

TMAC Resources Inc.

HOPE BAY PROJECT

Proponent's Response to Technical Comments on the Madrid-Boston Final Environmental Impact Statement

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Prepared by:



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LIST OF ATTACHMENTS

Attachment 1. Memo Response to KIA-FEIS-02

1. ID #KIA-FEIS-01

1.1 SUBJECT/TOPIC

Dermal exposure to soil assumptions still contain wrong unit conversions in calculations, and hence model results are incorrect for the HHERA.

1.2 REFERENCES

FEIS, Volume 6, Section 5.3.3.3, Page 51-52.

TMAC states:

"The assumptions used in the calculation of the EDI of COPCs via dermal exposure to soil were as follows: ...

- Toddlers have a surface area of hands exposed for soil loading of 4.56 cm², a soil loading rate to exposed skin of hands of 1.00 x 10⁻⁷ kg/cm², a soil loading rate to exposed skin of body (other than hands) of 1.00 x 10⁻⁸ kg/cm², and a body weight of 15.3 kg as recommended by Health Canada (2010b) and Richardson and Stantec Consulting Ltd. (2013).*
- Adults have a surface area of hands exposed for soil loading of 9.53 cm², a soil loading rate to exposed skin of hands of 1.00 x 10⁻⁷ kg/cm², a soil loading rate to exposed skin of body (other than hands) of 1.00 x 10⁻⁸ kg/cm², and a body weight of 76.5 kg as recommended by Health Canada (2010b) and Richardson and Stantec Consulting Ltd. (2013).*
- The surface area of the body (other than hands) exposed for soil loading for toddlers was 28.0 cm² (calculated as [9.70 cm² + 18.3 cm²]) and for adults was 89.1 cm² (calculated as [27.0 cm² + 62.1 cm²]). The values for surface area of the arms and legs were as recommended in Richardson and Stantec Consulting Ltd. (2013)."*

Table 5.3-14. Estimated Daily Intake of Contaminants of Potential Concern via Dermal Exposure to Soil.

Table 5.4-11. Estimated Daily Intake of Contaminants of Potential Concern via Dermal Exposure to Soil.

1.3 SUMMARY

We have advised the proponent to make corrections to several incorrect dermal exposure factors in KIA-IR72; however, they have not corrected the incorrect units and values this in FEIS. As a result, the exposure calculations for soil are all incorrect and the human health risk assessment remains incorrect/uncertain. This issue was previously discussed in the same IR as another related issue, the incorrect values for soil ingestion, but has been separated for ease of review.

1.4 DISCUSSION

1.4.1 Importance of Issue to the Impact Assessment Process

The use of the incorrect values has made the soil exposure calculations and the estimated daily intake of metals incorrect. As a result, metals, which are over the human health threshold under existing conditions, may not have been identified. As these values are again used in the project case this could result in predicted exceedances of human health thresholds not being identified. The validity of the human health risk assessment is integral to the environmental assessment.

1.4.2 Detailed Review Comment

Gap/Issue

Various values in the exposure assessment (*i.e.*, surface area of hands for toddlers, surface area of hands for adults, soil ingestion rate for toddlers, soil ingestion rate for adults, and body weights) are incorrect and orders of magnitude lower than Health Canada's recommendations (Health Canada, 2010a). We have advised the proponent to update these values in KIA-IR72, and the response by TMAC was that these corrections would be done. However, despite this being a relatively easy fix, the proponent has not made these relatively straightforward corrections. Where the proponent has determined that they would rather use values from Richardson and Stantec (2013) instead of Canadian guidelines, they have still not converted those values correctly.

Disagreement with DEIS Conclusion

The following conversions, shown below, demonstrate the incorrect values used by TMAC in models within the FEIS. It seems that they have converted square metres to square cm as though they were simply converting metres to centimetres (without the consideration of the value being squared, and hence subject to a multiplication factor of 1000 rather than 100. We also show the correct values from Health Canada, and a secondary estimate from Richardson and Stantec (with the correct unit conversion).

Hands surface area:

In the FEIS and DEIS, TMAC used:

4.56 cm² for toddlers

9.53 cm² for adults

In Richardson and Stantec (2013) guide:

0.0456 m² (456 cm² for toddlers)

0.0953 m² (953 cm² for adults)

In Health Canada (2010a) guide:

430 cm² toddler

890 cm² adult

Other parts exposed (arms+ legs) surface area:

In FEIS and DEIS:

28.0 cm² toddler

89.1 cm² adult

In Richardson and Stantec (2013) guide:

0.0970 + 0.1830 m² (970 + 1830 = 2800 cm²) toddler

0.2701 + 0.6210 m² (2701 + 6210 = 8911 cm²) adult

In Health Canada (2010a) guide:

890 + 1,690 = 2580 cm² toddler

2,500 + 5,720 = 8220 cm² adult

Reasons for Disagreement with Conclusion

As explained above, the values used in the FEIS remain highly incorrect. This has resulted in these errors being propagated throughout the soil exposure calculations. The result of this mistake, which has not been corrected following technical comments made for the DEIS, is that estimated exposure surface areas are a hundred times less than what they should be. As a result, metals, which are over the human health threshold under existing conditions, may not have been identified. The proponent needs to present a viable existing conditions model for human health. Further, these values are again used in the project case to predict the chemical exposure if the project is built. This could result in exceedances of human health thresholds not being determined. The proponent is required to present human health risk.

1.5 RECOMMENDATION/REQUEST

- Please correct all values associated with dermal exposure to soils shown above to either the Richardson and Stantec guidelines or Health Canada guidelines.
- Please recalculate estimated daily exposure for each metal in the existing and project cases, and reassess the human health risk as needed.
- Please update the human health risk assessment and discuss any changes, if additional risks to human health are identified.

1.6 TMAC RESPONSE FOR KIA-FEIS-01

Comments KIA-FEIS-01 and KIA-FEIS-04 both request revisions to the human health exposure assessment components of the FEIS HHERA; therefore, responses to these comments are provided together.

To address concerns raised in KIA-FEIS-01 regarding the dermal route of exposure to soil (and the units used for dermal surface areas), the first part of this response provides adjusted estimated daily intake (EDI) values using the dermal surface areas reported in Richardson and Stantec (2013).

To address concerns raised in KIA-FEIS-04 regarding the selection of soil ingestion rates in the human health exposure assessment, the second part of this response provides adjusted EDI values using the soil ingestion rates recommended by Health Canada (2010).

The third part of this response provides a comparison of the HQs (HQs) presented in the FEIS to those resulting from the incorporation of the adjusted EDIs described above.

Please note that changes to EDIs do not affect the selection of contaminants of potential concern (COPCs), as COPCs are identified in the problem formulation step of the risk assessment. Thus, only EDIs for the COPCs originally identified in the FEIS risk assessment are included herein.

Adjusted EDIs for the Dermal Route of Exposure to Soil

The adjusted EDI values for the dermal route of exposure to soil were calculated for the existing conditions and Project-related human health exposure assessments using the exposure characteristics summarized in Table 1-1. These exposure characteristics include the hand surface areas of 456 cm² (toddlers) and 953 cm² (adults) reported by Richardson and Stantec (2013). The resulting existing conditions and Project-related EDIs from incorporating the Richardson and Stantec (2013) values for surface area are presented in Tables 1-2 and 1-3, respectively.

Table 1-1. Adjusted Exposure Characteristics for Dermal Route of Exposure to Soil

Exposure Characteristics	Land User Toddler	Land User Adult	Off-duty Worker
Days/7 Days	7	7	7
Weeks/52 Weeks	12	12	26
Surface area of hands exposed for soil loading (cm ²)*	456	953	953
Surface area of arms and legs (not hands) exposed for soil loading (cm ²)*	2800	8911	8911
Soil loading rate to exposed skin of hands (kg/cm ² -event)	1.00E-07	1.00E-07	1.00E-07
Soil loading rate to exposed skin of arms + legs (kg/cm ² -event)	1.00E-08	1.00E-08	1.00E-08
Body Weight (kg)	15.3	76.5	76.5

Note:

* Adjusted values for dermal surface areas were obtained from Richardson and Stantec (2013)

Table 1-2. Adjusted Existing Conditions EDIs for the Dermal Route of Exposure to Soil

COPC	Estimated Daily Intake (mg/kg BW/day)		
	Land User Toddler	Land User Adult	Off-duty Worker
Aluminum	2.37E-02	1.19E-02	2.57E-02
Arsenic	1.26E-07	6.30E-08	1.37E-07
Cadmium	2.78E-09	1.39E-09	3.01E-09
Chromium	7.28E-06	3.65E-06	7.91E-06
Cobalt	1.60E-05	8.02E-06	1.74E-05
Copper	2.55E-06	1.28E-06	2.77E-06
Lead	1.67E-05	8.34E-06	1.81E-05
Magnesium	1.44E-02	7.24E-03	1.57E-02
Mercury	5.62E-08	2.81E-08	6.10E-08
Nickel	3.51E-06	1.76E-06	3.81E-06
Selenium	2.78E-09	1.39E-09	3.01E-09
Thallium	5.55E-07	2.78E-07	6.03E-07
Zinc	6.56E-06	3.29E-06	7.13E-06

Notes:

COPC = contaminant of potential concern

BW = body weight

Table 1-3. Adjusted Project-Related EDIs for the Dermal Route of Exposure to Soil

COPC	Construction Phase Estimated Daily Intake (mg/kg BW/day)			Operational Phase Estimated Daily Intake (mg/kg BW/day)		
	Land User Toddler	Land User Adult	Off-duty Worker	Land User Toddler	Land User Adult	Off-duty Worker
Aluminum	2.36E-02	1.18E-02	2.57E-02	2.36E-02	1.18E-02	2.57E-02
Arsenic	1.23E-07	6.17E-08	1.34E-07	1.23E-07	6.17E-08	1.34E-07
Cadmium	2.78E-09	1.39E-09	3.01E-09	2.78E-09	1.39E-09	3.02E-09
Chromium	7.29E-06	3.65E-06	7.91E-06	7.29E-06	3.65E-06	7.92E-06
Cobalt	1.59E-05	7.98E-06	1.73E-05	1.59E-05	7.99E-06	1.73E-05
Copper	2.53E-06	1.27E-06	2.74E-06	2.53E-06	1.27E-06	2.75E-06
Lead	1.67E-05	8.34E-06	1.81E-05	1.67E-05	8.34E-06	1.81E-05
Magnesium	1.44E-02	7.21E-03	1.56E-02	1.44E-02	7.22E-03	1.56E-02
Mercury	5.53E-08	2.77E-08	6.00E-08	5.53E-08	2.77E-08	6.00E-08
Nickel	3.51E-06	1.76E-06	3.81E-06	3.51E-06	1.76E-06	3.81E-06
Selenium	2.78E-09	1.39E-09	3.02E-09	2.78E-09	1.40E-09	3.02E-09
Thallium	5.55E-07	2.78E-07	6.03E-07	5.55E-07	2.78E-07	6.03E-07
Zinc	6.57E-06	3.29E-06	7.13E-06	6.57E-06	3.29E-06	7.13E-06

Notes:

COPC = contaminant of potential concern

BW = body weight

Adjusted EDIs for the Ingestion of Soil

The adjusted EDI values for the incidental ingestion of soil were calculated for the existing conditions and Project-related human health exposure assessments using the exposure characteristics summarized in Table 1-4. These exposure characteristics include the Health Canada (2010) soil ingestion rates of 80 mg/day (0.00008 kg/day) for toddlers and 20 mg/day (0.00002 kg/day) for adults. The resulting existing conditions and Project-related EDIs from incorporating the Health Canada (2010) soil ingestion rates are presented in Tables 1-5 and 1-6, respectively.

Table 1-4. Adjusted Exposure Characteristics for the Ingestion of Soil

Exposure Characteristics	Land User Toddler	Land User Adult	Off-duty Worker
Hours/24 Hours	24	24	12
Days/7 Days	7	7	7

Weeks/52 Weeks	12	12	26
Soil Ingestion Rate (kg/day)*	0.00008	0.00002	0.00002
Relative Absorption Factor (unitless)	1	1	1
Body Weight (kg)	15.3	76.5	76.5

Note:

* Adjusted values for soil ingestion rates were obtained from Health Canada (2010)

Table 1-5. Adjusted Existing Conditions EDIs for the Ingestion of Soil

COPC	Estimated Daily Intake (mg/kg BW/day)		
	Land User Toddler	Land User Adult	Off-duty Worker
Aluminum	2.57E-02	1.29E-03	1.39E-03
Arsenic	4.56E-06	2.28E-07	2.47E-07
Cadmium	3.02E-07	1.51E-08	1.63E-08
Chromium	7.92E-05	3.96E-06	4.29E-06
Cobalt	1.74E-05	8.70E-07	9.42E-07
Copper	4.62E-05	2.31E-06	2.50E-06
Lead	1.81E-05	9.05E-07	9.80E-07
Magnesium	1.57E-02	7.85E-04	8.50E-04
Mercury	6.10E-08	3.05E-09	3.31E-09
Nickel	4.19E-05	2.09E-06	2.27E-06
Selenium	3.02E-07	1.51E-08	1.63E-08
Thallium	6.03E-07	3.02E-08	3.27E-08
Zinc	7.13E-05	3.57E-06	3.86E-06

Notes:

COPC = contaminant of potential concern

BW = body weight

Table 1-6. Adjusted Project-Related EDIs for the Ingestion of Soil

COPC	Construction Phase Estimated Daily Intake (mg/kg BW/day)			Operational Phase Estimated Daily Intake (mg/kg BW/day)		
	Land User Toddler	Land User Adult	Off-duty Worker	Land User Toddler	Land User Adult	Off-duty Worker
Aluminum	2.57E-02	1.28E-03	1.39E-03	2.57E-02	1.28E-03	1.39E-03
Arsenic	4.46E-06	2.23E-07	2.42E-07	4.46E-06	2.23E-07	2.42E-07
Cadmium	3.02E-07	1.51E-08	1.63E-08	3.02E-07	1.51E-08	1.64E-08
Chromium	7.92E-05	3.96E-06	4.29E-06	7.93E-05	3.96E-06	4.29E-06
Cobalt	1.73E-05	8.66E-07	9.38E-07	1.73E-05	8.66E-07	9.38E-07
Copper	4.58E-05	2.29E-06	2.48E-06	4.59E-05	2.29E-06	2.48E-06
Lead	1.81E-05	9.05E-07	9.80E-07	1.81E-05	9.05E-07	9.80E-07
Magnesium	1.56E-02	7.82E-04	8.48E-04	1.57E-02	7.83E-04	8.48E-04
Mercury	6.01E-08	3.00E-09	3.25E-09	6.01E-08	3.00E-09	3.25E-09
Nickel	4.19E-05	2.09E-06	2.27E-06	4.19E-05	2.09E-06	2.27E-06
Selenium	3.03E-07	1.51E-08	1.64E-08	3.03E-07	1.51E-08	1.64E-08
Thallium	6.03E-07	3.02E-08	3.27E-08	6.04E-07	3.02E-08	3.27E-08
Zinc	7.14E-05	3.57E-06	3.87E-06	7.14E-05	3.57E-06	3.87E-06

Notes:

COPC = contaminant of potential concern

BW = body weight

Comparison of FEIS to Adjusted Hazard Quotients

The adjusted HQs presented herein were calculated as per the approach described in the HHERA (Volume 6, Chapter 5 of the FEIS). Briefly, a hazard quotient is the sum of all exposure pathway EDIs divided by the TRV for a specific COPC. Note the 'dermal contact' and 'incidental soil ingestion' sets of EDIs are only two of several additional exposure pathways (e.g., inhalation, ingestion of country foods, and the ingestion of water). Thus, the adjusted HQs shown below incorporate the updated dermal contact and soil ingestion EDIs in addition to the original EDIs from the other exposure pathways.

