoride"</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode. This method has a significant negative interference (i.e. results could be biased low) when Al3+ is present in the sample at a concentration greater than 2.5 mg/L.</td></tr>
<tr><td>F-SIE-VA</td><td>Water</td><td>Fluoride by SIE</td><td>APHA 4500-F Fluoride</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode. This method has a significant negative interference (i.e. results could be biased low) when Al3+ is present in the sample at a concentration greater than 2.5 mg/L.</td></tr>
<tr><td>HARDNESS-CALC-VA</td><td>Water</td><td>Hardness</td><td>APHA 2340B</td></tr>
<tr><td colspan="4">Hardness is calculated from Calcium and Magnesium concentrations, and is expressed as calcium carbonate equivalents.</td></tr>
<tr><td>HG-DIS-CVAFS-VA</td><td>Water</td><td>Dissolved Mercury in Water by CVAFS</td><td>EPA SW-846 3005A & EPA 245.7</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).</td></tr>
<tr><td>HG-TOT-CVAFS-VA</td><td>Water</td><td>Total Mercury in Water by CVAFS</td><td>EPA 245.7</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).</td></tr>
<tr><td>IONBALANCE-VA</td><td>Water</td><td>Ion Balance Calculation</td><td>APHA 1030E</td></tr>
</table>

Reference Information

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-L-HRMS-VA Water Diss. Metals in Water by HR-ICPMS EPA 200.8

Trace metals in water are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The procedures may involve laboratory sample filtration modified from APHA Method 3030B.

MET-DIS-ICP-VA Water Dissolved Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-L-HRMS-VA Water Total Metals in Water by HR-ICPMS EPA 200.8

Trace metals in water are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The procedures may involve preliminary sample treatment by acid digestion modified from APHA Method 3030E.

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulphuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

PH-MAN-VA Water pH by Manual Meter APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

It is recommended that this analysis be conducted in the field.

PH-MAN-VA Water pH by Manual Meter APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

It is recommended that this analysis be conducted in the field.

PO4-T-COL-VA Water Total Phosphate P by Color APHA 4500-P "Phosphorous"

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.

PO4-T-COL-VA Water Total Phosphate P by Color APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". All forms of phosphate are determined by the ascorbic acid colourimetric method. Dissolved ortho-phosphate (dissolved reactive phosphorous) is determined by direct measurement. Total phosphate (total phosphorous) is determined after persulphate digestion of a sample. Total dissolved phosphate (total dissolved phosphorous) is determined by filtering a sample through a 0.45 micron membrane filter followed by persulfate digestion of the filtrate.

SILICATE-COL-VA Water Silicate by Colourimetric analysis APHA 4500-SIO2 D.

This analysis is carried out using procedures adapted from APHA Method 4500-SiO2 D. "Silica". Silicate (molybdate-reactive silica) is determined by the molybdosilicate-heteropoly blue colourimetric method.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Reference Information

VA	ALS LABORATORY GROUP - VANCOUVER, BC, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate	*A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.*
mg/kg	*milligrams per kilogram based on dry weight of sample.*
mg/kg wwt	*milligrams per kilogram based on wet weight of sample.*
mg/kg lwt	*milligrams per kilogram based on lipid-adjusted weight of sample.*
mg/L	*milligrams per litre.*
<	*Less than.*
D.L.	*The reported Detection Limit, also known as the Limit of Reporting (LOR).*
N/A	*Result not available. Refer to qualifier code and definition for explanation.*

Test results reported relate only to the samples as receieved by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

GN-2

Appendix GN-2-1 Kitikmeot Training Model MOU

11/25/2007

MEMORANDUM OF UNDERSTANDING

Between

The Kitikmeot Inuit Association

And

The Kitikmeot Economic Development Commission

And

Miramar Hope Bay Ltd.
And

Nunavut Arctic College
And

The Department of Education (Education)
Government of Nunavut
November 25, 2007

Preamble

The Kitikmeot Economic Development Commission, the Kitikmeot Inuit Association, Miramar Hope Bay Ltd., Nunavut Arctic College, and the Department of Education, Government of Nunavut recognize the mutual benefit to be gained through collaborative efforts in areas related to the delivery of mine-related training, training related to economic and community development, labour market research, curriculum development, career development, and other related activities. The organizations agree that collaboration would result in synergy and natural linkages among our organizations. Such collaboration would benefit all parties, and would optimize the efficient and effective use of available resources.

Enhanced Cooperation

The Memorandum of Understanding confirms the desire of the parties to enhance, develop and further, to the extent possible, appropriate and complementary activities consistent with our institutions missions and priorities.

It is understood that this Memorandum is being entered into without prejudice, and in no way is intended to replace the relationship between Miramar Hope Bay Ltd. and the Kitikmeot Inuit Association established by the Doris North Inuit Impact Agreement.

Objective

The objective of the Memorandum of Understanding is to establish the Kitikmeot Economic Development Commission, the Kitikmeot Inuit Association, Miramar Hope Bay Ltd., Nunavut Arctic College, and the Department of Education as partners in developing a cooperative approach to education, labour force research, and training related to mine-related industries and activities. The five organizations will seek to identify opportunities and trends that benefit our stakeholders and partners. This agreement will also cover projects between the partners in the development of career orientation programs, transition to work programs, certification and registry requirements for the purpose of developing a "seamless" approach to services from high school to adult training.

Context

Nunavut is a rapidly evolving territory with a need to develop high quality, culturally appropriate, consistent and measurable approaches to the development and delivery of mine-related training and education initiatives within the context of the Pinasuaqtavut.

The Government of Nunavut has determined that mining and mine-related industries including mine reclamation and contaminated site clean-up are critical to the growth of the Nunavut economy. The Kitikmeot Economic Development Commission, the Kitikmeot Inuit Association, Miramar Hope Bay Ltd., Nunavut Arctic College, and the Department of Education, Government of Nunavut wish to develop programming which benefits the residents of communities associated with the Miramar Hope Bay Ltd. Doris North Project. All organizations are vitally concerned with the economic and social development of the community. The Government of Nunavut, the federal government, community development groups and others have allocated resources to support these initiatives. The purpose of this Memorandum of Understanding is to allow for the development of more formalized structures, and to form the basis of sub-agreements related to specific pilot projects, program and training development and delivery, and mechanisms to plan, deliver and evaluate all activities undertaken.

Scope

The scope of this Memorandum may include, but is not limited to:

- Opportunity Identification
- Needs Analysis including use of the Nunavut Community Skills Information System
- Education and Training, including the development of a training model to meet the needs of the development project and partners
- Career Planning and Career Development Activities
- Research, specifically in the area of labour force development
- Government/Community Liaison
- Development of Measurement Indicators
- Evaluation of Activities
- Capacity Building

Coordination

The Kitikmeot Economic Development Commission, the Kitikmeot Inuit Association, Miramar Hope Bay Ltd., Nunavut Arctic College, and the Department of Education each agree to designate one individual to oversee the administration and coordination of this Memorandum. These individuals will coordinate the development of sub-agreements related to specific projects and initiatives, and will be responsible for effective implementation of initiatives undertaken and in communicating undertakings and results to appropriate parties.

Specific Initiatives Identified for Immediate Investigation and Development:

- Activities related to overall planning for the development and delivery of a mine-related training and employment opportunities.
- Activities related to career preparation and development and promotion.
- Support for school curriculum development and orientation to mine-related trades and occupations.
- Mechanisms to evaluate programs and services being planned and delivered.
- Mechanisms to ensure appropriate registration and credit transferability, and to increase training opportunities to Nunavummiut.

- Identification of specific pilot projects. Coordination of activities related to funding sources, including development of cooperative, joint applications for funding.
- Funding and delivery of courses, including program/course promotion, registering of students, and certification.

Establishment of a Coordinating Committee

The partners agree to establish a Coordinating Committee to assist with the identification and implementation of actions identified of mutual benefit and interest. The Committee will work through consensus, and will develop Terms of Reference to guide its operations.

Duration and Termination

This Memorandum of Understanding shall be effective from the date of signing for a period of five years. The Memorandum may be amended or extended by mutual written consent. The agreement may be terminated at any time provided that the terminating party gives written notice of its intentions at least three months prior to termination.

As witness to their subscription to the above articles, the representatives The Kitikmeot Economic Development Commission, the Kitikmeot Inuit Association, Miramar Hope Bay Ltd., Nunavut Arctic College, and the Department of Education, Government of Nunavut have hereunto provided their endorsement.