Tables 1-7, 1-8, and 1-9 compare the adjusted HQs to the FEIS HQs for toddlers, adult land users, and off-duty workers, respectively. Note that aluminum was not screened in as a COPC during the problem formulation step of the Project-related HHERA and the HQs for aluminum are therefore excluded from the Construction and Operational Phases.

As shown in Tables 1-7, 1-8, and 1-9, the adjusted HQs are either equal to or greater than the FEIS values. However, the adjusted values increase proportionally across Existing Conditions and Construction/Operational Phases. Thus, the Project-induced incremental change in risk does not change from the FEIS when the dermal surface areas and soil ingestion rates are updated to the Richardson and Stantec (2013) and Health Canada (2010) values, respectively. Furthermore, no additional HQs above 0.2 are identified.

In summary, the adjusted exposure assessment and HQs presented herein do not have any material effect on the conclusions of the FEIS HHERA.

Table 1-7. FEIS vs. Adjusted Hazard Quotients For Toddler Land User

COPC	Existing Conditions Hazard Quotients		Relative Percent Difference	Construction Phase Hazard Quotients		Relative Percent Difference	Operations Phase Hazard Quotients		Relative Percent Difference
	FEIS	Adjusted		FEIS	Adjusted		FEIS	Adjusted	
Aluminum	1.1E-01	2.5E-01	79.6%	NA	NA	NA	NA	NA	NA
Arsenic	1.2E+00	1.2E+00	1.0%	1.2E+00	1.2E+00	1.0%	1.2E+00	1.2E+00	1.0%
Cadmium	7.9E-03	8.1E-03	2.9%	7.7E-03	7.9E-03	2.9%	7.9E-03	8.1E-03	2.9%
Chromium	4.3E+00	4.4E+00	1.5%	4.5E+00	4.6E+00	1.5%	4.5E+00	4.6E+00	1.5%
Copper	4.0E-02	4.0E-02	1.0%	4.0E-02	4.1E-02	1.0%	4.0E-02	4.1E-02	1.0%
Lead	1.5E-01	2.0E-01	29.3%	1.5E-01	2.0E-01	28.8%	1.5E-01	2.0E-01	28.9%
Manganese	8.7E-02	9.3E-02	6.0%	8.5E-02	9.0E-02	6.2%	8.5E-02	9.0E-02	6.2%
Mercury	2.3E-02	2.3E-02	1.5%	2.3E-02	2.3E-02	1.4%	2.3E-02	2.3E-02	1.4%
Methylmercury	2.9E+00	2.9E+00	0.0%	2.9E+00	2.9E+00	0.0%	3.2E+00	3.2E+00	0.0%
Nickel	2.3E-01	2.4E-01	1.3%	2.4E-01	2.4E-01	1.3%	2.4E-01	2.4E-01	1.3%
Selenium	2.0E-01	2.0E-01	0.0%	2.0E-01	2.0E-01	0.0%	2.0E-01	2.0E-01	0.0%
Thallium	2.3E-01	2.4E-01	6.1%	2.3E-01	2.4E-01	6.1%	2.3E-01	2.4E-01	6.0%
Zinc	3.4E-02	3.4E-02	0.4%	3.4E-02	3.4E-02	0.4%	3.4E-02	3.4E-02	0.4%

Note:

COPC = contaminant of potential concern

Table 1-8. FEIS vs. Adjusted Hazard Quotients For Adult Land Users

COPC	Existing Conditions Hazard Quotients		Relative Percent Difference	Construction Phase Hazard Quotients		Relative Percent Difference	Operations Phase Hazard Quotients		Relative Percent Difference
	FEIS	Adjusted		FEIS	Adjusted		FEIS	Adjusted	
Aluminum	3.5E-02	7.8E-02	75.8%	NA	NA	NA	NA	NA	NA
Arsenic	4.4E-01	4.4E-01	0.2%	4.4E-01	4.5E-01	0.2%	4.5E-01	4.5E-01	0.2%
Cadmium	3.0E-03	3.0E-03	0.5%	2.9E-03	2.9E-03	0.5%	3.0E-03	3.0E-03	0.5%
Chromium	1.7E+00	1.7E+00	0.4%	1.8E+00	1.8E+00	0.4%	1.8E+00	1.8E+00	0.4%
Copper	1.0E-02	1.0E-02	0.2%	1.0E-02	1.0E-02	0.2%	1.0E-02	1.0E-02	0.2%
Lead	2.5E-02	3.2E-02	24.9%	2.5E-02	3.2E-02	24.5%	2.5E-02	3.2E-02	24.5%

(continued)

Table 1-8. FEIS vs. Adjusted Hazard Quotients For Adult Land Users (completed)

COPC	Existing Conditions Hazard Quotients		Relative Percent Difference	Construction Phase Hazard Quotients		Relative Percent Difference	Operations Phase Hazard Quotients		Relative Percent Difference
	FEIS	Adjusted		FEIS	Adjusted		FEIS	Adjusted	
Manganese	2.8E-02	2.9E-02	5.0%	2.7E-02	2.8E-02	5.2%	2.7E-02	2.8E-02	5.2%
Mercury	9.1E-03	9.2E-03	1.1%	9.0E-03	9.1E-03	1.1%	9.0E-03	9.1E-03	1.1%
Methylmercury ¹	5.7E-01	5.7E-01	0.0%	5.8E-01	5.8E-01	0.0%	6.2E-01	6.2E-01	0.0%
Methylmercury ²	1.2E+00	1.2E+00	0.0%	1.2E+00	1.2E+00	0.0%	1.3E+00	1.3E+00	0.0%
Nickel	9.2E-02	9.2E-02	0.4%	9.3E-02	9.3E-02	0.4%	9.3E-02	9.4E-02	0.4%
Selenium	8.6E-02	8.6E-02	0.0%	8.6E-02	8.6E-02	0.0%	8.6E-02	8.6E-02	0.0%
Thallium	8.9E-02	9.4E-02	4.7%	8.9E-02	9.3E-02	4.8%	9.0E-02	9.4E-02	4.7%
Zinc	1.1E-02	1.1E-02	0.1%	1.1E-02	1.1E-02	0.1%	1.1E-02	1.1E-02	0.1%

Notes:

COPC = contaminant of potential concern

¹ Methylmercury hazard quotient for general adult population

² Methylmercury hazard quotient for sensitive populations

Table 1-9. FEIS vs. Adjusted Hazard Quotients For Off-Duty Workers

COPC	Existing Conditions Hazard Quotients		Relative Percent Difference	Construction Phase Hazard Quotients ³		Relative Percent Difference	Operational Phase Hazard Quotients ³		Relative Percent Difference
	FEIS	Adjusted		FEIS	Adjusted		FEIS	Adjusted	
Aluminum	3.6E-03	9.3E-02	184.9%	NA	NA	NA	NA	NA	NA
Arsenic	1.2E-02	1.3E-02	9.9%	1.1E-02	1.2E-02	10.0%	1.1E-02	1.3E-02	9.9%
Cadmium	7.9E-05	9.7E-05	20.5%	7.9E-05	9.7E-05	20.5%	7.9E-05	9.7E-05	20.5%
Chromium	6.7E-03	1.8E-02	93.9%	7.1E-03	1.9E-02	91.0%	7.2E-03	1.9E-02	90.1%
Copper	1.2E-04	1.6E-04	25.3%	1.2E-04	1.6E-04	25.2%	1.2E-04	1.6E-04	24.9%
Lead	6.8E-04	1.5E-02	182.7%	6.7E-04	1.5E-02	183.1%	6.7E-04	1.5E-02	183.0%
Manganese	1.7E-03	4.6E-03	94.8%	1.6E-03	4.6E-03	95.5%	1.6E-03	4.6E-03	95.0%
Mercury	1.2E-04	3.3E-04	94.6%	1.2E-04	3.2E-04	94.7%	1.2E-04	3.3E-04	93.7%
Methylmercury ¹	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylmercury ²	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	6.2E-04	1.2E-03	59.9%	6.3E-04	1.2E-03	59.4%	6.4E-04	1.2E-03	58.8%
Selenium	5.0E-04	5.0E-04	0.6%	5.0E-04	5.0E-04	0.6%	5.0E-04	5.1E-04	0.6%
Thallium	1.1E-03	1.0E-02	161.4%	1.1E-03	1.0E-02	161.4%	1.1E-03	1.0E-02	161.3%
Zinc	6.6E-05	8.5E-05	24.6%	6.5E-05	8.3E-05	25.1%	6.5E-05	8.4E-05	24.9%

Notes:

COPC = contaminant of potential concern

¹ Methylmercury hazard quotient for general adult population

² Methylmercury hazard quotient for sensitive populations

³ Only the Boston Operational Camp hazard quotients are shown as they are the greatest values across all 4 worker camps

References:

Health Canada. 2010. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. Version 2.0. Revised 2012. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Richardson, G. M. and Stantec Consulting Ltd. 2013. *Canadian Exposure Factors Handbook*. Toxicology Centre, University of Saskatchewan: Saskatoon, SK.

2. ID #KIA-FEIS-02

2.1 SUBJECT/TOPIC

Missing fish sampling data for Arctic Char, Whitefish and Lake Trout.

2.2 REFERENCES

FEIS, Volume 6, Section 5.3.3.6, Page 55.

TMAC states:

"Lake Trout were sampled in 2009 and 2010 and Arctic Char were sampled in 2017 for the Project.

In total, 38 Lake Trout and 17 Arctic Char collected from within the human health LSA ... had tissue metals analysed, and were included in the assessment."

FEIS, Volume 6, Section 5.3.3.6, Page 56, Table 5.3-16.

FEIS, Appendix V6-5C Concentrations of Contaminants of Potential Concern in Fish Tissue Samples

2.3 SUMMARY

This issue was first discussed in KIA-IR63 (Fish sampling methodology Arctic Char) and KIA-IR64 (Fish sampling methodology for Whitefish and Lake trout). KIA-DEIS-12 and KIA-DEIS-13 are also relevant to this issue. The response to our IRs clarified what the issue was, that data were omitted from the appendix V6-5, and TMAC agreed to correct the Appendix in the FEIS. However, TMAC has not followed through and missing data is still not provided.

2.4 DISCUSSION

2.4.1 Importance of Issue to the Impact Assessment Process

It is essential to provide the raw data for fish sampling, in order for it to be reviewed for completeness, and accuracy. This is a crucial part of the human health risk assessment as fish can have a significant effect on contaminant exposure. Baseline levels of COPCs in all fish samples must be presented.

2.4.2 Detailed Review Comment

Gap/Issue

As discussed in several related IRs and technical comments submitted for the DEIS, the FEIS is missing significant portions of data for fish sampling that was allegedly completed but has not been provided for review.

Disagreement with DEIS Conclusion

In the case of Arctic char, the original issue was that there were only 5 samples from a previous study, and only 3 of these were adults that would have used marine habitat (Arctic Char were used as a marine indicator species). In 2017, an additional 17 samples were taken to improve the baseline program in response to the KIA's concern about the very low sample size. However, in Appendix V6-5C, no Arctic Char data are provided for this current program. Instead, the previous dataset with the 5 samples (3 adults) was retained, even though this data has effectively been removed from the rest of the HHRA and is no longer discussed in the FEIS. Hence, Appendix V6-5C needs to be updated.

For Lake Trout, there was a discrepancy in the DEIS between whether there were 69 samples or 38. The FEIS continues to say 38 even though TMAC indicated in their response to our KIA- IR#64 that 69 was the correct number. They also stated that "2010 samples are missing from the Appendix V6-5C. We will update the appendix for FEIS." which they have not done. Instead, now there are only 25 Lake Trout samples shown in the Appendix.

Reasons for Disagreement with Conclusion

As described above, the FEIS is still missing substantial fish sampling data including all the raw data related to Arctic Char. TMAC has not revised the Appendix as they have committed to.

2.5 RECOMMENDATION/REQUEST

- Provide the dataset for 2010 freshwater fish sampling for Lake trout.
- Provide the dataset for 2017 fish sampling for Arctic char in the appendix.

2.6 TMAC RESPONSE FOR KIA-FEIS-02

Please see memorandum titled "TMAC Resources Inc. – Technical Comment KIA-FEIS-02 received from the Kitikmeot Inuit Association (KIA) regarding the Madrid-Boston Final Environmental Impact Statement", dated March 28, 2018.

3. ID #KIA-FEIS-03

3.1 SUBJECT/TOPIC

3.2 REFERENCES

FEIS, Volume 6, Section 5.3.2.2, Pages 5-30 and 5-31.

"To support food chain modeling for wildlife country food species, samples of lichen (Flavocetraria nivalis and F. cucullata) were also collected from 67 and 58 sites, respectively, within the human health LSA in 2010, 2011, and 2014, and analyzed for tissue metal concentrations."

"The lichen samples were pooled and included in the assessment as a diet item for country food species (i.e., caribou, Arctic ground squirrel, and willow ptarmigan)."

"An online search was conducted to determine if there was baseline vegetation data available nearby existing or proposed projects that could be included with the baseline vegetation data for the Project to increase the variety of vegetation species in the assessment. However, the nearby projects (e.g., Kiggavik, Gahcho Kué, Meliadine, Back River, Mary River, and Meadowbank) are located outside the Human Health RSA and likely are not representative of site-specific metal concentrations of the Madrid-Boston Project due to inherent differences in heavily mineralized areas."

FEIS, Volume 6, Section 5.3.6.3, Page 76.

"Although selected for their prevalence, the lichens and berries may not be representative of the actual foods consumed by the evaluated terrestrial mammals and birds. ...There can be a high degree of variation in metal concentrations between the plant species, likely due to species-specific physiological characteristics."

Appendix V6-5E, Table V6-5E4

Volume 6, Section 5.5.2.4, Ingestion of vegetation.

3.3 SUMMARY

This issue was first discussed in KIA-IR97 and reiterated in KIA-DEIS-22. The vegetation types used in the food chain model are not relevant to many of the wildlife consuming them. In the FEIS "vegetation", types have been limited to berries and lichen rather than utilizing new sampling data.

We had suggested during meetings associated with the DEIS that TMAC sample within the LSA/RSA to collect relevant data. TMAC suggested a middle ground, where the utilize data from nearby projects for the missing vegetation forage species. The KIA agreed to this, unsure that other sites would be relevant in terms of metal uptake. On further examination, TMAC determined that data collected from other sites was indeed not comparable to Hope Bay and missed an opportunity for additional sampling during the past field season. This produces an inaccurate model, which assumes ground squirrel, ptarmigan and other wildlife such as grizzly bears eat lichen. In many cases, forage species such as sedges (the most abundant vegetation in the area) may have higher levels of metals. This issue also results in no baseline data for before and after comparisons of mine effects on the dominant vegetation in the area.

3.3.1 Importance of Issue

Having representative data for baseline vegetation would be valuable as these data would substantially improve the food chain model and exposure models. The current data used as input to the model does not represent the correct vegetation types consumed by the species in the model. As a result, the outputs of the model become highly uncertain. Additional sampling would provide needed certainty in these modelled results, the resulting human exposure, the baseline HHRA and project case HHRA and ERA.

In addition, and of primary importance to the surface land owner, there are no existing data on the dominant vegetation types for a before-after comparison of the effects of the mine on this dominant and highly important vegetation type, which are consumed by wildlife that are eaten by Inuit. Vegetation sampling would also provide key before and after vegetation data that could help the KIA in post-development liability issues (particularly in the case of sedges, the most dominant vegetation covering the majority of the RSA, which has not been sampled for existing baseline metals).

3.3.2 Detailed Review Comment

Gap/Issue

The issue is that vegetation types used in the food chain model are not relevant to represent vegetation consumed by wildlife. The plant species that were collected (lichen and berries) were used to represent the vegetation component of the wildlife diets, although all wildlife do not consume these. Sampling was not completed for plants that are most representative of the site (sedges/grasses) or those that the consumers in the model would be most likely to consume (including leaves, seeds, grasses, and sedges for arctic ground squirrel; grasses, sedges, and forbs for caribou; and leaves, seeds, and twigs of dwarf trees for willow Ptarmigan). The proponent's response was that vegetation was not available at the sampling time. However, sedges are the dominant species in the LSA, and there has since been a field season available for sampling.

Disagreement with FEIS information/ conclusion

In the FEIS, the proponent has continued to not fill in data gaps and sample appropriate vegetation. TMAC, during the DEIS, pushed to complete an online search to determine if there were baseline vegetation data available from other nearby projects in lieu of additional sampling. Although baseline data was found, they have now supported our original assertion that these sites are likely too far away to be relevant. The likely lack of comparability of the sites was brought to the attention of the proponent by the KIA before they completed the search.

Reasons for disagreement

The predominant plant species such as grasses and sedges should be reasonably accessible, given their widespread distribution in the LSA and RSA. Given the distance to other project sites, comparable data is not readily available. Instead, a baseline-sampling program for sedges should be completed at the project site.

After completing a brief literature review we have also found that some sedges show bioaccumulation of metals through root uptake, and they can accumulate metals at concentrations higher than surrounding soils and water. Various species in the Cyperaceae (sedges) family are valued for their use in bioremediation due to their ability to grow in contaminated soils, tolerate metals, and accumulate metals. For example, Galal *et al.* (2017) studied *Cyperus articulatus* (jointed flatsedge) and found that Cd, Cu, Ni, Zn, Pb, and Co had seasonal bioaccumulation factor (BF) > 1 with the highest bioconcentration factors in the growing season. Very little is known about this diverse plant family, particularly in arctic environments, but there is the potential for metal transfer and bioaccumulation. This suggests that testing of water, soil and other plants such as berries and fungus associations, such as lichen, may not capture the greatest concentrations of metals. Sedges are unique in this ability. Sampling sedges would provide a better understanding of baseline metal concentrations in sedges, and provide a potentially more conservative input to the food chain model.

This information would support the food chain model, which is used to determine the human health risk in both the existing conditions HHRA and ERA as well as the project-related HHRA and ERA.

3.4 RECOMMENDATION/REQUEST

We recommend the following:

- Please complete sampling of vegetation that is typically consumed by the wildlife and prevalent on site, and which is dominant within the RSA (e.g., sedges);
- Keep baseline sedge data available for later use in before-after comparisons, if needed; and

- Run the models and complete EDI calculations using these new data to determine a more accurate baseline data for exposure.

3.5 TMAC RESPONSE FOR KIA-FEIS-03

As described in response to DEIS comment KIA-DEIS-22, TMAC committed to incorporating surrogate vegetation data from other projects in Nunavut (e.g., Meliadine, Meadowbank, Back River, etc.) if baseline vegetation data for those projects were publicly available. An exhaustive literature search of publicly available data from geographically-similar projects did not identify any relevant plant tissue data for incorporation into the HHERA. The plant tissue data was not considered relevant because the samples were located outside of the Project's Human Health Regional Study Area (RSA) and likely are not representative of site-specific metal concentrations of the Madrid-Boston Project due to inherent differences in metal concentrations in mineralized areas. Furthermore, future concentrations of metals in vegetation samples were calculated from dustfall results from the air quality model (see Section 5.4.2.5 of Volume 6, the FEIS). Vegetation samples from other projects that are outside of the human health RSA would be well outside of the air quality modeling domain, thus would be unaffected by Project metals in dustfall. Therefore, the baseline metal concentrations in those vegetation samples would be identical to the future metal concentrations. Thus vegetation samples from those projects were not included in the assessment as they were not considered to be sufficiently site-specific and they would be outside the air quality model domain and would not be affected by Project dustfall.

As described in the previous comment responses to KIA-IR-97 and KIA-DEIS-22, the existing database of lichen (n=78) and berry (n=59) samples is expected to be representative of the range of metals that might occur in vegetation on site.

Historically, vegetation sampling programs have been limited by the types of vegetation and/or berries available for collection at the time of sampling. In 2014, emphasis was placed on the co-collection of soil and vegetation samples (of the same species) at each sampling site. The purpose of this approach was to enable calculation of Project-specific soil-to-vegetation bioaccumulation factors for metals. In contrast to lichen (which was identified at each sampling site), sedge and other plant species were not available for sampling at each site. Thus, emphasis was placed on collecting lichen at these sites. For these reasons, lichen would likely be the species used for monitoring if future monitoring is required for vegetation.

Please note that the collection of more baseline vegetation data would not alter the conclusions of the risk assessment since it would not affect the percent change in baseline versus Project-related risk estimations. TMAC will speak with the KIA prior to the hearings to come to agreement as to where sedge samples can be collected for baseline purposes.

4. ID #KIA-FEIS-04

4.1 SUBJECT/TOPIC

Soil ingestion assumptions

4.2 REFERENCES

FEIS, Volume 6, Section 5.3.3.3, Page 49-50.

TMAC states:

"The assumptions used in the calculation of the EDI of COPCs via soil ingestion were as follows:

... Toddlers have a soil ingestion rate of 0.00002 kg/day and a body weight of 15.3 kg (Richardson and Stantec Consulting Ltd. 2013).

Adults have a soil ingestion rate of 0.0000016 kg/day and a body weight of 76.5 kg (Richardson and Stantec Consulting Ltd. 2013)."

And

Table 5.3-13. Estimated Daily Intake of Contaminants of Potential Concern via the Soil Ingestion Exposure Route

4.3 SUMMARY

This issue was first identified in KIA-IR72 where the KIA noted that soil ingestion rates used did not follow Health Canada (2010a), and instead used Richardson and Stantec (2013). Soil ingestion rates were further discussed in KIA-DEIS-14 where, after further review of Richardson and Stantec (2013), and given the unique considerations of the land users, we recommended that the Health Canada guidelines be used. A commitment was made during the DEIS hearings to meet with both Health Canada and the KIA to provide more rationale as for their selection, and to be input on the thresholds to be used. However, the KIA did not participate in a meeting, and are unaware of the outcomes of a meeting with Health Canada.

As nothing has changed in the FEIS concerning soil ingestion rates, the concern expressed within the DEIS review remains the same. This issue was previously discussed in the same IR as another related issue, regarding dermal exposure, but has been separated for ease of review.

4.3.1 Importance of issue

Using the soil ingestion rates recommended by Health Canada (2010a), will result in more conservative and descriptive estimates that had better reflect the rural situation of the

project and the specific land users concerned. With this change, the human health risk assessment will be more appropriately conservative and will enable a higher confidence in the conclusions of the FEIS.

4.3.2 Detailed Review Comment

Gap/Issue

The values used to estimate soil ingestion rates in the FEIS are substantially lower than the recommended guidelines and studies specific to this type of land user, which suggests that human health risks are underestimated.

Disagreement with DEIS conclusion

Upon further review of the values for soil ingestion rates in Richardson and Stantec (2013), Wilson et al. (2013), and a brief literature review, it was deemed by the KIA that the Health Canada Guidelines would be preferable in the case of the Hope Bay project. We have presented several soil ingestion rates for comparison, which illustrates the stark discrepancy between values selected by TMAC and those used in other guidelines and studies:

Health Canada (2010a) (applicable to all Canadians including Canadian Aboriginal Populations):

80 mg/day Toddler

20 mg/kg/day Adult

United States EPA (2011):

100 mg/day Toddler

50 mg/day Adult

Ontario (2011):

200 mg/day Toddler

50 mg/day Adult

Richardson and Stantec (2013) from Wilson et al. (2013) used in the FEIS:

20 mg/day Toddler

1.6 mg/day Adult

Doyle et al. (2012) (rural/remote population doing outdoor activities):

N/A Toddler

75 mg/day Adult

Irvine et al. (2014) (rural population practicing a wilderness lifestyle):

N/A Toddler

52 mg/day Adult

Reasons for disagreement with DEIS conclusion

There are no soil ingestion rates specific to Nunavut, where the project is located, and so deferring to the National standard is a reasonable assumption; otherwise, considering the range of values shown above should be considered. The values used in the FEIS represent the lowest of all studies and guidelines examined independently. Using agreed upon guidelines, is preferable to using data from a single study, as we can expect that they have incorporated information from multiple sources and best professional judgement.

Nunavut residents and the land users are a unique rural group with close ties to the land and potentially greater soil ingestion than typical Canadian residents used in other studies. Therefore, studies such as Doyle *et al.* (2012) and Irvine *et al.* (2014) should be given more weight, as these are the only studies that have measured soil ingestion rates in a group that resembled the project area users, a rural/remote population, and doing outdoor activities. Doyle *et al.* (2012), investigated soil ingestion in 7 adult subjects of a remote First Nations community in British Columbia during a 3-week camping and fishing excursion. They found a mean adult soil ingestion rate of 75 ± 120 mg/d (90th percentile = 211 mg/d). Irvine *et al.* (2014) followed 9 subjects in northern Alberta engaged in a variety of outdoor traditional activities during the day (e.g., fishing, hunting, food gathering), and determined a soil ingestion rate of 52 mg/day (for adults). These studies strongly suggest that remote populations and traditional land users have soil ingestion rates of about 52-75 mg/day (for adults). This supports the use of the Canadian guideline for adults and toddlers, which are more appropriate to cover rural populations and activities on average.

The Wilson *et al.* (2013) study (*i.e.*, Richardson and Stantec) used in the FEIS may be relevant for some populations of Canadians, particularly those in typical urban areas, but not others. The model used to calculate a soil ingestion rate, used values from a number of other studies of typical residential populations, which rely on assumptions of certain activities, behaviours, and time spent outdoors.

The authors of the study used by TMAC themselves advise that “activities for which there might be a higher propensity for particle exposure might include: traditional land use, ...outdoor schools and summer camps where students have been noted to spend large amounts of time outside; and occupations or hobbies involving large amounts of time in contact with soil or dust and/or greater propensity for particle adhesion to the hands” and that in these cases “ingestion rates can be adjusted on a site-specific basis to account for differences in exposure patterns”. This suggests that this study was not meant to apply under the project conditions where traditional land users are being evaluated.

There is a great deal of uncertainty with soil ingestion studies, therefore the use of the 95th percentile, rather than the mean ingestion rate should also be considered. This would mean that adult soil ingestion rates of approximately 200 mg/day. At minimum, the Canadian or more guidelines should be used to avoid underestimation of soil ingestion

by most land users in Nunavut. Alternatively, an average guideline level could be derived by consideration of the suite of values provided earlier.

4.4 RECOMMENDATION/REQUEST

We recommend the following:

- Use soil exposure values that are higher (such as those recommended by Health Canada, 2010a), as the situation of the project and land users concerned will be more accurately described by these values and the human health risk assessment will be more realistic and appropriately conservative.
- Please use the revised soil ingestion rates for calculations of COPCs exposure, estimated daily exposure for each metal in the existing and project cases, and reassess the human health risk as needed.
- Please update the human health risk assessment with this new information, and discuss any changes, if additional risks to human health are identified.
- If an agreement with Health Canada has been reached to allow for the use of Stantec and Richardson, over their values, please update the KIA; there was a commitment to include them in discussions of this issue with Health Canada.