Formal notices pursuant to this agreement should be directed to:

Irene Tanuyak,
Assistant Deputy Minister
Department of Education
Government of Nunavut
P.O. Bo x 1000
Iqaluit, Nunavut
X0A 0H0

Tel: (867) 975-5629
Fax: (867) 975-5635

Mr. Fred Elias
Kitikmeot Inuit Association
P.O. Box 18
Cambridge Bay, NU
XOC

Tel: (867) 983-2458
Fax: (867) 983-2701

Mr. Gabriel Nirlungayuk
Director
Kitikmeot Economic Development Commission
P.O. Box 18
Cambridge Bay, NU
XOC

Tel: (867) 983-2095
Fax: (867) 983-2075

Ms Heather Duggan
Miramar Hope Bay Ltd.
#300-889 Harbourside Drive,
North Vancouver, B.C. V7P 3S1

Tel: (604) 985-2572
Fax: (604) 980-0731

Ms Fiona Buchan Corey
Campus Director
Kitikmeot Campus
Nunavut Arctic College
P.O. Box
Cambridge Bay, NU
XOC
Tel: (867) 983-4108
Fax: (867) 983-4106

As witness to the subscription to the terms of this agreement, the parties hereby provide their endorsement as of November 22, 2007.

witness	Fred Elias, Executive Director Kitikmeot Inuit Association
witness	Gabriel Nirlungayuk, Director Kitikmeot Economic Development Commission
witness	Tony Walsh, President Miramar Hope Bay Ltd.
witness	Kathy Okpik, Deputy Minister Department of Education
witness	Dan Vandermeulen, President Nunavut Arctic College

GN-6

Appendix GN-6-1 Nunavut Housing Needs Survey Fact Sheet – Cambridge Bay

Nunavut Housing Needs Survey
Fact Sheet – Cambridge Bay

Background:

The Nunavut Housing Needs Survey (NHNS) is a survey of households in 25 communities in Nunavut, conducted from November 2009 to June 2010. The primary objective of the survey was to collect data on the housing needs of Nunavummiut so as to assist the Government of Nunavut in planning and providing housing. The overall response rate was 44% for Cambridge Bay.

This fact sheet presents some of the survey results for Cambridge Bay. Similar fact sheets are available for the territory as a whole and for each region and each community. All numbers in this fact sheet have been rounded. Percentages were calculated from unrounded numbers and the denominator excludes the non-response categories "refusal", "don't know", and "not stated".

More survey information and results are available on the Nunavut Bureau of Statistics' website which may be accessed at http://www.eia.gov.nu.ca/stats/housing.html or you may wish to contact one of our Information Officers at 867-473-2656 or 867-473-2660. Collect calls are accepted.

Survey highlights for Cambridge Bay:

Housing stock and housing tenure in Cambridge Bay:

A) Cambridge Bay had a total of 540 dwellings, of which 480 were occupied by their usual residents. The remaining 60 dwellings were unoccupied or occupied temporarily by persons who considered their usual home elsewhere.

B) The most common types of dwellings were single detached houses (54%) and row houses with 3 or more units side-by-side (36%).

C) Of the 480 dwellings occupied by usual residents, about 7 dwellings out of 10 were rented while 3 out of 10 were owned.

D) About half of the housing occupied by residents of Cambridge Bay was classified as public housing. The second most common type of housing was owner-occupied dwellings, representing about 3 dwellings out of 10. The remaining occupied dwellings were staff housing and other types of rented housing.

Nunavut Housing Needs Survey
Fact Sheet – Cambridge Bay

State of housing for dwellings occupied by usual residents in Cambridge Bay:

E) Of the 480 households, which is the equivalent of all dwellings occupied by usual residents, about 7 out of 10 were satisfied with the condition of their dwelling.

F) About 31% of occupied dwellings (140) required major repairs for items such as defective plumbing or defective electrical wiring, a leaking oil or sewage tank, or a broken hot water boiler. The need for major repairs is based solely on the opinion of the respondent.

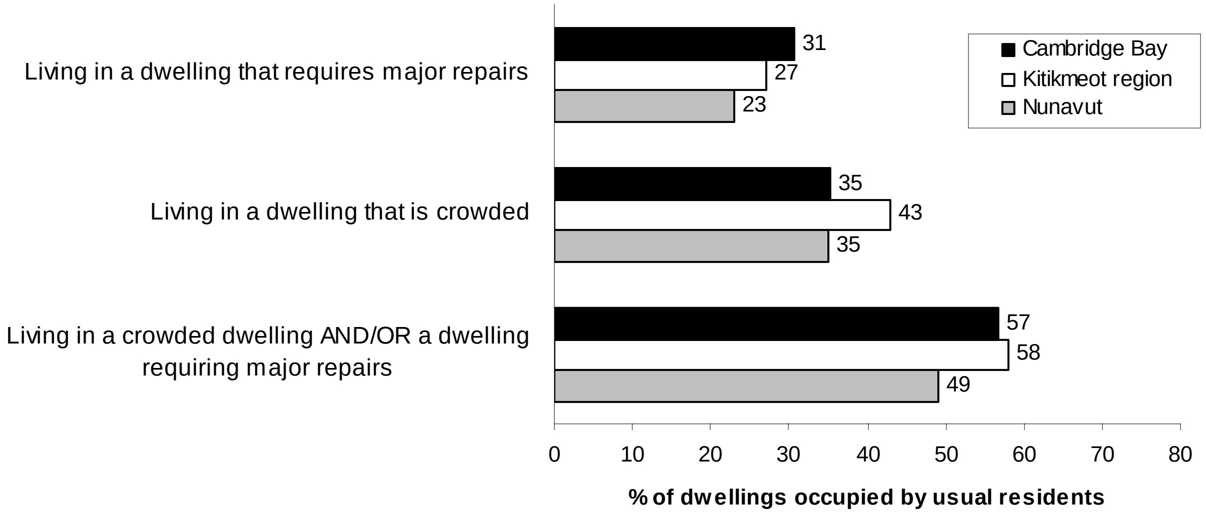
G) Approximately 35% of occupied dwellings (170) were classified as crowded, based on the lack of enough bedrooms. The majority of those dwellings, about 130 out of 170, were classified as crowded because they required one additional bedroom.

H) In about half of the crowded dwellings, respondents indicated that they regularly used the living room for sleeping because there was no other place to sleep.

I) In Cambridge Bay, 57% of the occupied dwellings (260) were below housing standards, meaning they were either crowded or in need of major repairs or a combination of both. Housing affordability was not measured in the survey.

J) Public housing had the highest proportion of dwellings below housing standards (75%) compared with other types of housing such as owner-occupied dwellings, staff housing or other rental housing.

Chart 1. Summary of the state of housing for dwellings occupied by usual residents, Cambridge Bay, Kitikmeot region and Nunavut, 2009-2010



Note: The need for major repairs is based on the opinion of the respondent. A dwelling is classified as crowded if there is a lack of a sufficient number of bedrooms.

Cambridge Bay housing needs for dwellings below housing standards:

K) For each person in a household, the survey asked if they would move out if additional housing were available in their community.

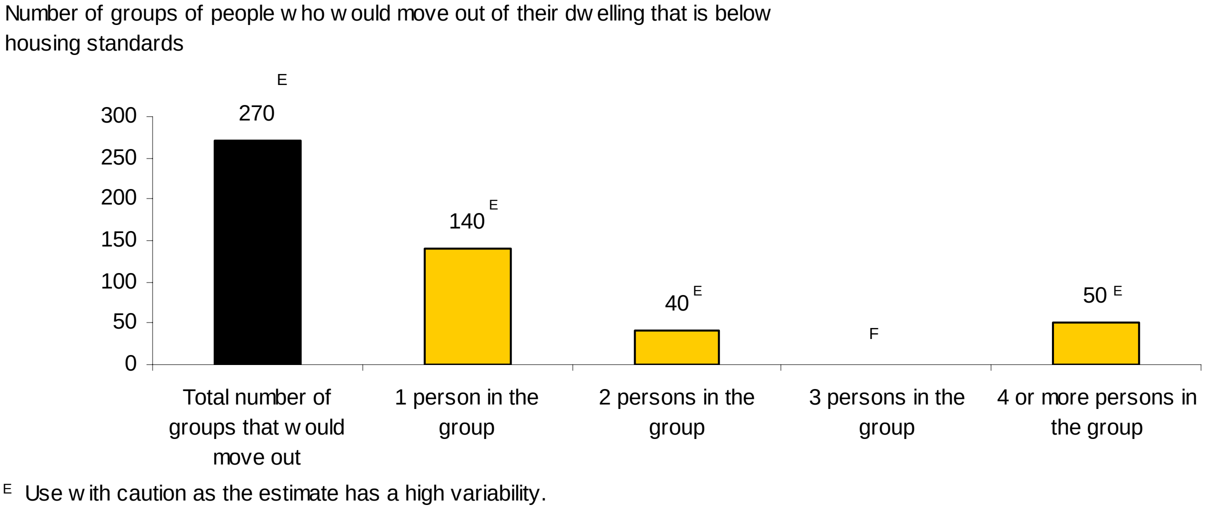
L) In the majority of the occupied dwellings below housing standards, about 180 out of 260, in Cambridge Bay, at least one person or a group of household members would move out if more housing were available.

M) Out of the 1,200 or so persons living in a dwelling below housing standards, about 580 of them or nearly half responded that they would move out if more housing units were available in their community.

N) Of the 580 people who would move out, some of them would move out on their own and others would move out with people living in the same dwelling or elsewhere. This represents a total of about 270 groups of people that would move out of their current housing if additional housing were available.

O) This number of groups (approximately 270) represents the number of dwellings that would be required to house the groups moving out of dwellings below housing standards. About 54% of these groups wishing to move would be people moving out alone while approximately 46% would be a group of two or more persons moving out together.