4.5 TMAC RESPONSE FOR KIA-FEIS-04

Comments KIA-FEIS-01 and KIA-FEIS-04 both request revisions to the human health exposure assessment components of the FEIS HHERA; therefore, responses to these comments are provided together. Please refer to the response provided under KIA-FEIS-01.

5. ID #KIA-FEIS-05

5.1 SUBJECT/TOPIC

Inorganic arsenic fraction

5.2 REFERENCES

Volume 6, Section 5.3.3.6, Page 55.

TMAC states:

"For calculations of EDI, the arsenic concentration in country food items was adjusted to account for the amount of inorganic arsenic that is likely to be present, as that is the most toxic form. The inorganic arsenic fraction was used in the calculation of EDI from country foods. For caribou and Arctic ground squirrel, it was assumed that 70% of the total arsenic was inorganic and for willow ptarmigan, it was assumed that 50% of the total arsenic was inorganic (EFSA 2009, 2014). For berries, it was assumed that 100% of the arsenic was inorganic (Nicholson 2002). For fish, it was assumed that 10% of the arsenic was inorganic (Phillips 1990; Slejkovec, Bajc, and Doganoc 2004; Rosemond, Xie, and Liber 2008; Rahman, Haseqawa, and Lim 2012). For soil and water ingestion, it was assumed that 100% of the arsenic was inorganic."

5.3 SUMMARY

In KIA-IR75, the KIA requested clarification on arsenic, as it appeared that using adjustment factors might substantially underestimate the inorganic arsenic present. In response to KIA-IR75, TMAC stated that the toxicity reference value used in the assessment is based specifically on ingestion of inorganic arsenic. Therefore, in order to use this TRV, the estimated daily ingestion of inorganic arsenic (not total arsenic) had to be calculated. They also noted that references were provided to support the selection of inorganic arsenic proportions in country foods and other media. After a thorough review of all references provided, this problem was again reiterated in KIA-DEIS-16 due to insufficient evidence to support the arsenic proportions used for caribou, arctic ground squirrel, and ptarmigan.

During a meeting that occurred during the DEIS hearing, TMAC agreed to look more into this issue; however, the resulting FEIS remains unchanged. As there has been no change in the FEIS, and no additional references provided, this issue remains an outstanding concern. This issue is also related to another technical comment for Lifetime cancer risk, which, when combined, may lead to ILCR being underestimated (KIA-FEIS-06).

5.3.1 Importance of issue

Without the inclusion of more conservative factors to estimate inorganic arsenic from total arsenic, human health risks may be significantly underestimated. Fair estimation of inorganic arsenic is needed to allow a more accurate estimation of arsenic exposure under baseline conditions, for the existing conditions HHRA and under the predicted project conditions. As arsenic is already above the incremental lifetime cancer risk (ILCR) benchmark in baseline conditions, it is important to provide accurate estimates for arsenic exposure. This assumption is also important to the ERA for assessing impacts to wildlife.

5.3.2 Detailed Review Comment

Gap/Issue

Total arsenic measured was adjusted by a factor to estimate inorganic arsenic, the most toxic form. However, there is still an outstanding concern over several of the factors used as they are significantly underestimating inorganic arsenic in country foods. For example, it was assumed that for caribou and arctic ground squirrel, 70% of the total arsenic was inorganic; and for willow ptarmigan, 50% of the total arsenic was inorganic. For ptarmigan, this in effect cuts the concentration of arsenic used in half, with no justification.

We had also cautioned that the simplification that organic arsenics are not toxic at all is problematic, as some organic compounds have been found to be more toxic than inorganic compounds. For example, DMA and MMA (toxic organic by-products from inorganic arsenic metabolism) have been determined to be highly toxic intermediates (Petrick et al., 2000). This highlights the need to be conservative with any factors used to estimate the inorganic arsenic component in country foods, as doing so may inherently underestimate the total effect of arsenic compounds.

Disagreement with FEIS conclusion

There is insufficient evidence for the assumption that, for caribou and Arctic ground squirrel, 70% of the total arsenic was inorganic. There was no relevant basis for using the value of 70%, and the rationale behind using this value is not explained in the FEIS. Further, the references provided do not specifically address arsenic fractions in country foods or even in meat products of any kind, even though the references within the FEIS are used to suggest that they do. For example, EFSA (2009), does not mention using 70% concerning meat, and does not address arsenic in meat. The other reference included in the FEIS, EFSA (2014), also does not address country foods. Instead, EFSA (2014) states that “different percentages of iAs [inorganic arsenics] in foods of terrestrial origin have been described in the literature, with accepted values between 25% and 100% of the tAs [total arsenics] (Yost et al., 1998; HKTDS, 2012)”. This is a considerable range, and in light of this uncertainty for fractions of inorganic arsenic in foods of terrestrial origin, this would support a value of 100% being used until additional research is completed. The studies referenced in this range also do not suggest a value of 70% for these country foods. HKTDS

(2012) did not estimate the ratios of inorganic to total arsenic. Yost *et al.* (1998) was a preliminary study of meats with extremely small sample sizes that found a factor of 100% for meat. EFSA (2014) only uses 70% as an estimate for all for foods of terrestrial origin as it was an average of the factors derived for all food types in general (besides seafood). This general method, while sufficient for the purposes of estimating overall risk to the European population, is not appropriate for a mine HHRA and a specific country food.

A better approach would be to use a factor measured for arsenic in meat specifically. A ratio of 100% should be used, as it was measured for meats in the Yost *et al.* (1998) study. While additional research is needed in this area, this measured value is preferable to an average estimate, represents the best reasonable judgement for meats and is appropriately conservative given the high variability of arsenic fractions among food types.

Similarly, there is also insufficient evidence for the assertion that 50% of total arsenic is inorganic for ptarmigan, rather than using the same value as for arctic ground squirrel and caribou (70%), or 100% as we have determined for meat. Again, the references provided do not have recommendations for ptarmigan, country foods, or even specific values for meat. We continue to recommend the use of 100% as the Yost *et al.* (1998) study found for meat.

Finally, it is still unclear if the effects of DMA and MMA (organic metabolized by-products from inorganic As) have been considered. As shown by Petrick *et al.* (2000), the relative toxicities of arsenic compounds are not as straightforward as was once assumed. Petrick *et al.* (2000) has shown that the organic arsenic MMA III toxicity is greater than that of inorganic arsenite in Chang human hepatocytes. This is unexpected as Monomethylarsonous Acid (MMAIII) is an intermediate in inorganic arsenic methylation, the primary detoxication pathway of inorganic arsenic. These potentially toxic organic arsenic species are not addressed in the HHRA. If it is assumed that these compounds are to be covered by the inorganic As US EPA toxicity reference values, this should be indicated in the FEIS text.

Reasons for disagreement with FEIS conclusion

Without the use of the best available factors to estimate inorganic arsenic from total arsenic, as described above, the baseline exposure of arsenic is significantly underestimated; existing and project-related human health risks are not appropriately described. The information provided in the references from the FEIS were insufficient to explain the rationale for the values used for inorganic arsenic factors in several country foods.

In addition, TMAC only offered that there were no assumptions about the potentially toxic organic arsenic species. A more detailed approach may be needed to address this group, and acknowledgement of the uncertainty associated with arsenic metabolites.

5.4 RECOMMENDATION/REQUEST

We recommend the following:

- Correct the factors for the proportion of inorganic arsenic to 100% of total arsenic to reflect the best available research on meats, for arctic ground squirrel, caribou, and ptarmigan. Then, update exposure and risk calculations.
- Please read the references given clearly demonstrate how adjustment factors for inorganic arsenic are derived and provide additional references in the FEIS.
- Please acknowledge the uncertainty associated with arsenic metabolites in the FEIS and provide rationale as to how they are considered

5.5 TMAC RESPONSE FOR KIA-FEIS-05

The concerns raised by KIA regarding the assumptions of arsenic speciation are appreciated and ERM has assigned significant resources to address KIA's comments. As previously stated in response to KIA-DEIS-16, the proportion of inorganic arsenic does not materially affect the outcome of the assessment, which is based on the percent change of risk between the existing conditions risk and Project-related risk.

If the fraction of inorganic arsenic is changed to 100% for meat in the Project-related HHERA, then the same adjustment is made to the existing conditions HHERA. As shown in the sections below, the assumption of 100% inorganic arsenic in meat (i.e., mammalian and avian meat) does not materially increase the level of Project-related risk relative to existing conditions. Thus, the conclusion that there is no significant incremental change in risk is not affected by the fraction of inorganic arsenic ingested by wildlife and humans.

Also previously stated in response to KIA-DEIS-16, there is concern about the overall conservatism of the risk assessment and that the risk due to arsenic (and other metals) is already substantially overestimated. There is the potential to further increase the perception of risk, particularly for arsenic where cancer is one of the endpoints considered. Consumption of country foods is important to Inuit and an overly conservative risk assessment has the potential to frighten people away from consuming country foods, which is not the intent of the HHRA.

Please note the TRVs used in the HHERA (expressed as mg/kg BW/day) are for inorganic arsenic. Knowledge of the toxicokinetics or the toxic mechanism(s) of action (including the generation of potentially toxic intermediates or metabolites, etc.) does not ultimately change the previously observed dose-response relationships of inorganic arsenic (or the thresholds at which exposure to inorganic arsenic result in toxicity).

It is well known that a great deal of uncertainty exists in toxicological testing. The characterization of the toxicokinetics and potential mechanisms of action of inorganic arsenic toxicity (e.g., toxic intermediates, MMA^{III} toxicity, etc.) does not introduce

'additional' uncertainty at the dose-response level. Rather, knowledge of these toxicological processes (for any toxicant) help explain the inherent variability of dose-response relationships (e.g., across species, sex, age, etc.) that is already understood to broadly exist in toxicity testing. The variability of dose-response relationships is precisely why uncertainty factors and other conservative approaches are used in risk assessment.

The HHERA presented in the DEIS and FEIS is a preliminary quantitative risk assessment (PQRA) by nature of its extensive use of modelled data (for the Project-case) and use of conservative assumptions; consideration of metabolites of organo-arsenites or any other organo-metals is beyond the scope of a PQRA, especially as it identified a negligible change in risk due to the Project.

Please see the sections below to see how changing the fraction of total arsenic to 100% inorganic arsenic in meat does not introduce any material changes to the overall conclusions of the human health or ecological risk assessments.

Result of Assuming 100% Inorganic Arsenic: Human Health

Table 5-1 shows the estimated daily intake (EDI) of arsenic from individual and all (i.e., EDI_{total}) country foods considered in the HHERA. These adjusted values were calculated by assuming 100% inorganic arsenic in all mammalian and avian country foods meats. The general approach used for calculating EDIs is described in Volume 6, Chapter 5 of the FEIS.

Table 5-1. Adjusted Estimated Daily Intake of Arsenic from Country Foods

Country Food	Existing Conditions Estimated Daily Intake of Arsenic (mg/kg BW/day)		Construction Phase Estimated Daily Intake of Arsenic (mg/kg BW/day)		Operational Phase Estimated Daily Intake of Arsenic (mg/kg BW/day)	
	Adults	Toddlers	Adults	Toddlers	Adults	Toddlers
Caribou	4.53E-08	1.13E-07	4.44E-08	1.11E-07	4.44E-08	1.11E-07
Caribou Liver	9.23E-10	2.31E-09	9.05E-10	2.26E-09	9.05E-10	2.26E-09
Caribou Kidney	3.96E-10	9.90E-10	3.88E-10	9.71E-10	3.88E-10	9.71E-10
Arctic Ground Squirrel	1.23E-08	3.08E-08	1.21E-08	3.02E-08	1.21E-08	3.03E-08
Ptarmigan	1.92E-06	4.80E-06	1.90E-06	4.74E-06	1.90E-06	4.74E-06
Berries	6.14E-07	1.54E-06	6.58E-07	1.65E-06	6.58E-07	1.65E-06
Arctic Char	1.26E-04	3.16E-04	1.26E-04	3.16E-04	1.26E-04	3.16E-04
Lake Trout	3.18E-06	7.94E-06	3.27E-06	8.17E-06	4.30E-06	1.07E-05
EDI_{total}	1.32E-04	3.30E-04	1.32E-04	3.30E-04	1.33E-04	3.33E-04

Notes:

Adjusted EDIs assume 100% of arsenic in mammalian and avian meat is inorganic arsenic

BW = body weight

EDI_{total} = the sum of EDIs from each country food

Table 5-2 compares the Existing Conditions, Construction Phase, and Operational Phase hazard quotients from the FEIS to the adjusted hazard quotients when 100% of the arsenic in mammalian and avian country foods is assumed to be inorganic.

Table 5-2. Comparison of FEIS and Adjusted Hazard Quotients for Arsenic: Human Health

Receptor	Existing Conditions Hazard Quotients		Construction Phase Hazard Quotients		Operational Phase Hazard Quotients	
	FEIS	Adjusted ¹	FEIS	Adjusted ¹	FEIS	Adjusted ¹
Adult Land Users	4.4E-01	4.5E-01	4.4E-01	4.5E-01	4.5E-01	4.5E-01
Adult Off-duty workers ²	1.2E-02	1.2E-02	1.1E-02	1.1E-02	1.1E-02	1.1E-02
Toddlers	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00	1.2E+00

Notes:

¹Adjusted hazard quotients assume 100% of arsenic in mammalian and avian meat is inorganic arsenic

²Hazard quotients for off-duty workers were the same at all 4 camps

Shaded cells represent adjusted hazard quotients that are greater than FEIS values

As shown in Table 5-2, the adjusted hazard quotients for adult land users are greater (by only 2% approximately) than the FEIS values in both Existing Conditions and the Construction Phase. However, the Existing Conditions and Construction Phase increases are proportional. In other words, there is no increased Project-related risk relative to Existing Conditions after adjusting the fraction of inorganic arsenic consumed by humans. No other Existing Conditions or Project-related hazard quotients for any human receptor were changed due to the fraction of inorganic arsenic in country foods.

Table 5-3 compares the Incremental Lifetime Cancer Risk (ILCR) calculated in the FEIS to the adjusted ILCR when 100% of the arsenic in mammalian and avian country foods is assumed to be inorganic. Because the ILCR calculations also incorporate exposure to arsenic from dermal contact to soil, as well as exposure via the ingestion of water and incidental ingestion of soil, the adjusted ILCRs (but not the FEIS ILCRs) presented herein also incorporate the suggested changes to dermal surface areas and soil ingestion rates discussed in KIA-FIES-01 and KIA-FEIS-04 (e.g., adult hand surface area of 953 cm², adult arms plus legs surface area of 8911 cm², and adult soil ingestion rate of 0.00002 kg/day). Furthermore, to address concerns raised in KIA-FEIS-06, the adjusted ILCRs also assume a 21-year exposure period. This 21-year exposure period conservatively incorporates 17 years of exposure to Operational Phase conditions (rather than the proposed 10-year Operational Phase), as well as 4 years of exposure to Construction Phase conditions.

Table 5-3. Comparison of FEIS and Adjusted Incremental Lifetime Cancer Risk

Receptor	Existing Conditions ILCR		Summed ILCR from Construction and Operational Phases		Relative Percent Difference of ILCR between Existing Conditions and Project-related Conditions	
	FEIS	Adjusted ¹	FEIS	Adjusted ¹	FEIS	Adjusted
Adult Land Users	4.09E-05	6.16E-05	4.24E-05	6.38E-05	3.6%	3.5%
Adult Off-duty workers	1.10E-06	1.21E-06	1.07E-06	1.22E-06	-2.8%	0.8%

Notes:

ILCR = Incremental lifetime cancer risk due to ingestion (country foods, water, and soil) and dermal contact

¹Adjusted ILCR values incorporate the following adjustments:

100% of arsenic in mammalian and avian meat is inorganic arsenic;

An exposure period of 21 years (see response to KIA-FEIS-06);

Dermal surface areas were adjusted according to KIA-FEIS-01; and

Soil ingestion rate was adjusted according to KIA-FEIS-04

Shaded cells represent adjusted ILCR values that are greater than FEIS values

As shown in Table 5-3, the adjusted ILCRs for adult land users and off-duty workers are greater than the FEIS values for both Existing Conditions and for the summed Project-related exposure. However, the incremental change (i.e., relative percent difference) in ILCR between Existing Conditions and Project-related conditions remain roughly equivalent when the FEIS results are compared to the adjusted results. For this reason, there is no material increase in Project-induced cancer risk relative to the results presented in the FEIS when the fraction of inorganic arsenic used in exposure calculations is adjusted to 100% (as previously described).

Result of Assuming 100% Inorganic Arsenic: Wildlife

Table 5-4 shows the adjusted estimated daily intake (EDI) of arsenic calculated as a sum of the EDIs for the ingestion of prey, vegetation, soil/sediment, and water by wildlife. These adjusted EDI values were calculated by assuming 100% inorganic arsenic in all mammalian and avian prey items. The general approach used for calculating EDIs is described in Volume 6, Chapter 5 of the FEIS.

Table 5-4. Adjusted Estimated Daily Intake of Arsenic in Wildlife

Wildlife Species	Total (summed) EDI of Arsenic due to the Ingestion of Vegetation, Soil/Sediment, Water, and Prey (mg/kg BW/day)		
	Existing Conditions	Construction Phase	Operational Phase
Caribou	5.18E-05	5.08E-05	5.08E-05
Muskox	1.38E-02	1.36E-02	1.36E-02
Wolverine	1.87E-02	1.85E-02	1.85E-02
Grizzly Bear	1.82E-03	1.79E-03	1.80E-03
Wolf	1.57E-04	1.56E-04	1.70E-04
Arctic Ground Squirrel	9.48E-03	9.31E-03	9.32E-03
Arctic Shrew	8.70E-02	8.51E-02	8.51E-02
Northern Red-backed Vole	1.03E-01	1.01E-01	1.01E-01
Willow Ptarmigan	2.50E-02	2.47E-02	2.47E-02
American Tree Sparrow	6.48E-02	6.37E-02	6.37E-02
Peregrine Falcon	1.87E-02	1.84E-02	1.85E-02
Canada goose	5.34E-02	5.34E-02	5.34E-02
Red-breasted Merganser	3.78E-02	3.79E-02	3.83E-02
Least Sandpiper	1.59E-01	1.59E-01	1.59E-01
Long-tailed Duck	4.57E-02	4.58E-02	4.59E-02
Herring Gull	8.44E-02	8.44E-02	8.44E-02
Yellow Warbler	4.95E-02	4.84E-02	4.84E-02
Brant	1.87E-02	1.86E-02	1.86E-02
Ringed Seal	1.07E-01	1.07E-01	1.07E-01

Notes:

Adjusted EDIs assume 100% of arsenic in mammalian and avian meat is inorganic arsenic

BW = body weight

Table 5-5 compares the Existing Conditions, Construction Phase, and Operational Phase hazard quotients for each wildlife species from the FEIS to the adjusted hazard quotients when 100% of the arsenic in mammalian and avian wildlife prey items is assumed to be inorganic.

Table 5-5. Comparison of FEIS and Adjusted Hazard Quotients for Arsenic: Wildlife

Valued Ecosystem Component	Existing Conditions Hazard Quotients		Construction Phase Hazard Quotients		Operational Phase Hazard Quotients	
	FEIS	Adjusted ¹	FEIS	Adjusted ¹	FEIS	Adjusted ¹
Caribou	4.98E-05	4.98E-05	4.88E-05	4.88E-05	4.88E-05	4.88E-05
Muskox	1.33E-02	1.33E-02	1.30E-02	1.30E-02	1.30E-02	1.30E-02
Wolverine	1.44E-02	1.80E-02	1.41E-02	1.78E-02	1.42E-02	1.78E-02
Grizzly Bear	1.67E-03	1.75E-03	1.65E-03	1.72E-03	1.65E-03	1.73E-03
Wolf	1.50E-04	1.51E-04	1.49E-04	1.50E-04	1.63E-04	1.63E-04
Arctic Ground Squirrel	9.11E-03	9.11E-03	8.95E-03	8.95E-03	8.96E-03	8.96E-03
Arctic Shrew	8.36E-02	8.36E-02	8.18E-02	8.18E-02	8.19E-02	8.19E-02
Northern Red-backed Vole	9.95E-02	9.95E-02	9.75E-02	9.75E-02	9.76E-02	9.76E-02
Willow Ptarmigan	1.12E-02	1.12E-02	1.10E-02	1.10E-02	1.10E-02	1.10E-02
American Tree Sparrow	2.89E-02	2.89E-02	2.84E-02	2.84E-02	2.84E-02	2.84E-02
Peregrine Falcon	7.16E-03	8.35E-03	7.03E-03	8.22E-03	7.05E-03	8.25E-03
Canada Goose	2.38E-02	2.38E-02	2.38E-02	2.38E-02	2.38E-02	2.38E-02
Red-Breasted Merganser	1.69E-02	1.69E-02	1.69E-02	1.69E-02	1.71E-02	1.71E-02
Least Sandpiper	7.09E-02	7.09E-02	7.09E-02	7.09E-02	7.11E-02	7.11E-02
Long-tailed Duck	2.04E-02	2.04E-02	2.04E-02	2.04E-02	2.05E-02	2.05E-02
Herring Gull	3.77E-02	3.77E-02	3.77E-02	3.77E-02	3.77E-02	3.77E-02
Yellow Warbler	2.21E-02	2.21E-02	2.16E-02	2.16E-02	2.16E-02	2.16E-02
Brant	8.34E-03	8.34E-03	8.32E-03	8.32E-03	8.33E-03	8.33E-03
Ringed Seal	1.03E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01	1.03E-01

Notes:

¹Adjusted hazard quotients assume 100% of arsenic in mammalian and avian meat is inorganic arsenic
Shaded cells represent adjusted hazard quotients that are greater than FEIS values

As shown in Table 5-5, some of the adjusted hazard quotients are greater than the FEIS values during Existing Conditions, as well as during the Construction and Operational Phases. However, increases in the Construction and Operational Phases are roughly proportional to increases during Existing Conditions.

Table 5-6 below shows the relative percent change between Existing Conditions and the Construction and Operational Phases of the Project. The percent change calculated in the FEIS is compared to the adjusted percent change calculated when 100% of arsenic in meat is assumed to be inorganic.

Table 5-6. Percent Change in Hazard Quotient Between Existing Conditions and the Construction/Operational Phases

Valued Ecosystem Component	Relative Percent Difference (%) Between Existing Conditions and the Construction Phase Hazard Quotients		Relative Percent Difference (%) Between Existing Conditions and the Operational Phase Hazard Quotients	
	FEIS	Adjusted	FEIS	Adjusted
Caribou	-2.0	-2.0	-2.0	-2.0
Muskox	-1.8	-1.8	-1.7	-1.7
Wolverine	-1.6	-1.3	-1.3	-0.9
Grizzly Bear	-1.7	-1.7	-1.5	-1.4
Wolf	-0.8	-0.8	7.7	7.7
Arctic Ground Squirrel	-1.8	-1.8	-1.7	-1.7
Arctic Shrew	-2.1	-2.1	-2.1	-2.1
Northern Red-backed Vole	-2.0	-2.0	-2.0	-2.0
Willow Ptarmigan	-1.4	-1.4	-1.3	-1.3
American Tree Sparrow	-1.8	-1.8	-1.8	-1.8
Peregrine Falcon	-1.8	-1.5	-1.5	-1.2
Canada Goose	-0.1	-0.1	0.0	0.0
Red-Breasted Merganser	0.1	0.1	1.3	1.3
Least Sandpiper	0.0	0.0	0.3	0.3
Long-tailed Duck	0.0	0.0	0.3	0.3
Herring Gull	0.0	0.0	0.0	0.0
Yellow Warbler	-2.1	-2.1	-2.1	-2.1
Brant	-0.2	-0.2	-0.2	-0.2
Ringed Seal	0.0	0.0	0.0	0.0

Note:

Shaded cells represent instances when the relative percent difference was different between the FEIS and adjusted values.

As shown in Table 5-6, the percent change of risk between Existing Conditions and Construction/Operational Phases remains roughly equivalent between the FEIS and adjusted values. For this reason, there is no material increase in Project-induced risk relative to the results presented in the FEIS when the fraction of inorganic arsenic used in exposure calculations is adjusted to 100% (as previously described).

Conclusion

It is expected that the results presented in this memorandum satisfy the reviewer's concerns regarding arsenic speciation. It is demonstrated herein that the conclusions of the HHERA are not materially influenced by the conservative assumption that 100% of the arsenic in wildlife meat is inorganic.

6. ID #KIA-FEIS-06

6.1 SUBJECT/TOPIC

Lifetime cancer risk

6.2 REFERENCES

FEIS, Volume 6, Section 5.3.5.3, page 69

TMAC states:

"Based on being exposed for 14 years out of an 80 year lifetime (to allow for comparison to the Project- related HHRA that considers the Construction and Operational phases, which total 14 years in duration) for three months of the year for adult land users and half of the year for off-duty workers, the ILCRs for arsenic, cadmium, chromium, and nickel are shown in Table 5.3-21."

FEIS, Volume 6, Section 5.4.4.4, Page 132.

6.3 SUMMARY

This issue was first discussed in KIA-IR88 and reiterated in KIA-DEIS-20. The KIA requested clarification on the timeframe used to calculate incremental lifetime cancer risk (ILCR). As shown in the statement provided, only the cancer risk from 14 years of exposure were considered (construction and operations). However, given the objective of determining land user's life time cancer risk which is considered the total exposure over 80 years, it would be more conservative to also include any risk from the closure and post closure phases from the full 21 years of the mine (including reclamation and post-closure), particular for land users that will continue to hunt and fish in the area post-closure (possibly after finishing work at the mine). As no change has been made in the FEIS this issue remains for the baseline and predicted ILCR under the project. This issue is also related to another technical comment for inorganic arsenic fractions, which, when combined, may lead to ILCR being underestimated (KIA-FEIS-05).

6.3.1 Importance of issue

Modifying the ILCR predictions to be more descriptive and include these additional years of exposure would be more conservative and would ensure that human cancer risk due to the project is accurately described. This would help ensure human health impacts are fully considered.

6.3.2 Detailed Review Comment

Gap/Issue

The issue of lifetime cancer risk has not been assessed for the entire potential exposure period. It would be more appropriate to include an estimate of exposure from the entire lifetime of the mine (21 years including reclamation and post-closure phases), since cancer risk is based on cumulative long-term exposure effects, rather than acute toxicity. Since the effects are cumulative, the total risk is important, rather than only focusing on the worst phase of the project. This more conservative approach would ensure human health is protected.

Disagreement with FEIS conclusion

The FEIS does not consider the reclamation, closure, and post-closure phases for land users. The sample calculation shows a factor of (14/80) being applied. This means that the assumption is that after the operations phase there are zero effects predicted. A more accurate approach in determining the ILCR would instead take into account an average concentration and a time for each phase. The total ILCR would then be the sum of these results. There is reason to believe that these additional years could have non-zero effects on human health, which should be presented. Human exposure would continue during reclamation as activities such as moving rocks and driving would create dust dispersal. During post-closure tailings and mine, areas may remain contaminated for many years (as the metal contaminants would persist). There is also the potential for increased animal use of the area, as the noise and human presence is no longer a deterrent leading to continued exposure to COPCs through wildlife and country foods.

Reasons for disagreement with DEIS conclusion

A more nuanced approach such as accounting for multiple phases, with separate average concentrations, would provide a more realistic estimate of the ILCR. For the ingestion cancer risk, the risk is already above the threshold in the baseline case, and the project increases the hazard quotient by 9.1%. It is important to quantify this risk as it is close to the 10% threshold, above which measure health effects would be expected. The inhalation cancer risks predicted are below the Canadian threshold, so the addition of this approach would confirm that no risks are expected.

6.4 RECOMMENDATION/REQUEST

Please provide an estimate of the total ILCR for the entire length of the project (21 years) combining the current ILCR predictions and the additional risk from the reclamation and closure and post-closure phases.