Chart 2. Number of dwellings required to house groups moving from dwellings that are below housing standards by group size, Cambridge Bay, 2009-2010



E Use with caution as the estimate has a high variability.

F Too unreliable to be published.

Nunavut Housing Needs Survey
Fact Sheet – Cambridge Bay

People in immediate need of housing in Cambridge Bay:

P) The number of people in Cambridge Bay who did not have a usual home at the time of the survey and were living temporarily in another person's dwelling is too unreliable to be published.

Q) About 1 occupied dwelling out of 3 housed temporary residents without a usual home elsewhere in the 12 months prior to the time of the survey.

People on the waiting list for public housing in Cambridge Bay:

R) About 150 or so residents of Cambridge Bay aged 15 years and over reported that they were on the waiting list for public housing. This represents about 1 person out of 10 for those aged 15 and over.

S) The number of people aged 15 years and over in Cambridge Bay by the length of time on the public housing waiting list is too unreliable to be published.

Please note that the data for Chart 3 is too unreliable to be published.

Telephone and Internet access in Cambridge Bay:

T) About 300 households or nearly 2 out of 3 in Cambridge Bay had access to the Internet from within their dwelling.

U) The majority of households, or 87%, had a telephone. Most of these households had a regular land line telephone.

GN-11

Appendix GN-11-1 Potential Dustfall Associated with Subaerial Tailings Deposition at TMAC Doris North Project, Nunavut Memorandum

Memorandum

Refer to File: A.1_Doris TIA Dust Emissions Memo.docx

Date: January 18, 2016

To: Sharleen Hamm (TMAC) and John Roberts (TMAC)

From: Elizabeth Sherlock (ERM) and Derek Chubb (ERM)

Cc: Tara Weerasuriya (ERM) and Mark Garrison (ERM)

Subject: **Potential Dust Fall Associated with Subaerial Tailings Deposition at TMAC Doris North Project, Nunavut**

ERM Consultants Canada Ltd. (ERM) was engaged by TMAC Resources Inc. (TMAC) to determine potential dust fall and distribution as a result of changing tailings deposition from subaqueous to subaerial at the Hope Bay Belt Doris North Project (the Project). This work is in support of the amendment application (the Amendment Application) for the Project Certificate and the Type A Water Licence, technical comments; specifically Government of Nunavut Technical Comments GN-11 and GN-12. The Reviewer's Recommendation/Request(s) as submitted to NIRB (January 2016):

> *The Proponent should revise the effects assessment to consider a range of dust control and dust effects scenarios relating to wildlife and wildlife habitat.*

Supplemental modelling to further quantify the potential dust fall and distribution as a result of the subaerial tailings deposition was completed (Appendix A). Based on conservative assumptions for maximum TIA dust emissions without the application of mitigation, the AERMOD modelling predicts, the maximum monthly distribution of dust deposition is greater than deposition guidelines within a localized spatial area with in the watershed area of the TIA. The dust deposition concentration falls below objectives at distances greater than approximately 250 metres of the surface of the tailings. With the implementation of mitigation measures, it is anticipated that the spatial area affected by dust deposition will further reduce. This supports the assessment presented in the Amendment Application (document P4-1, section 2.4.2) that with implementation of mitigation measures to reduce dust deposition no significant residual effects are anticipated to the terrestrial environment.

TMAC acknowledges predictive modelling can simplify complex natural systems and is committed to monitoring dust fall through ongoing implementation of the Air Quality Management Plan (AQMP; TMAC 2015) to ensure monitoring objectives are being met and, when exceedances are noted, adaptive management actions are implemented to reduce the dust source. To monitor and assess the environmental effects from dust fall, TMAC will revise the Wildlife Monitoring and Mitigation Plan to address any potential attraction of wildlife to the TIA and, if needed, conduct a risk analysis to determine if the ingestion of tailings or surrounding vegetation could produce health effects for large mammals.

— APPENDIX A —

AERMOD Dustfall Modelling for the Doris North TIA

AERMOD DUSTFALL MODELLING FOR THE DORIS NORTH TIA

ERM Consultants Canada Ltd. (ERM) was engaged by TMAC Resources Inc. (TMAC) to determine potential dust fall and distribution as a result of changing tailings deposition from subaqueous to subaerial at the Hope Bay Belt Doris North Project (the Project). This work is in support of the amendment application for the Project Certificate (Nunavut Impact Review Board (NIRB) No. 003) and the Type A Water Licence (Nunavut Water Board (NWB) No. 2AM-DOH1323) (the Amendment Application).

1. INTRODUCTION

The Doris North Project includes the extraction of gold from ore through a processing method that will generate tailings (slurry of water and rock particles) that will be deposited in a single area, referred to as the Tailings Impoundment Area (TIA). Current authorizations allow the deposition of material to the TIA using subaqueous methods such that there is a water cover maintained throughout the year over the solid material stored. This water cover acts as a reclaim water source for reuse in the processing facility. In the Amendment Application, TMAC is requesting a change in the tailings deposition such that the solids portion of the tailings is collected in one area of the TIA via subaerial deposition wherein the deposited material would be exposed to the atmosphere. The reclaim water would accumulate in another area of the TIA separated from the solids by an interim dike. Exposure of tailings solids during and following deposition in the TIA to wind erosion may potentially generating emissions of Total Suspended Particulate (TSP) that leads to dust deposition or dust fall as a result of the rapid deposition of entrained particles, especially the coarser fractions.

Air quality is an important environmental factor in ensuring the conservation of local vegetation, wildlife, and human health values. The Doris North Final Environmental Impact Statement (FEIS) included an impact assessment of the valued component air quality and monitoring under the AQMP (TMAC 2015) is currently ongoing in fulfillment of commitments under NIRB Project Certificate 003.

Subaerial tailings deposition was not considered as part of the FEIS and so related effects were not previously assessed. To assess the potential impact of resultant dust deposition, a study was conducted, comprised of a TSP emission rate estimate from the TIA, and computer based predictive modelling aimed at characterizing the areas with highest dust deposition to be expected from the TIA, without the application of mitigation measures. This approach represents a conservative, but realistic, maximum estimate of the extent and rate of dust deposition.

The dust fall deposition has been assessed by comparing the results to appropriate federal and provincial objectives/standards. Canada's national, provincial, and territorial governments have established ambient air quality thresholds for dust deposition that are intended to ensure long-term protection of public health and the environment. As there are no standards set by Federal or Nunavut Territorial governments, the Alberta Guidelines for dust fall are used and incorporated into the current Doris North AQMP (TMAC 2015).

2. RELEVANT DEFINITIONS, LEGISLATION AND GUIDANCE

Since ambient air quality and tailings deposition are broad terms, it is important to define terminology used within this memo. Table 2-1 provides definition for these and other related terms.

Table 2-1. Air Quality, Dust Deposition, and Tailings Terminology

Term	Description
Ambient air quality	Ambient air quality refers to the quality of outdoor air in the surrounding environment. It is typically measured near ground level, away from direct sources of pollution.
Fugitive dust	Fugitive dust is particulate matter suspended in the air by wind action and human activities such as the mechanical disturbance of granular material exposed to the air. Common sources of fugitive dust include unpaved roads, aggregate storage piles and construction operations. Particles can be composed of a wide range of materials, including minerals (sand, rock dust), engine soot, organic materials or salt.
Total suspended particulates (TSP) matter	TSP are particles that have a diameter of 100 µm or less that can be suspended in the air. Sources of TSP include vehicle and engine exhaust and fugitive dust. Most particles with diameters between 2 and 100 µm are a result of fugitive dust.
Dust fall (Dust deposition)	Small, dry, solid particles projected into the air by natural forces, such as wind or by man-made processes, which are deposited on the ground. Dust particles are usually in the size range from about 1 to 100 µm in diameter. They settle rapidly under the influence of gravity and are deposited on the soil and vegetation. This settleable fraction of total particulate is also referred to as dust fall.
Dusting event	If the wind gust during any hour of the day exceeds the threshold wind velocity, thereby causing emissions of TSP, that day is considered to have a dusting event.
Active area	A spatial area that has the potential to generate TSP emissions. May also be referred to as the “exposed area”.
Inactive area	A spatial area that has no potential to generate TSP emissions
Active deposited tailings surface area	Refers to spatial area within the TIA that is currently being used for tailings deposition from perimeter spigots. May also be referred to as “active tailings deposition area” or “tailings beach”.
Previous Tailings	Refers to spatial areas within the TIA that has been used during operations for tailings deposition, however, it is outside the current area of tailings deposition. May also be referred to as “inactive tailings” deposition area.

Table 2-2 summarizes the guidelines for TSP used to evaluate the Doris North Project TIA predicted dust deposition.