6.5 TMAC RESPONSE FOR KIA-FEIS-06

Here we present adjusted incremental lifetime cancer risk (ILCR) calculations for both the inhalation and ingestion routes of exposure. The approach used to calculate the ILCR is identical to the FEIS (Volume 6, Chapter 5). The adjustments include extending the overall exposure period from 14 years (i.e., 4 years of Construction Phase and 10 years of Operational Phase exposure) to 21 years (i.e., 4 years of Construction Phase and 17 years of Operational Phase exposure). Although the Operational Phase is proposed for 10 years, extending the Operational Phase duration to 17 years is a conservative approach as the Closure and Post-Closure Phases are reasonably expected to have improved conditions relative to the Operational Phase.

Because the 'ingestion pathway' ILCR calculation incorporates the ILCRs from the ingestion of country foods, water, and soil (and also includes dermal contact with soil), the adjustments pertaining to the fraction of inorganic arsenic in meat (adjusted to 100% as per KIA-FEIS-05), dermal surface areas [adjusted to Richardson and Stantec (2013) values as per KIA-FEIS-01], and soil ingestion rates [adjusted to Health Canada (2010) values as per KIA-FEIS-04] were incorporated into the adjusted ILCR values reported herein.

The following section summarizes the adjusted ILCRs values for the inhalation route of exposure, and is followed by a summary of the adjusted ILCRs for the 'ingestion pathway'.

Adjusted ILCR Values For the Inhalation Route of Exposure

As shown in Table 6-1, when the exposure period is extended to 21 years (as described above), the total adjusted Existing Conditions ILCR values due to the inhalation of arsenic, cadmium, chromium, and nickel do not substantially increase relative to the FEIS values (shown in parentheses), and remain well below 1.0×10^{-5} (i.e., $1.0\text{E-}05$).

Table 6-1. Adjusted Existing Conditions ILCR Values: Inhalation Route

Parameter	Incremental Lifetime Cancer Risk	
	Adult Land User	Off-duty Worker
Arsenic	1.46E-08	1.58E-08
Cadmium	6.08E-09	6.58E-09
Chromium	1.17E-07	1.27E-07
Nickel	2.73E-08	2.95E-08
Total Adjusted ILCR¹	1.65E-07 (1.10E-07)	1.79E-07 (1.19E-07)

Notes:

¹ Corresponding FEIS values presented in parentheses

ILCR = Incremental lifetime cancer risk

As shown in Table 6-2 (below), when the exposure period is extended to 21 years, the total adjusted Construction and Operational Phase ILCRs (and summed Project-related ILCRs) values due to the inhalation of arsenic, cadmium, chromium, and nickel do not substantially increase relative to the FEIS values (shown in parentheses), and remain below 1.0×10^{-5} (i.e., $1.0\text{E-}05$).

Adjusted ILCR Values For the Ingestion and Dermal Contact Routes of Exposure

As shown in Table 6-3, when the exposure period is extended to 21 years (and the additional adjustments to exposure characteristics previously described are incorporated), the total adjusted Existing Conditions ILCR values due to ingestion of water, soil, and country foods, as well as through dermal contact with soil, do not substantially increase relative to the FEIS values (shown in parentheses). The FEIS HHERA already identified the total ILCR for adult land users to be greater than 1.0×10^{-5} (i.e., $1.0\text{E-}05$) in Existing Conditions. The adjusted ILCRs do not provide any additional indication of risk that is substantially greater than the ILCR values in the FEIS. The adjusted off-duty worker ILCR for Existing Conditions remains below 1.0×10^{-5} .

Table 6-2. Adjusted Project-related ICLR Values: Inhalation Route

Parameter	Incremental Lifetime Cancer Risk for the Construction Phase					Incremental Lifetime Cancer Risk for the Operational Phase					Summed Incremental Lifetime Cancer Risk				
	Land User Adult	Doris Camp	Boston Exp. Camp	Boston Op. Camp	Quarry D Camp	Land User Adult	Doris Camp	Boston Exp. Camp	Boston Op. Camp	Quarry D Camp	Land User Adult	Doris Camp	Boston Exp. Camp	Boston Op. Camp	Quarry D Camp
Arsenic	1.82E-09	8.25E-10	5.29E-10	2.79E-09	1.84E-09	4.42E-09	2.03E-09	4.21E-09	1.38E-08	3.18E-09	6.24E-09	2.86E-09	4.74E-09	1.66E-08	5.02E-09
Cadmium	5.57E-10	2.53E-10	1.62E-10	8.53E-10	5.63E-10	1.36E-09	6.22E-10	1.29E-09	4.22E-09	9.75E-10	1.91E-09	8.75E-10	1.45E-09	5.08E-09	1.54E-09
Chromium	9.38E-07	4.25E-07	2.73E-07	1.44E-06	9.49E-07	2.28E-06	1.05E-06	2.17E-06	7.11E-06	1.64E-06	3.22E-06	1.47E-06	2.44E-06	8.55E-06	2.59E-06
Nickel	5.32E-08	2.41E-08	1.55E-08	8.15E-08	5.38E-08	1.29E-07	5.94E-08	1.23E-07	4.03E-07	9.32E-08	1.83E-07	8.35E-08	1.39E-07	4.85E-07	1.47E-07
Total Adjusted ILCR¹	9.93E-07 (9.93E-07)	4.51E-07 (4.51E-07)	2.89E-07 (2.89E-07)	1.52E-06 (1.52E-06)	1.00E-06 (1.00E-06)	2.42E-06 (1.42E-06)	1.11E-06 (6.52E-07)	2.30E-06 (1.35E-06)	7.53E-06 (4.43E-06)	1.74E-06 (1.02E-06)	3.41E-06 (2.42E-06)	1.56E-06 (1.10E-06)	2.59E-06 (1.64E-06)	9.05E-06 (5.95E-06)	2.74E-06 (2.03E-06)

Notes:

¹ Corresponding FEIS values presented in parentheses

Quarry Exp. Camp = Boston Exploration Camp; Boston Op. Camp = Boston Operational Camp

ILCR = Incremental lifetime cancer risk

Table 6-3. Adjusted Project-related ILCR Values: Ingestion and Dermal Contact Routes

Pathway	ILCR for Inorganic Arsenic: Adult Land Users	ILCR for Inorganic Arsenic: Off-duty Workers
Drinking Water	6.33E-07	1.09E-06
Soil Ingestion	8.72E-08	9.44E-08
Soil Dermal Contact	1.99E-08	4.30E-08
Country Foods		
Caribou	2.14E-08	NA
Caribou Liver	4.36E-10	NA
Caribou Kidney	1.87E-10	NA
Arctic Ground Squirrel	5.82E-09	NA
Ptarmigan	9.08E-07	NA
Berries	2.90E-07	NA
Marine fish (Arctic Char)	5.97E-05	NA
Freshwater fish (Lake Trout)	1.50E-06	NA
Total Adjusted ILCR¹	6.16E-05 (4.09E-05)	1.23E-06 (1.10E-06)

Notes:

¹ Corresponding FEIS values presented in parentheses

Shaded cells = ILCRs greater than 1.0E-05

ILCR = Incremental lifetime cancer risk

As shown in Table 6-4 (below), when the exposure period is extended to 21 years (and the additional adjustments to exposure characteristics previously described are incorporated), the adjusted values for the summed Project-related ILCRs due to the ingestion of water, soil, and country foods, as well as through dermal contact with soil, increase proportionally with the adjusted Existing Conditions ILCRs (see Table 6-3). The FEIS HHERA already identified the summed Project-related ILCR for adult land users to be greater than 1.0×10^{-5} (i.e., 1.0E-05). The adjusted ILCRs do not provide any additional indication of risk that is substantially greater than the ILCR values in the FEIS. The adjusted Project-related ILCR for off-duty workers remains below 1.0×10^{-5} .

In summary, the adjusted ILCR values presented herein do not change the conclusions of the HHERA in the FEIS (Volume 6, Chapter 5). Adjustments resulted in increased Project-related ILCR values, but these increased values were proportional to and off-set by corresponding increased ILCR values under Existing Conditions.

Table 6-4. Adjusted Project-related ILCR Values: Ingestion and Dermal Contact Routes

Pathway	Construction Phase		Operational Phase		Summed Incremental Lifetime Cancer Risk for an Land User Adult	Summed Incremental Lifetime Cancer Risk for an Off-duty Worker
	Land User Adult	Off-duty Worker	Land User Adult	Off-duty Worker		
	ILCR for Inorganic Arsenic	ILCR for Inorganic Arsenic	ILCR for Inorganic Arsenic	ILCR for Inorganic Arsenic		
Drinking Water	1.86E-07	3.02E-07	6.11E-07	7.64E-07	7.97E-07	1.07E-06
Soil Ingestion	2.01E-08	2.17E-08	8.53E-08	9.24E-08	1.05E-07	1.14E-07
Soil Dermal Contact	5.55E-09	1.20E-08	1.39E-08	3.01E-08	1.94E-08	4.21E-08
Country Foods						
Caribou	3.99E-09	NA	1.70E-08	NA	2.10E-08	NA
Caribou Liver	8.15E-11	NA	3.46E-10	NA	4.28E-10	NA
Caribou Kidney	3.50E-11	NA	1.49E-10	NA	1.84E-10	NA
Arctic Ground Squirrel	1.09E-09	NA	4.63E-09	NA	5.72E-09	NA
Ptarmigan	1.71E-07	NA	7.25E-07	NA	8.96E-07	NA
Berries	5.93E-08	NA	2.52E-07	NA	3.11E-07	NA
Marine fish (Arctic Char)	1.14E-05	NA	4.83E-05	NA	5.97E-05	NA
Freshwater fish (Lake Trout)	2.94E-07	NA	1.64E-06	NA	1.94E-06	NA
Total Adjusted ILCR¹	1.21E-05 (1.20E-05)	3.36E-07 (3.04E-07)	5.17E-05 (3.04E-05)	8.87E-07 (7.69E-07)	6.38E-05 (4.24E-05)	1.22E-06 (1.07E-06)

Notes:

¹Corresponding FEIS values presented in parentheses

Shaded cells = ILCRs greater than 1.0E-05

ILCR = Incremental lifetime cancer risk

References:

Health Canada. 2010. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. Version 2.0. Revised 2012. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Richardson, G. M. and Stantec Consulting Ltd. 2013. *Canadian Exposure Factors Handbook*. Toxicology Centre, University of Saskatchewan: Saskatoon, SK.

7. ID #KIA-FEIS-07

7.1 SUBJECT/TOPIC

Noise effects significance

7.2 REFERENCES

FEIS, Volume 6, Section 5.4.1.4, Page 5-102.

"The residual effects due to noise and vibration were assessed as Not Significant (Volume 4, Section 3.10.6), and adverse effects to human health are not likely to occur. This is because the magnitude of the effects due to noise after mitigation were low or moderate at the identified human receptor locations. Residual effects are confined to the PDA or LSA, and are intermittent, of medium duration, and reversible."

7.3 SUMMARY

In the DEIS, the conclusion for noise was that the effects were non-significant; however, given that many thresholds for human health are exceeded, adverse effects may occur for human health.

7.3.1 Importance of Issue

It is important to ensure that human health risks for workers due to excessive noise are appropriately mitigated.

7.3.2 Detailed Review Comment

In the DEIS, the conclusion for noise was that the effects were non-significant in part because "management practices or mitigation is available (but was not incorporated into the noise modeling) to decrease noise in areas where the magnitude may be higher". However, this explanation has since been removed in the FEIS. Review of FEIS, Volume 4, and Section 3 reveals that predicted sound pressure levels have already assumed all best practices and mitigation measures are included. With numerous exceedances of human health thresholds for workers, such as thresholds for sleep disturbance, speech interference, and the potential for annoyance from both continuous noise and instantaneous noise, it seems more likely that adverse effects will occur for human health. In particular, if there are no additional mitigation measures offered, it seems unlikely that these residual effects will be mitigated.

7.4 RECOMMENDATION/REQUEST

Please describe additional mitigation that will be used to reduce the human health impacts of noise on workers to below Health Canada thresholds, the thresholds for sleep that are important for the long-term health of workers. If none is available, discuss impacts to human health due to these exceedances.

7.5 TMAC RESPONSE FOR KIA-FEIS-07

Exposure of acoustic and vibration emissions on workers (including work camps and accommodations related to the subject of study) is legislated by applicable occupational health and safety standards and regulations. TMAC will abide by occupational health and safety regulations, and provide our workers with a safe work environment, including work camp accommodation areas.

8. ID #KIA-NIRB-08

8.1 SUBJECT/TOPIC

Monitoring and mitigation

8.2 REFERENCES

FEIS, Volume 6, Section 5.4 and 5.6.

8.3 SUMMARY

This issue was first discussed in KIA-IR-117 and KIA-DEIS-25, where a monitoring program that would feed into/trigger an updated HHRA and ERA, in the event of differences between the modelled predictions and measurements, was suggested. In response, TMAC referenced various management plans pertaining to air quality, wildlife, and The Follow-up and Adaptive Management Plan (Volume 1, Annex 13), etc. During meetings held during the DEIS hearings, TMAC indicated that they would consider adding an adaptive feedback trigger to re-run the ERA and HHRA models, should values measured end up much higher than anticipated. However, no additions were made in the FEIS.

8.3.1 Importance of issue

The HHRA and ERA were heavily dependant on the modelled results of the predicted soil and water concentrations. An updated HHRA and ERA would be much more accurate and useful, once actual environmental concentrations are available through monitoring. Continued use of these tools, should be considered in adaptive management to better describe and communicate human health risk and environmental risk to stakeholders.

8.3.2 Detailed Review Comment

Gap/Issue

The monitoring and adaptive management plans listed do not presently require any feedback to the HHRA or ERA. The general comments such as “should monitoring results indicate effects beyond those predicted, a review of the mitigation measures currently employed will be undertaken” (WMMP, Annex 22), require little in a practical sense. The current adaptive management for the wildlife management plan does not monitor tissue concentrations in wildlife, nor does it have any explicit implications for human health. Many of the plans listed often require even less concrete actions. The “Follow-up and Adaptive Management Plan” referred to, was not located in the FEIS or DEIS.