Table 2-2. TSP and Dust Fall Guidelines

Pollutant	Averaging Time	Concentration in Air ($\mu g/m^3$) – Nunavut	Deposition on Ground Surface ($mg/dm^2/30$ day) – Alberta[a]
TSP	24-hour	120	-
	Annual	60[b]	-
Dust fall	30-day	-	53[c] and 158[d]

Notes: (-) dash indicates not applicable

a. Only criteria for pollutants and averaging periods absent in Canadian Ambient Air Quality Standards (CAAQS) or Nunavut standard are presented.

b. Geometric mean, the average of the logarithmic values of a data set converted back to a base 10 number, Environmental Guideline for Ambient Air Quality (Government of Nunavut 2011).

c. Residential and Recreational, Alberta Ambient Air Quality Guideline (AAAQG) (Government of Alberta 2013).

d. Commercial and Industrial, Alberta Ambient Air Quality Guideline (AAA) (Government of Alberta 2013).

3. EMISSIONS RATE ESTIMATION FOR TSP

To estimate the dust fall resulting from rapid settling of TSP emissions from the Doris North TIA on the local environment, ERM initially estimated the total TSP emission rate from the TIA and incorporated this rate into a computer based modelling program to understand the extent of deposition.

Observations of dust emissions generated by wind erosion have shown that emission rates tend to decay rapidly (half-life of a few minutes) during an erosion event with extreme winds (WRAP 2004). This is because aggregate material surfaces are characterized by finite availability of erodible material (mass/area) or erosion potential. Extreme winds (wind gusts) may quickly deplete a substantial portion of the erosion potential and any natural crusting of the surface that binds the erodible material, thereby further reducing the erosion potential. Conversely, emissions generated by wind erosion are dependent on the frequency of disturbance of the erodible surface because each time that a surface is disturbed, its erosion potential is restored. In the case of tailings deposition, the erosion potential is restored with the continued discharge of tailings to the beach area and the gradual drying out of the tailings as the tailings deposition area grows.

TSP emissions resulting from wind erosion that may be generated from the tailings beach area are estimated using the US EPA AP42 Chapter 13.2.5 for Industrial Wind Erosion (the “AP42 method”; US EPA 2006), where the erosion potential function (P) for a dry, exposed surface is expressed as:

$$P = 58\ (u^* - u^*_t\ )^2 + 25\ ((u^* - u^*_t)$$

$$P = 0 \text{ for } u^* \leq u^*_t$$

where:

P = Erosion potential corresponding to the observed (or probable) fastest mile of wind for the i^{th} period between disturbances, g/m^2
u^* = friction velocity (m/s)
u^*_t = threshold friction velocity (m/s)

The resulting calculation is valid only for a time period as long, or longer, than the period between surface disturbances. Therefore for every disturbance (N) that occurs per year, an emission factor can be obtained through the summation of individual disturbances as follows:

$$\text{Emission factor} = k \sum_{i=1}^{N} P_i$$

where:

k = particle size multiplier
N = number of disturbances per year
Pi = erosion potential corresponding to the observed (or probable) fastest mile of wind for the ith period between disturbances, g/m^2.

A disturbance is defined as an action that results in the exposure of fresh surface material. On a storage pile or area, this would occur whenever aggregate material is either added to or removed from the existing surface. A disturbance of an exposed area may also result from the turning of surface material to a depth exceeding the size of the largest pieces of material present.

Threshold friction velocity (u^*_t) is the wind speed at which particles (up to 100 µm) would be transported and generate fugitive dust. Threshold friction velocities are not typically available for specific materials, and as such an estimate is generated using the published values presented in the AP42 method (US EPA 2006) summarized in Table 3-1. The threshold friction velocity ranges from 0.54 to 1.33 m/s for material representing variable particle size distributions. The material with particle size distribution in the AP42 method, similar to the Doris tailings include uncrusted coal pile, ground coal and fine coal dust on concrete pad, for which threshold friction velocities are known. The threshold friction velocity value of 0.73 m/s is based on the average of these three data values. This converts to a threshold wind velocity of 13.9 m/s at the reference anemometer height of 10 m.

Table 3-1. Threshold Friction Velocities (from the US EPA AP42 Method)

Material	Threshold Friction Velocity (m/s)	Threshold Wind Velocity at 10 m (m/s)
Overburden	1.02	19
Scoria (roadbed material)	1.33	25
Ground coal (surrounding coal pile)	0.55	10
Uncrusted coal pile	1.12	21
Scraper tracks on coal pile	0.62	12
Fine coal dust on concrete pad	0.54	10

Friction velocity (u*) and P (based on 'fastest mile') are calculated using measured wind speed data available from the Doris North meteorological station (Doris station). A minimum of three years is indicated by the US EPA AP42 method to capture the variability of weather in calculating emissions. For this study, available weather data from 2012, 2013 and 2014 have been used to estimate emissions. The predominant wind directions at the Doris station are along the west-northwest to east-southeast axis (ERM Rescan 2012-2014). Winds in the Doris North region typically blow from the west-northwest quadrant year round, although winds are also common from the east and southeast. For the dataset considered in this study, average annual wind speeds at Doris station are 5.5 m/s (19.7 km/h), and average speed of gusts recorded are 26.1 m/s (94 km/h).

The methodology for calculating TSP emissions and creating model input data is based on screening the hourly wind speed for meteorology data for 2012, 2013, 2014 to determine if a dusting event would have occurred during that event. The screening is carried out by comparing the wind gust (maximum wind speed recorded) for each hour and comparing to the threshold wind velocity of 13.9 m/s. This screening determines the number of days each month that exceed the threshold wind velocity and would have potential dusting events and is the basis of estimating total TSP emissions over the course of each day. The approach is to calculate the emissions over each day of the year that has a dusting event and sum these to estimate annual emissions. Table 3-2 summarizes the number of days that may have a dusting event; the analysis showed that there were 78 to 99 days per year (2012 to 2014) when the wind gusts exceeded the threshold wind velocity of 13.9 m/s and as such could result in dust emissions from the TIA. Most of the days with potential dust events occur during the winter months from September to April.

Table 3-2. Potential Number of Days with "Dusting Events"

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2012	10	10	12	4	2	4	3	5	11	4	9	4	**78**
2013	16	4	6	17	5	5	5	4	5	6	6	14	**93**
2014	13	13	15	7	6	1	5	3	10	6	11	9	**99**

Table 3-3 shows the distribution of the duration of these events over 2012; these events could be as short as 1-2 hours during the day subject to dusting or more than 18 hours. Similar tables are generated for 2013 and 2014.

Using the equations presented in this memo, the total emissions were calculated for each day of the year. Hourly wind speeds for each day are first screened to determine if the wind gust during any hour exceeds the threshold wind velocity. If no hours exceed the threshold wind velocity, no TSP emissions are calculated for the day. If any hour exceeds the threshold wind velocity, the wind erosion potential (P) is calculated based on the formula presented above, which is released instantaneously, when the wind gust occurs. The units of P are grams/square metre (g/m^2). However, modeling instantaneous emissions is not practical, hence the released TSP emissions are assumed to be released over an hourly period, which is the basic time step in the model.

The maximum value of P over all hours of the day is then transformed in two stages into the units that are required for model input. The first stage is to convert the resulting hourly emissions (g/m^2/hr) associated with the wind gust into model input units (g/m^2/second) by dividing the hourly emissions by 3600 (the number of seconds in an hour). The second stage is to distribute the maximum value of P over all hours in the day where the hourly wind gust exceeds the threshold wind velocity.

Table 3-3. Calculated Number of Days with Dusting Events in 2012

Month	Maximum Wind Speed (m/s)		Average Wind Speed (m/s)		Number of Days with a Dusting Event					
						Duration of Dusting Event (hours)				
	Hourly	Gust	Hourly	Gust	Total	1-2	3-6	7-12	13-18	18+
Jan	16.5	20.1	5.4	7.3	10	2	2	3	1	2
Feb	15.8	21.9	5.2	7.2	11	1	4	5	1	0
Mar	15.0	18.1	5.7	7.6	11	4	2	4	1	0
Apr	17.3	22.4	5.0	6.6	4	0	2	1	1	0
May	12.4	16.1	4.4	5.9	3	1	0	2	0	0
Jun	12.0	16.1	4.7	6.6	3	1	2	0	0	0
Jul	11.8	16.3	4.7	6.8	3	2	1	0	0	0
Aug	11.7	16.3	4.9	6.9	5	2	0	3	0	0
Sep	17.4	22.8	6.0	8.3	11	4	4	1	2	0
Oct	14.5	21.0	4.6	6.5	4	2	2	0	0	0
Nov	15.0	19.6	5.9	8.1	9	3	3	1	1	1
Dec	13.9	15.9	4.3	5.8	4	2	0	2	0	0
Annual	**17.4**	**22.8**	**5.1**	**7.0**	**78**	**24**	**22**	**22**	**7**	**3**

A sample calculation to show this two-stage process is provided in Table 3-4. On January 2, 2012, there were six hours when the threshold wind velocity was exceeded. The value of P for each hour is calculated, and then divided by 3,600 to determine the unrefined emission rate in g/m²/s. The maximum value of 1.09E-03 g/m²/s for P is then distributed over the six hours (1.09E-03/6 = 1.94E-04). In this manner, an hourly emissions data set is constructed for each hour of each year that is used as input to the model (note that hours where the wind gust does not exceed the threshold wind velocity are assigned a TSP emission rate of zero).

Table 3-4. Example of Calculation to Derive the Maximum Emission Rate

Date	Hour	Maximum Gust (m/s)	Hourly Emissions (P value) (g/m²/hr)	Unrefined TSP (g/m²/s)	Refined TSP (g/m²/s)	# of Hours Above Threshold	Sample Calculation (g/m²/s)
2-Jan-12	1	1.411	0.00E+00	0.00E+00	0.00E+00		
	2	0.980	0.00E+00	0.00E+00	0.00E+00		
	18	13.750	0.00E+00	0.00E+00	0.00E+00		
	19	15.789	3.11E-00	7.97E-04	1.94E-04		
	20	16.328	4.20E-00	1.09E-03	1.94E-04	6	1.94E-04
	21	16.022	3.57E-00	9.22E-04	1.94E-04		
	22	16.169	3.87E-00	1.00E-03	1.94E-04		
	23	15.231	2.08E-00	5.18E-04	1.94E-04		
	24	15.956	3.44E-00	8.86E-04	1.94E-04		

A limitation of the AP 42 method is the consideration of how a surface disturbance occurs; in the present case, erosion potential is determined by a gradual drying process and not by the mechanical disturbance (e.g. driving over the material, using a bulldozer to move the material, etc.) anticipated in the AP42 methodology. The number of surface disturbances (N) of the TIA surface area presented in the Amendment Application (SRK 2015; document P6-13 of the Amendment Application) would be minimal, therefore N=0 and theoretically there would be no wind erosion. This is contrary to anticipated environmental conditions at the Project, where erosion can result due to the high energy of prevailing winds. Accordingly, the methodology presented above, calculating daily emissions based on the maximum gust and then distributing the emissions over hours with a wind gust greater than the threshold, is used to overcome some of the limitations of the AP42 methodology for application to this type of dust source in an area with cold temperatures and high prevailing winds.

The estimated emission rate ranges from 2.64 E-06 to 2.07 E-03 $g/m^2/s$ for the three years included in the calculations. Although based on an estimated friction velocity, these estimated rates provide a conservative estimate of TSP that may be eroded from the active and inactive tailings deposition areas without the implementation of mitigation measures. This total estimated TSP emission rate (in $g/m^2/s$) is used to determine the total TSP emissions (Section 4.0).

4. EMISSIONS ESTIMATION FOR TOTAL TSP FROM THE TIA

Based on the estimated emission rates ($g/m^2/s$), the total emissions from the TIA are calculated using the total active area exposed to potential wind erosion. A conservative assumption on the TIA total active area is based on the tailings deposition plan presented in document P6-13 of the Amendment Application. To be conservative, the maximum area available to erode and generate dust is based on Year 4 of operations as it includes year round tailings deposition as well as "previous tailings" surfaces. Figure 1 shows the cumulative extent of deposition at the end Year 4 (from P6-13 of the Amendment Application) with 'tailings deposition' shown in yellow (0.36 km^2 or 36 ha) and "previous tailings" in gray (0.06 km^2 or 6 ha). Table 4-1 provides the Total Cumulative Tailings Surface Area for each of the five operating years excerpted from Appendix C of P6-13 of the Amendment Application.

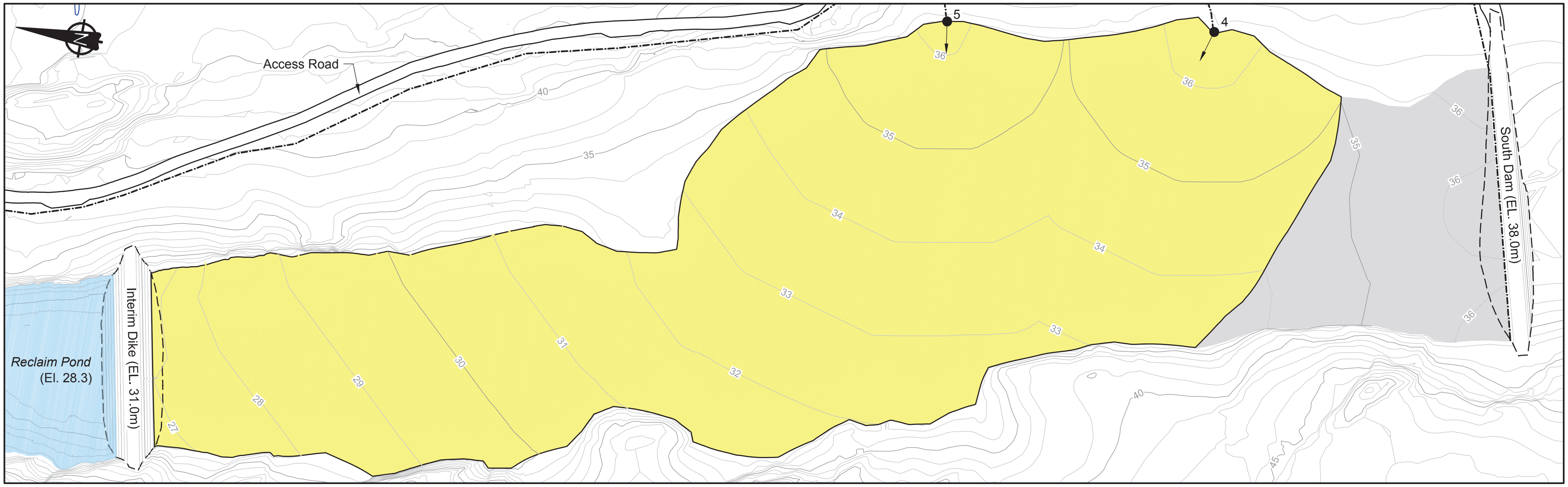
Table 4-1. Proposed Development of the Tailings Beach (SRK 2015; P6-13)

Period	Cumulative Tailings Discharge Volume (Mm^3)	Active Deposited Tailings Surface Area (ha)[1]	Previous Tailings Surface Area not Impacted by Active Deposition (ha)[2]	Total Tailings Surface Area (Cumulative - ha)
Year 1	0.34	17	0	17
Year 2	0.68	23	0	23
Year 3	1.35	34	0	34
Year 4	2.03	36	6	42
End of Mine (Year 4,Month 5)	2.32	30	14	44

Notes:
1. The deposited tailings surface area is the resultant surface area from active tailings deposition for the period indicated.
2. The previous tailings surface area is the exposed tailings surface that is not covered by active deposition (i.e. these areas could be progressively reclaimed).

Figure 1
Tailings Deposition Area (Year 4)

DRAFT



TAILINGS DEPOSITION - YEAR 4

Spigot Elev.: No. 4: 36.5m
No. 5: 36.25m
Deposited Tailings (Cumulative): 2.03Mm³
Duration: 1 Year
Production Rate: 1,546.8m³/day (2,000tpd)
Deposited Tailings Surface Area (cumulative): 0.36km²
Previous Tailings Surface Area: 0.06km²

LEGEND

◄—●	Deposition Location
—	Major Contour (5m)
—	Minor Contour (1m)
-·-·-	Approximate Tailings Line
🟨	Current Deposition
⬜	Previous Deposition
¦‗‗¦	Proposed Dam / Dike

NOTES

1. Deposition durations are approximate and were based on an average production rate of 1,000tpd for years 1 and 2 and 2,000tpd for years 3 and 4.
2. Assumed an average deposited tailings beach slope of 1.0%.
3. A deposited tailings dry density of 1.29 t/m³ was used (based on laboratory testing).
4. All tailings volumes presented include ice entrainment, which was assumed at 20% of production.
5. Dam and dike elevations shown were assumed constant for throughout deposition.
6. Total storage requirement is 2.32Mm³ (tailings 1.93Mm³ + ice entrainment 0.39Mm³).

Source: SRK Consulting (2015).

Although the tailings are exposed to wind, only a portion of the surface would be erodible and generate dust based on the wetness/moisture content. For calculating the total TSP to be generated by the TIA, it was assumed that 75% of the tailings surface area is exposed to wind erosion and that 25% of the tailings surface area is wet as a result of tailings being discharged from the spigots (see Figure 2). Those areas of the tailings beach further away from the spigot could become dry, and the finer particles would become available for transport through wind erosion. It is anticipated that over the course of the year with variable weather conditions in conjunction with variable tailings discharge the area available for drying and becoming a source for dust will change. It is unlikely that the 75% of the deposited tailings surface area would be available to dry and become a source for TSP, however, it does represent a conservative maximum area. For this study, the area available to generate TSP is assumed to be 33 ha (= 6 ha + 75% x 36 ha).

Based on the calculated emission rates presented in Section 3 of this memo and the associated area of the tailings available to generate TSP, Table 4-2 shows the range of total TSP emissions estimated to be generated for the modelling period (2012 to 2014) from wind gusts exceeding 13.9 m/s and without the application of mitigation measures.

Table 4-2. Total TSP Emissions Estimated from Doris North TIA Without Mitigation

Modelled Meteorological Period Year	Active Area[1] (ha)	Estimated Uncontrolled TSP Emissions for Year 4 (tonnes/per annum)
2012	33	129.1
2013	33	174.6
2014	33	153.7

Notes:
1. Active area, estimated based on Year 4 of operations comprising of 6 ha of "Previous Tailings" + 75% x 36 ha of "Tailings".