Instead, we propose an adaptive management component for the HHRA and ERA that would be triggered if the models do not accurately predict COPCs due to the project. In the event that COPCs due to the project are identified in soil, water, or other media. In such a case, the HHRA and ERA would be completed again with the new information, so that human health risks and environmental risks can be communicated.

Disagreement with DEIS conclusion

The effectiveness of the Human Health and Environmental Risk Assessment rest heavily on soil and water models, which must inherently make significant assumptions. As a result, the model outcomes have significant uncertainties. The proposed adaptive HHRA and ERA would monitor and alert those concerned in the event that human health guidelines are expected to be exceeded and which scenarios are of concern. For example, monitoring plans could include potential adaptive responses to objective exceedances such as "evaluation of potential impacts and conduct an updated HHRA".

Reasons for disagreement with DEIS conclusion

The current monitoring and mitigation plans do not connect with the predicted HHRA and ERA. Using these tools again in adaptive management would strengthen the management approach, and in the event of exceedances of the modeled values, it would allow for communication of potentially important risks.

8.4 RECOMMENDATION/REQUEST

We recommend the following:

- Consider adding more potential responses to adaptive plans. For example, if modelled predictions are exceeded, conducting an updated HHRA or ERA and providing this information in existing monitoring reports.

8.5 TMAC RESPONSE FOR KIA-NIRB-08

A series of management plans have been developed for the Hope Bay Project. Details of the Environmental Management System (EMS) and associated environmental management and adaptive management plans are described in Volume 1, Section 10 of the FEIS.

As per Section 9 of the Nunavut Impact Review Board (NIRB) EIS guidelines, the environmental management plans include regular monitoring and reporting of site surface water and groundwater quality, air quality, noise quality, aquatic effects, and wildlife mitigation and monitoring, etc. As per the requirements of the Project Certificate and the terms and conditions of the Type A Water License for the Phase 2 Project, the results of environmental monitoring will be reported on a monthly or annual basis (depending on the type of monitoring performed). The KIA will continue to have

opportunities to review monthly and annual reports for all environmental effects monitoring at Hope Bay. As such, the KIA will have opportunities to discuss and have input into adaptive management for the Project either directly with TMAC or through the continual and adaptive feedback process which the NIRB manages for all approved Projects. TMAC believes that adaptive management will be the first step in reducing any emissions before they exceed predicted levels (especially considering several are regulated limits) over the life of the project. HHRA's are commonly done in scenarios where a contamination legacy exists as a result of a significant accident or malfunction, or a situation where insufficient or no regulatory oversight resulted in a legacy site. The regulatory oversight for the Hope Bay Project, along with comprehensive environmental monitoring, reporting and adaptive management is sufficient to protect wildlife and people.

9. ID #KIA-NIRB-09

9.1 SUBJECT/TOPIC

Effects of road dust on vegetation communities

9.2 REFERENCES

Volume 3, Section 2.2.1, Page 2-3
Volume 3, Section 2.6.5.3, Page 2-49 to 2
Volume 8, Section 8.5.2.2, Page 8-50
Volume 8, Section 8.5.3.3, Page 8-60
Volume 8, Section 8.5.4, Table 8.5-3, Page 8-61
Volume 8, Section 8.5.4.2, Page 8-79
Volume 8, Section 8.5.5.2, Page 8-84 and 8-86
Volume 8, Section 8.8, Page 8-90
Annex V8-2, Section 2.2., Page 4

9.3 SUMMARY

The FEIS (section 8.5.2.2) states that airborne fugitive dust and contaminants are potential effects from the Project that could alter Vegetation and Special Landscape Features, and that the long-term cumulative effects of dustfall on arctic plant communities can be substantial.

Mitigation strategies (Section 8.5.3.2) include “a speed limit of 50 km/hr on all Phase Project roads to reduce dust generation, and that dust control will be carried out, as needed, on all-season roads. Dustfall monitoring will also be undertaken to evaluate the assessment of dust effects on vegetation and determine if additional monitoring or mitigation is required.”

The FEIS states (Table 8.5-3) that after mitigation, no alteration of vegetation and Special Landscape Features indicators outside of the PDA is expected because of fugitive dust or other airborne contaminants. Additionally, all alteration effects are anticipated to occur within the PDA and are accounted for as a loss. However, the FEIS appears to contradict this statement in section 8.5.4.2, where it states, “Where effects remain after the application of mitigation measures, these are not expected to occur outside of the PDA. The exceptions to this are potential effects from fugitive dust which may affect areas outside the PDA.”

Quantitative air modeling was performed and indicated that “fugitive dust will not result in exceedances of Canadian Council of Ministers of the Environment agriculture guidelines for metal concentrations in soils” and in instances where baseline metal

concentrations exceed these guidelines, Project effects will result in minor increases to soil concentrations but not predicted to cause risks to human health. Based on this assessment, vegetation was not expected to be negatively altered by the Project due to fugitive dust or other airborne emissions, and this potential effect was not considered further in the assessment.

The FEIS further states in Section 8.5.5.2 and 8.5.5.3 that residual effects to the Vegetation VEC and Special Landscape Features VEC are **Not Significant** as the magnitude is low, and the geographic extent of the effects are limited to the PDA.

The Impact statement (Section 8.8) says “direct loss and alteration of Vegetation and Special Landscape Features are predicted to occur primarily during the Construction phase for Madrid-Boston” and that residual effects are Not Significant and will be limited to the PDA. Effects due to alteration were not identified outside the PDA after mitigation, and alteration was excluded from further assessment.

9.3.1 Importance of Issue

The cumulative effects of dust deposition over time on arctic vegetation and special landscape features located next to unpaved roadways can be significant due to their sensitivity and fragility. Demonstrated road dust effects are both physical (e.g., blocking stomata) and chemical (e.g., introduction of minerals and changes in soil pH) in nature. These effects have been shown to alter vegetation composition and productivity many hundreds of metres away from roads (i.e., well beyond the 100 metre PDA defined in the FEIS). Fugitive dust from other sources (e.g., mines) is also a concern. Sources of local traditional knowledge have stated that fine dust from mines travels “many, many miles before it lands.”

9.3.2 Detailed Review Comment

Dust from roads (and other sources) has been shown to have some of the most damaging effects on vegetation communities in northern arctic ecosystems, due to their sensitivity and the prevalence of gravel roads (Farmer, 1993). These direct and indirect impacts to vegetation communities extend well beyond the construction period, and can have estimated recovery times of centuries to millennia (Chapin and Shaver, 1985; Forbes *et al.*, 2001).

Demonstrated effects of dust include alterations to vegetation communities due to changing pH. This often leads to an increased amount of graminoids, which can outcompete sphagnum, mosses, shrubs, lichens, and forbs (Myers-Smith *et al.*, 2006). Road dust may also contain significant concentrations of metals (Santelmann & Gorham, 1988). Lichens are sensitive to metals and sulfur dioxide, which can be introduced through dust and other emissions (Myers-Smith *et al.*, 2006).

Dust is expected to have significant impacts regardless of road location (Leadley *et al.*, 1996). Factors which influence the distance dust will travel include traffic, gravel properties, size and amount of dust particles, moisture content, use of dust suppressants, and wind direction (Everett, 1980). Dust impacts have been shown to increase over time, with significant changes in vegetation communities observed beyond 100 metres from roadside (Myers-Smith *et al.*, 2006). Dust effects have been measured 200 metres (Santelmann and Gorham, 1988) to over a kilometre away from roadside (Everett, 1980). Dust effects (vegetation alteration) have been modeled to occur up to 600 metres away on the Dalton Highway, dependent on road location (Leadley *et al.*, 1996). Another study on road dust observed that Lakes within 1 km of the Dempster Highway generally had higher values for alkalinity, conductivity, TDS, pH, and minerals (Gunter, 2017).

Dustfall was included in air quality models conducted for this project; however, exceedance thresholds were established based on ambient air quality guidelines and standards for human health and are not specific to vegetation. Based on the results of other previous studies, it is unlikely that the effects of dust on vegetation and special landscape features will be restricted to the 100 metre PDA as stated in the FEIS, despite the mitigation measures proposed (e.g., speed limits and dust suppression measures). It is likely that some alteration of vegetation communities will occur beyond 100 metres from roadside, particularly in later years of operation and dust levels accumulate.

9.4 RECOMMENDATION/REQUEST

KIA recognizes that some dust mitigation measures have been specified, while others are optional.

The KIA requests the following additions:

- Ensure that dustfall and vegetation monitoring will capture potential impacts that extend beyond the PDA to allow for compensation and offsetting, and better inform future planning and best practices (e.g., optimal location of fences or spot treatments);

KIA requests that road and road upgrades also limit the amount of fine particles (<0.075mm) to below 20% whenever possible.

9.5 TMAC RESPONSE FOR KIA-NIRB-09

TMAC has conducted baseline dust sampling and has a dust fall monitoring program in place for the existing Doris and proposed Phase 2 development that distinguishes Project-related dust fall from background [existing] levels. This program evaluates the amount of dust being deposited upwind and downwind from the Project to determine the contribution of the Project to natural dust fall levels within and outside of the PDA, as previously requested and agreed to by the KIA.

The existing and proposed dust fall sampling program is identified in the Air Quality Management Plan (Annex V8-2). Also, Section B.2.2 of the Hope Bay Project Air Quality Management Plan presented in the FEIS includes dust fall monitoring locations intended to quantify dust fall levels with distance from the Doris-Windy All Weather Road. The proposed dust fall monitoring stations will be situated from between 50 m to 200 m from the road (both within and outside the PDA), with the intent to quantify the gradient in dust fall levels with distance from the road.

TMAC commits to conduct vegetation monitoring if the results of dust fall monitoring indicate that there is the potential for effects on tundra vegetation beyond that predicted in the PDA.

TMAC confirms that road and road upgrade construction material will limit the amount of fine particles (<0.075 mm) to below 20% whenever possible. The existing technical specifications for all site road construction specify Run of Quarry material, which is coarse well graded rock, and surfacing material, which has a maximum of 15% finer than 0.08 mm. It is therefore not anticipated that meeting this objective will require any additional controls.

10. ID #KIA-NIRB-10

10.1 SUBJECT/TOPIC

Invasive Plant Management

10.2 REFERENCES

Volume 8, Section 8.5.2.2, Page 8-51

Volume 8, Section 8.5.3.3, Pages 8-57 to 8-59

10.3 SUMMARY

The FEIS acknowledges that invasive species are the second biggest threat to biodiversity after habitat loss, and that their introduction and spread could be due to equipment and vehicle operation and transportation along all weather roads, and furthermore, areas of disturbed soil can increase the chances of their establishment. Climate change can potentially exacerbate the risk of invasive plant establishment, as warming temperatures permit species to grow that might not otherwise be adapted to tolerate cold conditions. Climate change should therefore be considered as part of a long-term management strategy.

The FEIS states that “Invasive plant species management for the Project will be informed by the Pest Management Plan for

Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia (BC MOFR 2015), which outlines an integrated pest management (IPM) approach for invasive plants. This indicates that an invasive plant management plan specific to the project will not be developed as a stand-alone document and will be based on guidance documents for different geographic regions and ecosystems. While the paucity of information on invasive plants in arctic ecosystems is acknowledged, a project specific invasive plant management plan should be developed which can be updated based on best practices and available research on arctic ecosystems.

The FEIS further states “in the event that invasive plant species are observed on site, a monitoring program will be developed.” This indicates that invasive plant monitoring is intended to be reactive, rather than proactive, which can have implications for management. Some invasive species can be very hard to identify by non-specialists. Early detection is essential to manage invasive plants.

10.3.1 Importance of Issue

Effective management of invasive plants will require an adaptive management plan with ongoing monitoring, particularly as the potential risk of colonization and establishment of invasive plant species increases due to warmer arctic temperatures.

10.3.2 Detailed Review Comment

Climate model projections show an Arctic-wide end of century increase of 13 Celsius in late fall and 5 Celsius in late spring for a business-as-usual emission scenario (Overland et al., 2013). These temperature increases can change ecological conditions significantly, making conditions less severe and permitting establishment and spread of new plants, including invasive species that could potentially harm natural systems and outcompete native plants.

Between 2005 and 2010, the number of alien plant species in the NWT increased from 94 to 116. These are mostly found in or near communities, near roads and along disturbed areas such as cut-lines, pipelines and mine sites (NWT, 2015). This trend may correlate with observed trends in climate and human activity.

The NWT (2015) states that some introduced plant species have succeeded in spreading in some Arctic habitats, mostly those already disturbed by human activities. Introduced plant species can spread and cause harm to natural habitats, out-competing native plant species.

10.4 RECOMMENDATION/REQUEST

The KIA requests the following:

- Develop an adaptive management plan for invasive plants that incorporates most recent information regarding the occurrence, establishment, spread, and control of invasive plants in Arctic tundra ecosystems, including potential implications of changing climate on vegetation. The plan should include a monitoring component that focuses on early detection.

10.5 TMAC RESPONSE FOR KIA-NIRB-10

TMAC understands the importance of invasive plants and has a program in place to address this issue. This is a national concern where a number of management practices have already been developed that are directly applicable to the Hope Bay Project. It is not necessary to develop a Project-specific invasive plant species management plan. Regardless, TMAC commits to including a section in the Wildlife Mitigation and Monitoring Plan (WMMP) on invasive plant species detection and management, and report in the annual compliance report.

The objectives of the invasive vegetation monitoring program are to:

1. Detect the presence of invasive plant species within and adjacent to the Project footprint through long-term monitoring; and
2. Assess disturbed areas to determine recolonization by plants, invasive or native.

Methods

Surveys specific to invasive plant species will occur in focal areas that have been disturbed. The survey area will expand as necessary to include disturbed areas as the Project develops. Site selection considers potential entry points and locations where there is a higher volume of humans, vehicles, and equipment entering or leaving the site (i.e., Roberts Bay laydown areas, along the airstrip, and camps).

Presence/absence sampling methods will be used to survey areas where invasive species are most likely to be found, because it is an efficient and targeted method for surveying invasive plants (ANPC 2012; Government of Alberta 2014; Oldham 2007). The method involves surveys targeting disturbed habitats (i.e., along buildings, infrastructure and roads). Targeted areas are surveyed on foot with some sections surveyed in a vehicle at slow speeds along the roads.