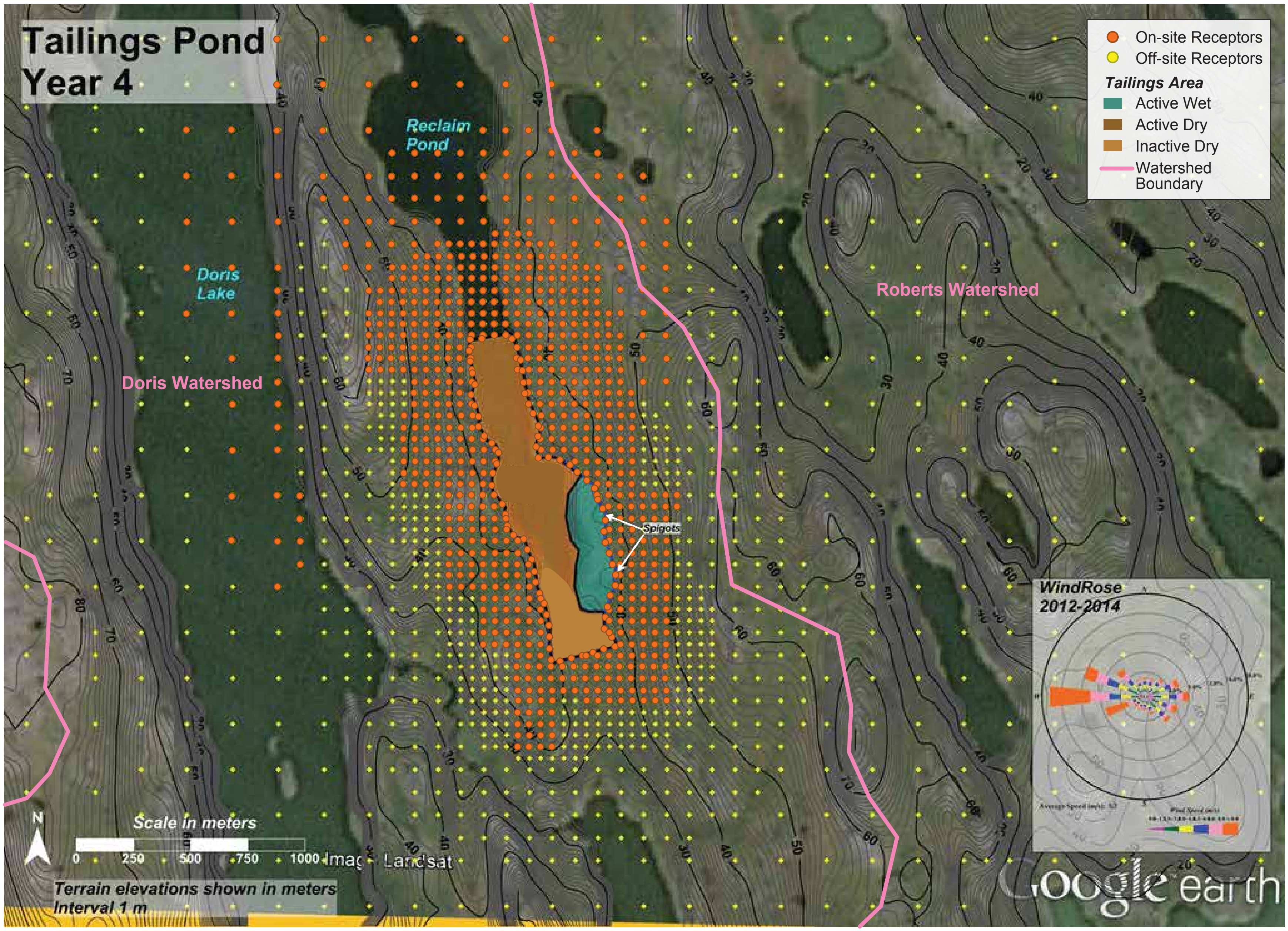
5. DEPOSITION RATE ESTIMATION FOR TSP

Once the TSP emission rate ($g/m^2/s$) is determined (Section 3), further calculations are conducted in the model to obtain the dry deposition flux (g/m^2), for a specified period. Two methods are available for use within the computer based model to estimate dry deposition. The method used is based on AP42 methodology and determined whether a significant fraction (greater than about 10%) of the total particulate mass has a diameter larger than 10 µm (method 1) or if the distribution is unknown (method 2).

To determine which method to use, tailings grain size and dry density are considered. Tailings grain sizing completed by Knights Piesold Ltd., (KP 2009) for the Doris tailings, indicates that 51.2% of the material is silt and the median grain size is 41.8 microns and the deposited tailings dry density is 1.29 g/cm^3 (document P6-13, Appendix C [SRK 2015]). This dry density value is applied to each fraction in the absence of density measurements specific to each fraction. Based on this information the model methodology to estimate deposition rate is selected; in this case, method 1 within the computer based model. The selected method is applied to each particle size category and the model calculates the resultant total TSP emissions on an hourly basis and provides a total sum for the user-specified period, in this case, 30 days. The default output unit for the dry deposition is g/m^2, for 30 days.

Figure 2

Receptor Grid and Terrain Surrounding the TIA



6. DISPERSION AND DUST FALL MODELLING

The AERMOD air dispersion modelling system (US EPA approved version 9.0 [US EPA 2014]) was chosen for the modelling study. The AERMOD atmospheric dispersion modeling system is a state of the science, steady-state dispersion model widely used as a regulatory model for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources. The AERMOD modelling system consists of two main model packages AERMET and AERMOD which serve as a meteorological model and an air quality dispersion model, respectively. AERMOD is capable of modeling the tailings beach emissions as a polygon to reflect the spatial distribution as accurately as possible. As the area of impact from the tailing beach area is not expected to extend more than a few kilometers, AERMOD was chosen as it is fully capable of handling the effects of wind erosion on dust settling and dispersion.

This computer based modelling calculates and contours the dust deposition for comparison to the guideline (mg/100cm^2/30 days) by calculating the total TSP emitted from the TIA and fractionating it into dust deposited on the ground (dust fall or deposition) and the residual airborne TSP concentration.

There is inherent uncertainty associated with the use of any model as real world processes, such as atmospheric conditions, are simplified. The approach in determining the model inputs is to assume 'worst case' conditions; however, these inputs also need to reflect realistic environmental and operational conditions. In general, air dispersion models accurately but conservatively predict atmospheric concentrations and deposition levels so that model results are often interpreted with the understanding that the predicted effects are likely overestimated.

The dispersion modelling completed includes the following key aspects:

- Selection of dispersion modelling receptors is based on Alberta Ministry of the Environment modelling guidance. One modelling domain was selected encompassing the area around the TIA with boundaries of approximately 20 km in all directions. The size of the modelling domain was established such that it was large enough to encompass the area within which TSP would approach background concentrations within the modelling domain. Receptors within the modelling domain are also categorized as being onsite/offsite to illustrate their location relative to the current Kitikmeot Inuit Association lease boundary (Figure 2);
- Gridded terrain data for the modeling domain, available in 1 degree digital elevation models (DEMS) files (~90 m resolution); detailed site elevations were incorporated into the modelling;
- Use of three years of meteorological data from the Doris North meteorological station site located approximately 2 km north of the TIA and upper air data from the Nunavut Cambridge Bay upper air station (NOAA and ESRL 2016);
- Preparation of meteorological data sets for input to AERMOD using the AERMET processor;
- Use of calculated hourly emission rate estimates to assess TSP deposition as outlined in this memo;

- Dry Deposition and Depletion options in AERMOD which directs AERMOD to estimate plume depletion due to dry removal mechanisms. To account for depletion, the deposition flux is multiplied by a source depletion factor, which represents the fraction of material that remains in the plume at the downwind distance x (i.e., the mass that has not yet been deposited on the surface). The source depletion factor is calculated as the ratio of the adjusted source strength at downwind distance, to the initial source strength;
- Modeling is conducted for each year (2012-2014) to account for year-to-year variations in the wind. Maximum predicted values were summarized to compare to standards and or guidelines, and predicted values at each receptor were used to create a TSP deposition contour map (Figure 3). The contour maps are useful to evaluate the spatial distribution of predicted dust fall in comparison to applicable guidelines.

7. RESULTS

Figure 3 presents the results of the highest month of unmitigated TSP deposition over the three years of meteorological data conditions modeled. The results show that deposition greater than the guideline of 53 mg/100 cm^2/30 days was limited in this 'worst case' month to within a maximum distance of 250 metres from the TIA. This demonstrates that under conservative assumptions, dust fall is expected to be localized to within the drainage basin of the TIA and will not extend to the area outside the TIA.

Based on the predicted TSP deposition rates from this study, mitigation measures required to meet current guidelines for dust deposition will be minimal, as deposition of dust is expected to be localized (within 250 metres of the tailings surface and within the TIA catchment). In addition, air quality monitoring will be conducted as per the AQMP (TMAC 2015) with dust suppression methods (as outlined in P6-13 of the amendment application) implemented as needed.

The Project and its proposed amendments have been designed to minimise, mitigate and/or manage potential adverse effects on the environment. As part of the requirements of the Project Certificate an AQMP (TMAC 2015; that includes dust fall as a parameter) has been implemented and updated as outlined within the Plan. The AQMP (TMAC 2015) is currently under revision and the findings of this study will inform any further additions needed within the Plan supporting an adaptive approach to air quality.

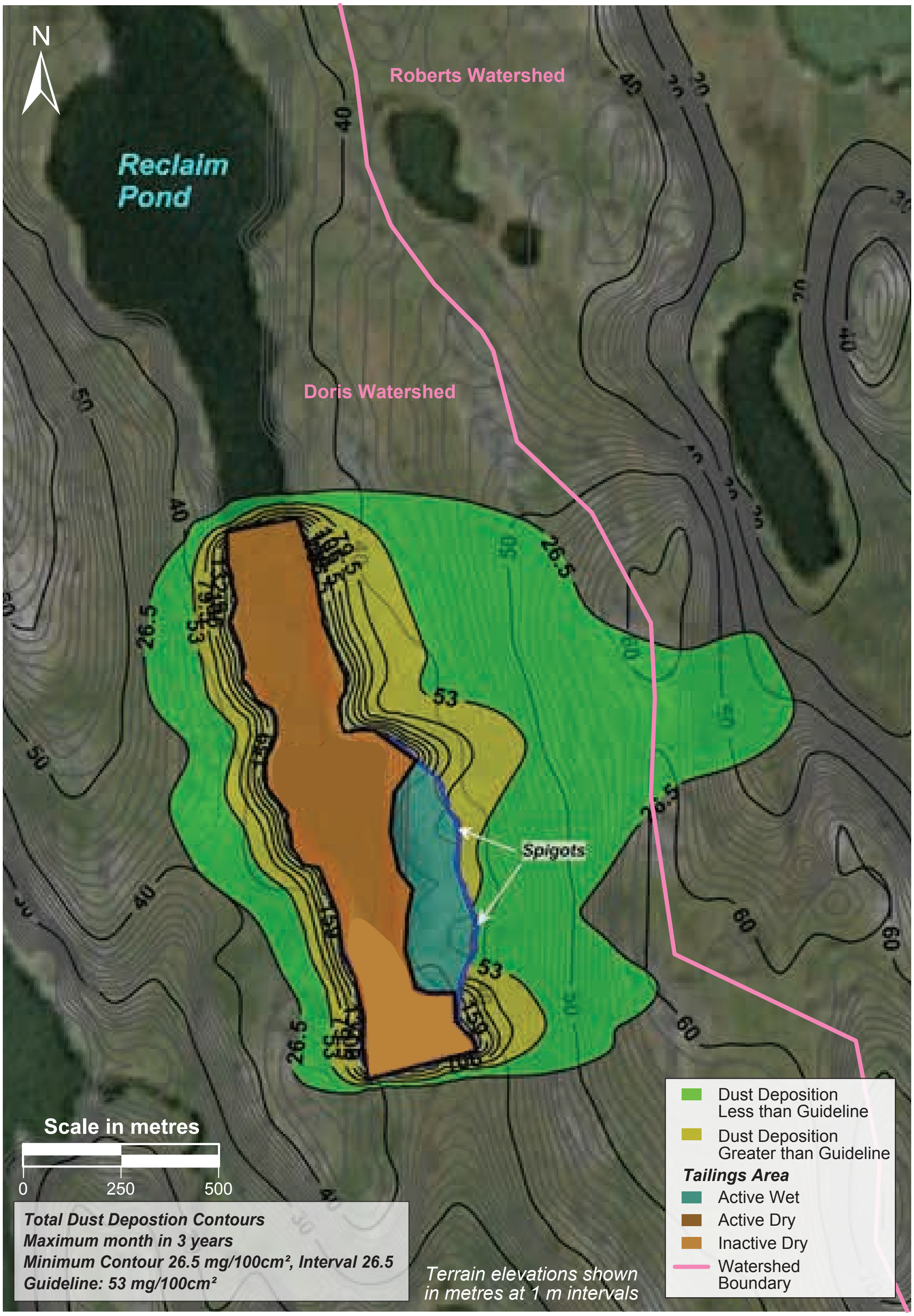
8. CONCLUSION

In conclusion, the change in tailings deposition from subaqueous to subaerial increases the potential for dust deposition in the area of the TIA. Emissions calculations and modeling of TSP potentially released from the Doris North TIA, based on the conservative assumptions and methodology outlined in this memo, indicate that the guidelines for dust fall within the current AQMP (TMAC 2015) are met except the localized area within the watershed basin of the TIA without the application of dust suppression methods.

Figure 3

Unmitigated Total Dust Deposition Contours

ERM



Total Dust Depostion Contours
Maximum month in 3 years
Minimum Contour 26.5 mg/100cm², Interval 26.5
Guideline: 53 mg/100cm²

Terrain elevations shown in metres at 1 m intervals

Source: Google earth.

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INAC-4

Appendix INAC-4-1 Validation of Groundwater Quality Predictions Memo

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Memo

To:	John Roberts, PEng	**Client:**	TMAC Resources Inc.
From:	Gregory Fagerlund	**Project No:**	1CT022.002
Reviewed By:	Maritz Rykaart, PhD, PEng	**Date:**	December 8, 2015
Subject:	Response to IR: AANDC NIRB #5 - Validation of Groundwater Quality Predictions		

1 AANDC-NIRB #5: Validation of Groundwater Quality Predictions

1.1 Concern

The groundwater model predicts an inflow rate of up to 2,650 m^3/day. The worst case predicted groundwater quality into the mine is 14,750 mg/L of chloride. These predictions of water quantity and quality are critical for water management planning. Literature is available for sub-permafrost chemistry and for other northern Canadian underground mines. The existing study does not compare literature values with the predicted water chemistry. This would aid in identifying what the water quantity and quality predictions for the Doris North project are in relation to previously observed water qualities in other northern mines.

1.2 Information Request

Provide a comparison with existing northern Canadian mines and academic studies to show that the predicted range for groundwater quantity and quality is reasonable. Show that the mine water management plan is capable of managing the “worst case” literature scenario.

1.3 Importance of Issue

Available information concerning groundwater quality of relevant, active, northern Canadian mines should be used to validate model predictions and evaluate the functionality of the mine site water management plan in preventing negative environmental effects to the receiving environment (Roberts Bay).

2 TMAC Response

2.1 Context

This memo documents a review of groundwater inflow and groundwater quality studies and predicted versus measured values for northern Canadian underground mines.

SRK researched groundwater inflow measurements reported by closed or operating mines located in continuous permafrost environments to benchmark the inflow predictions estimated for the Doris North Project. The available public data are limited. No information was found for closed mines such as Polaris, Nanisivik, and Rankin Inlet. SRK obtained useful public information on measured mine inflows as well as predicted inflow and Total Dissolved Solids (TDS) concentrations for three operating mines located in the Northwest Territories: Diavik, Ekati, and Snap Lake (Beale 2014, Golder 2014, Kuchling 2000, Itasca 2013). In addition to those three mines, additional TDS concentrations data were found in a publication by Frape and Fritz (1987) as well as other documentation for mining projects located in the Canadian North: Back River, Gahcho Kue, Courageous, Jay, Lupin, Meadowbank, and Meliadine (Cumberland 2005, Golder 2012, Golder 2013, Golder 2014, Rescan 2015).

2.2 Groundwater Inflows

2.2.1 Background

The Ekati and Diavik mines are operating open pit and underground diamond mines that started respectively in 1997 and 2001. The operating Snap Lake mine is an underground diamond mine that started in 2004. Background information related to the hydrogeological system for each of these mines is provided below.

2.2.2 Ekati Mine

Hydrogeologic conditions for the Ekati Mine, NT, are summarized as follows:

- Dewatering data exists for six mines at four sites: the Panda and the Koala open pits and underground mines, the Fox pit mine and the Misery pit mine.
- All of these mines are situated in open taliks with the respective lakes dewatered prior to mining. Permafrost is estimated to extend down to 320 to 485 mbgs.
- The competent granitic country rock at the Ekati Mine, which comprises a majority of the rock domain, is described as generally low hydraulic conductivity, between $1x10^{-9}$ and $1x10^{-7}$ m/s and decreasing with depth.
- The Ekati mines are characterized by Enhanced Permeability Zones (EPZs), which are zones of greater fracturing and good hydraulic connectivity, related to structures such as faults, found to be present at operating diamond mines in crystalline rock of the Canadian Shield. Hydraulic conductivity of the EPZs ranges between $1x10^{-6}$ and $1x10^{-5}$ m/s, across variable widths (transmissivity between about $8x10^{-5}$ and $1x10^{-3}$ m^2/s).

2.2.3 Diavik Mine

Hydrogeologic conditions for the Diavik Mine, NT, are summarized as follows:

- Combined dewatering data exists for the underground mine labelled A154/A418.
- The underground mines A154/A418 are located in an open talik associated with Lac de Gras. The lake was not dewatered prior to mining operations, but a portion of the lake is dyked off. Permafrost is estimated to extend down to 400 mbgs.
- The hydraulic conductivity of the competent bedrock ranges between $1x10^{-8}$ and $6x10^{-7}$ m/s and decreasing with depth.
- The Diavik project is also characterized by EPZs. Hydraulic conductivity of the EPZs ranges between $1x10^{-6}$ and $3x10^{-6}$ m/s. During mining, an EPZ was found to be the source of substantial groundwater inflow.

2.2.4 Snap Lake Mine

Hydrogeologic conditions for the Snap Lake Mine, NT, are summarized as follows:

- Inflows have been measured in the underground workings since 2004.
- The mine extends down under the permafrost and into the open talik associated with Snap Lake. The depth of the permafrost is between 140 and 180 mbgs away from the influence of the lake. Snap Lake was not dewatered prior to mining operations, but a portion of the lake is dyked off.
- The hydraulic properties of the competent country rock range between $1x10^{-9}$ and $4x10^{-7}$ m/s, which is relatively similar to the rock mass at the mine and generally decreasing with depth.
- The Snap Lake project is also characterized by multiple EPZs. Hydraulic conductivity of the EPZs ranges between $1x10^{-8}$ and $8x10^{-6}$ m/s.

2.2.5 Measured and Predicted Groundwater Inflows

At the Ekati project in 2012, an annual total average mine water inflow of approximately 1,200 m^3/day was reported to the Panda and Koala underground mines, and 1,000 m^3/day to the Fox pit. During mining of the Misery pit, minor groundwater inflows were reported; in 2010 pit inflow was observed to range between 200 and 300 m^3/day and was interpreted to originate primarily from the active zone. The measured inflows were within the bounds of the groundwater numerical model predictions completed in 2005 and 2006. The predictions ranged between 1,000 and 1,700 m^3/day for the Panda and Koala underground mines, and 400 and 4,300 m^3/day for the Fox pit mine.

At the Diavik project, a combined flow between 3,300 and 6,600 m^3/day was reported to the underground mine labelled A154/A418, in 2009 and 2010. Several groundwater models were completed and updated prior to and after mining operations started. Because the mine plans and objective of those models changed, it is difficult to compare the predictions with the mine inflow measured in 2009 and 2010. However, it is possible to state that the incorporation of the EPZ identified during mining and calibration with data collected during mining provided accurate predictions of groundwater inflows and quality.

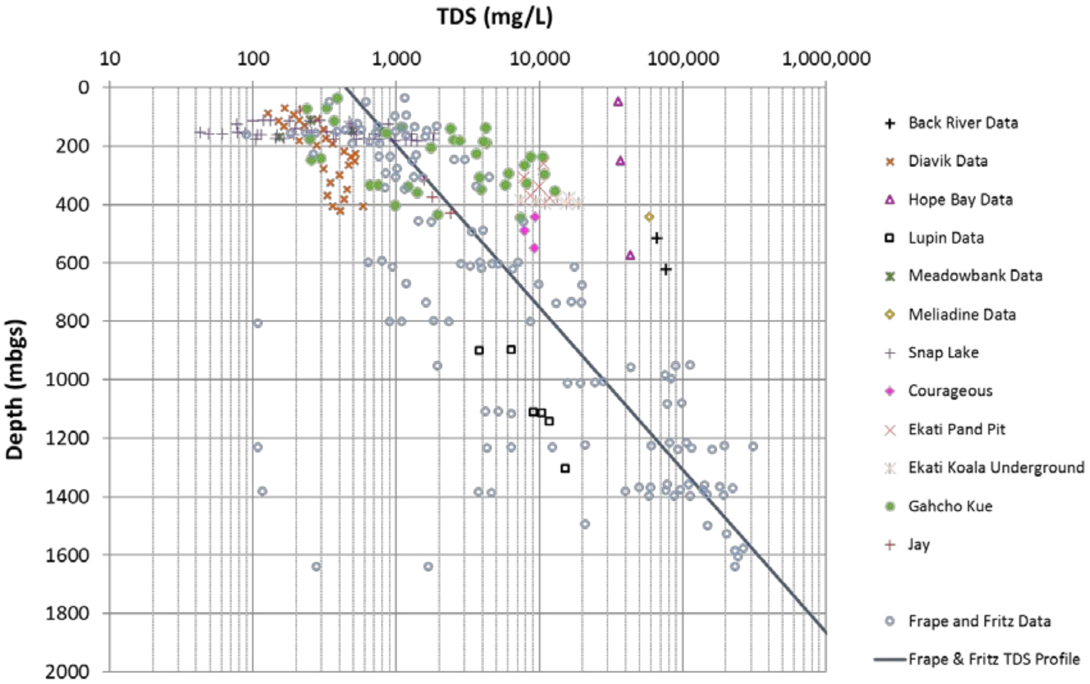
At the Snap Lake project, a measured inflow to the workings of approximately 50,000 m^3/day was reported in 2015. With the use of real underground flow measurements for calibration, the most recent numerical models, built after 2011, predicted the same magnitude of inflow as measured in year 2015, and future peak inflow of about 60,000 m^3/d for the year 2017. Earlier numerical model versions (2001, 2002) underestimated the inflows, with a predicted peak inflows between 24,000 and 34,000 m^3/day for the year 2018, about half of the flow observed in 2015. The major differences between the early and late inflow predictions at Snap Lake are linked to updated field data and modifications to the mine plan. New findings changed the permafrost depth assumption, the characterisation of hydrogeological units and their properties, the characterisation of structural features, and the calibration of leakage factors associated with underground tunnels.

2.3 Groundwater Quality

A dataset of groundwater TDS concentrations sampled across the Canadian Shield was compiled and plotted against depth in Figure 1. The dataset regroup TDS concentrations published by Frape & Fritz (1987) and public data reported at mine projects (Back River, Lupin, Meadow Bank, Meliadine Snap Lake, Courageous, Ekati, Gahcho Kue, and Jay).

The distribution of TDS concentrations with depth shows that brackish to hypersaline water is commonly observed in permafrost environments and salinity (TDS) generally increases with depth. Concentrations on the scale of tens of grams per litre have been measured at depths of 500 mbgs, beneath continuous permafrost. The occurrence of very old, brine water in a number of places on the Canadian Precambrian Shield suggests that these deep flow systems are very sluggish and slow moving under natural conditions (i.e. pre-mining) (Frape and Fritz, 1987).

Gascoyne (2003) reported several potential sources of salinity. The potential sources are (1) rock-water interactions, including reactions with rock matrix minerals and fracture-filling minerals, (2) soluble salts present at grain boundaries and in fluid inclusions, (3) residual saline hydrothermal fluids, and (4) marine fluids (possibly more saline than present) or basinal brines that entered the rock during ancient times, pre-glacial in origin (Gacoyne 2003). Furthermore, In situ cryogenic concentration due to ice and methane hydrate formation may have concentrated the remaining fluids, as noted for the Lupin Mine (Stotler 2009).



Source: TDS_Versus_Depth.xlsx

Figure 1: TDS versus Depth

2.4 Summary

The benchmarking results do demonstrate that predictions of groundwater inflow and groundwater quality for the Doris North Project are reasonable compared to predictions and observations at other mines in the Canadian North.

Between the Ekati, Diavik and Snap Lake mines, the Ekati mine has the most similarities with the Doris North Project. In terms of average hydraulic conductivity of the rock mass, the competent country rock at the Ekati mine is considered to be relatively similar to the Doris Project, even though the hydrostratigraphic units differ from the units found at the Project. In terms of mine inflow, both Ekati and Doris predict an average flow rate around 2,000 m^3/day.

At the Diavik and Snap Lake mines, unlike Ekati mine, average hydraulic conductivities are slightly more permeable and the predicted inflows are significantly higher. The higher magnitude of inflows, observed and predicted, at Snap Lake and Diavik are linked to the connection with the lakes at their surface via the EPZs; however, the significance of the EPZs were not fully understood until mining commenced. A similar scenario cannot be ruled out at Doris North. Close examination of water-producing intersections during drilling suggested structures are present with high permeability, but these are typically associated with more than one structure. The current dataset however does not show a clear increase in fracture frequency, major lithological change, or obvious structural features associated with high hydraulic conductivity therefore the inflow predictions accounted for a zone of high permeability between 100 and 500 m depth rather than a specific structural feature such as an EPZ. From a practical perspective, further data collection at Doris North may never be enough to reduce the uncertainty associated with EPZs; the only real proof of concept being actually intercepting the features as part of mining. Mining development will provide ample opportunity to learn and adjust as mining progresses, which is consistent with what has happened at the benchmarked sites.

In terms of salinity, TDS concentration measured at Doris North are higher than what has been reported elsewhere, with the exception of the Back River and Meliadine projects. What causes the Doris groundwater to be more saline has not been established. Nonetheless, compared to the general distribution of TDS elsewhere in the Canadian Shield, the measured salinity at the Doris North Project leads to conservative predictions of the groundwater quality discharging into the mine.

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