No invasive plant species have been detected at the operating Doris Site during Phase 2 Project baseline surveys which conducted 52 ground surveys and 100 wetland surveys in 2010 and a rare plant survey by an expert rare plant botanist in 2014. Monitoring will continue every 3 to 5 years in conjunction with other monitoring programs or as triggered by observations of exotic invasive plant species.

Should invasive plants be identified on site, control and possible eradication methods would be developed based on guidance documents identified in the FEIS:

- Integrated Vegetation Management Plan: For Transmission Rights-of-way (BC Hydro 2010);
- Invasive Alien Plant Program: Reference Guide (BC MFLNRO 2010);
- Pest Management Plan for Invasive Alien Plants on Provincial Crown Lands in Central and Northern British Columbia (BC MOFR 2010); and
- Invasive Species Council of British Columbia (ISCBC 2017)

References:

Alberta Native Plant Council. 2012. ANPC guidelines for rare plant surveys in Alberta — 2012 update. 22 pp. (<http://anpc.ab.ca/wp-content/uploads/2015/01/Guidelines-For-Rare-Plant-Surveys-in-AB-2012-Update.pdf>)

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Oldham, M.J. 2007. 2006 survey of exotic plants along Northwest Territories highways.
Presented to the Government of the Northwest Territories. 44 pp.
(http://www.enr.gov.nt.ca/sites/enr/files/reports/exotic_plants_survey.pdf)

11. ID #KIA-FEIS-11

11.1 SUBJECT/TOPIC

Road effects and traffic management for wildlife VECs

11.2 REFERENCES

FEIS, Volume 4, Sections 9.8.3.3, 9.10.3.3, 9.12.3.3, 9.14.3.3

11.3 SUMMARY

Disruption of Movement, including the impact of roads, was re-evaluated in the FEIS and considered to have residual effects for all mammalian wildlife VECs (caribou, grizzly bear, muskox, furbearers). The magnitudes of the predicted effects were predicted to be low, and residual effects were rated Not Significant after using planned mitigation and management, an in consideration of anticipated low traffic levels. However, traffic rates exceed the threshold set by TMAC for grizzly bear and wolverine, for the road section between Madrid and Doris; very little is known about the spatial movement patterns and preferences of these species through the RSA. These factors make it difficult to agree with a low magnitude rating without further information or monitoring that can lead to informed responses.

To mitigate disruption of movement due to traffic, TMAC proposes several mitigation measures, including vehicle management. To enable further protections of the movement patterns of wildlife VECs, we recommend traffic rate monitoring, and that traffic rates (presented seasonally, and not just as an annualized average) be reported for each stretch of Phase 2 road with WEMP reports. If traffic rates known to disrupt wildlife movements are indicated over important seasons (e.g., migration periods), these data may be used for adaptive management. Such data will also supply valuable information to use alongside radio-collar data, and camera monitoring data to investigate impacts of large-scale variations in traffic rates on interaction of wildlife with roads associated with the project.

11.3.1 Importance of Issue

The significance of road effects on wildlife is dependent on accurate estimates of traffic levels, as well as strong supporting studies of wildlife movement and behaviour. If actual traffic rates during Project construction and operation are higher than predicted, wildlife movements and migration could be significantly disrupted. This is important for species that have disturbance thresholds lower than the traffic rates they may encounter at the Project site (of which there are some reported for this project within the FEIS; namely, grizzly bear and wolverine). It is also important to have this

information to compare traffic rate fluctuations on caribou herds that pass through the Project area during fall and/or spring migration.

11.3.2 Detailed Review Comment

Gap/Issue

In the KIA's review of the DEIS, we commented on TMAC's use of a traffic rate of 20 vehicles per day to assess impacts of traffic on wildlife, which did not match traffic rates reported in the project description (KIA-DEIS-01). The KIA thanks TMAC for updating these traffic estimates in the FEIS, including a breakdown by year and road sections in Table 9.8-20. The maximum predicted traffic levels occur on the 9.5 km stretch of road from Doris to Madrid, wherein rates are predicted to include 98 return trips per day, or 196 one-way trips, or vehicles, per day. This is 9.8-fold higher than the traffic rates assessed within the DEIS.

For grizzly bear and wolverine, TMAC made revisions in the FEIS and used a more conservative >100 vehicles per day threshold, following the results of Northrup *et al.* (2012), which were applicable to grizzly bear. Predicted traffic on Doris-Madrid portion of the Phase 2 road exceed this threshold throughout the life of the Project (51-98 return trips per day, corresponding to 102-196 vehicles per day; Table 9.8-20); yet, TMAC argues that Phase 2 roads will not significantly disrupt grizzly bear and wolverine movement because traffic rates will only exceed thresholds and impact movements over a short (14%) segment (pp. 9-449, 9-477). The magnitudes of the impacts of existing and proposed roads were considered negligible for caribou and low for grizzly bear, wolverine, and muskox. In technical comment KIA-DEIS-01, we also provided a literature review of the impacts of roads on grizzly bear, caribou, and wolverine.

We agree that Phase 2 roads are likely sufficiently permeable to ungulates based on the expected traffic levels predicted for the project but question their permeability to grizzly bear and wolverine.

Disagreement with WL information/ conclusion

We have low confidence in TMAC's conclusion that disruption of movement due to Phase 2 road traffic is of low magnitude for species where thresholds are exceeded. TMAC selected a threshold of >100 vehicles per day for grizzly bear and wolverine and expected traffic on the Doris-Madrid road exceeds this threshold by double the value. Higher traffic rates on this road section can be ignored because it is 14% of the total length of road (9.5 km of 67.3 km), if this is an area over which wildlife movement is more important and frequent compared to areas further south within the RSA. However, we do agree species that are wide ranging can generally navigate around infrastructure if those required diversions are infrequent. It will be those portions of the population that forage and move more frequently along the coastline that may be negatively impacted by this threshold exceedance. We also note that a key recent research paper on

wolverine is not yet included in the FEIS; this study suggests a lower threshold that would be exceeded over the entire length of road (Scrafford *et al.* 2018).

The residual effects analyses for disruption of movement for grizzly bear and wolverine had low confidence ratings, partly due to the high uncertainty around effects of traffic and roads on wildlife movement. We agree with this confidence rating. Because of this threshold exceedance and low confidence, additional monitoring and adaptive management measures should be put in place. Specifically, we recommend that at least two real time traffic counters be put in place within the southern (south of Madrid) and northern (north of Madrid) sections of road. These real time traffic data will be invaluable alongside other monitoring programs already proposed, as they will allow TMAC to relate traffic variability to variability in impacts on wildlife movement and spatial patterns. If unforeseen impacts are seen, or if traffic rates are higher than anticipated, traffic can be further managed to minimize impacts.

Reasons for disagreement

TMAC set a >100 vehicles per day threshold for grizzly bear and wolverine; however, they subsequently argued that exceedances of this threshold would be inconsequential. Further, new research suggests a more appropriate threshold for wolverine would be 60 vehicles/24 hours, which is exceeded along the length of the road (67.3 km), which may be of greater consequence.

There is not enough known about preferred travel corridors used by the species potentially affected. We also do not know the degree to which traffic will fluctuate seasonally, during periods that may correspond to wildlife migration. This uncertainty warrants a greater effort put into monitoring for seasonal and spatial patterns in traffic rate exceedances and related movement impacts on wildlife.

11.4 RECOMMENDATION/REQUEST

The KIA requests that TMAC:

- Re-assess road impacts on wolverine using a threshold based on the latest research (30 vehicles/12 hrs, or 60 vehicles/24 hrs);
- Install two traffic counters – one along the Doris-Madrid road section and one along the road section between Madrid-Boston;
- Analyze actual traffic rates (seasonally) in each of the two main sections of the road (vs. wildlife monitoring data, (matched temporally and spatially) around roads (e.g., satellite-collared caribou data), and include results in annual Wildlife Monitoring reports; and
- Use results to inform adaptive management.

11.5 TMAC RESPONSE FOR KIA-FEIS-11

TMAC acknowledges the KIA's concern about the potential effects of the proposed road and traffic on grizzly bear and wolverine movement. TMAC attempted to address this concern by updating traffic forecasts, and discussing the concern and likelihood of risk with the elders and land users in workshop. While literature suggests that wolverine and grizzly bear may show a behavioural response to roads in southern environments, local knowledge holders did not reflect concern about that response.

Updating the effects assessment to reflect a potential higher sensitivity to traffic volumes will not further inform Project-related effects significance determination on grizzly bear or wolverine.

In association with other technical comments, TMAC commits to the following:

1. TMAC will quantify road traffic as a number of vehicle passes per day throughout a year and report annually in the WMMP compliance report (i.e., as per response to GN-20).
2. TMAC will consider the traffic levels, observed effects, and reflect on adaptive management options in consultation with the IEAC.

Discussion:

The FEIS evaluated the potential for the proposed Phase 2 road and vehicle traffic to disrupt the movement of terrestrial mammals, including caribou, muskox, wolverine and grizzly bear. TMAC used the best available information at the time of writing of the FEIS, including monitoring reports from the Doris site, a review of mitigation measures by Inuit Elders and landusers on site, and the scientific literature. Based on these sources, the FEIS concluded that the average daily traffic on site is unlikely to impede the movements of terrestrial wildlife VECs.

The KIA reviewer recommended updating the assessment of disruption of movement using a journal article by Scrafford et al. (2018). TMAC reviewed this article and notes that it was not available for consideration in the FEIS as it was published after the submission of the FEIS in December 2017.

TMAC does not agree that the Scrafford et al. (2018) article warrants a reassessment of wolverine disruption of movement because this study has limited applicability to the Project site in terms of the landscape, level of habitat alteration, and human activity. The Scrafford et al. (2018) study was conducted on radio-collared wolverines in the boreal forest of northern Alberta on the border with British Columbia. Scrafford et al. (2018) estimated the density of roads within the seasonal ranges of collared wolverines, with the ranges represented by 95% minimum convex polygons (MCPs). Roadways included all season roads (both paved and unpaved) and temporary winter roads. The average density of roads within the winter home range of male and female wolverines were 0.62

km/km² and 0.58 km/km², respectively. Within the summer home ranges, the average density of roads was 0.66 km/km² and 0.55 km/km² for males and females, respectively. Hence, the study area for the Scrafford et al. (2018) is different from the Project site in two key respects:

- 1) the Scrafford et al. (2018) study is located in a forested environment vs. the open tundra of the Project site, and
- 2) The Scrafford et al. (2018) study site has a much higher road density (0.62 km/km² and 0.58 km/km²) than the Project site (0.015 km/km² in the RSA).

The Scrafford et al. (2018) study reported that collared wolverines increased their rate of movements when nearer to roadways relative to areas further from roads regardless of traffic volumes, and increased traffic volumes, up to 30 vehicles/12 hr (2.5 vehicles/hr), resulted in quicker movement rates when wolverines were near roads. However, Scrafford et al. (2018) states:

“wolverines are always forced to be near roads because of the abundance of roads on the landscape and their need to move across roads to find foraging and breeding opportunities as well as patrol their home range. However, wolverines attempt to stay away from the immediate road corridor, where the risk of predation is likely greatest, with increased movement. We hypothesize that wolverines disproportionally rely on speed when there is risk from roads because strong avoidance would prohibitively increase the time needed to patrol their expansive home ranges in environments with abundant roads”.

Scrafford et al. (2018) hypothesizes that increased movement rates near roadways is due to predation risk by wolves in the cleared road right of way, compared to the surrounding forested environment. Obviously, this does not apply in the open tundra of Nunavut.

These results highlight that the behaviours found during the Scrafford et al. (2018) do not reliably extended to the Project site with: 1) lower road densities, 2) lower levels of human activity and 3) the open terrain of the tundra – i.e., the Boston road will not create a break in the forest where wolves can see wolverine.

Furthermore, the Scrafford et al. (2018) does not evaluate whether or not wolverines crossed or did not cross roads in relation to road networks or traffic levels, and cannot be extended for use for a potential threshold for when a barrier to movement may occur. Scrafford et al. (2018) also states:

“wolverine populations in our study appear robust based on the capture history of individuals. This probably means that the threshold of road density, or the magnitude of human use of roads necessary to elicit negative effects at the population level, has not yet occurred in our study area”

As stated in the FEIS, the proposed Boston road and associated traffic volumes are not expected to alter wolverine movement patterns and the effect is rated as Not Significant. It is possible that wolverines that may come in contact with the Project roads may elicit similar responses to collared wolverines in the Scrafford et al. (2018), with higher movement rates near roadways. However, the wolverine population in the area in the area is considered to be stable and robust (Volume 4, Section 9.14.4.1). Therefore, it is unlikely that these increased movement behaviours will result in a population level effect based on the conclusions of Scrafford et al. (2018).

References:

Scrafford. M. A., T, Avgar, R. Heeres, and M.S. Boyce. 2018. Roads elicit negative movement and habitat-selection responses by wolverines (*Gulo gulo luscus*). Behavioral Ecology, 395:27-36

12. ID #KIA-FEIS-12

12.1 SUBJECT/TOPIC

Migratory stand watch survey methods and results

12.2 REFERENCES

FEIS Volume 4, Section 9.2.10.2, 9.2.11.2, 9.16.3.3, 9.16.3.5, 9.18.3.3, 9.18.3.5
FEIS Volume 1, Annex V1-7 Type A Water Licence Applications, Package P5-8,
Section 3.1

12.3 SUMMARY

The proposed wind turbines at Doris and Boston sites were assessed by TMAC for potential effects on migratory birds, including raptors, waterbirds, and upland birds. No residual effects of disruption of movement were predicted for any bird VECs because a minor percentage was observed flying within the potential zone of interaction with wind turbines. Migration was also observed to be broad front (rather than a concentrated movement "corridor") without any topographic features constraining movement. Therefore, TMAC concluded that birds would be able to manoeuvre around the wind turbines.

Residual effects of direct mortality were predicted due to the risk of collision with wind turbine blades. However, based on the lack of avian collision reports at Diavik Diamond Mine, the limited number of proposed wind turbines for Hope Bay Phase 2 (vs. 'wind farms'), placing turbines away from waterbird breeding habitat and high use areas, and considering the sensitivity and resiliency of local bird populations, TMAC concluded that the residual effects of direct mortality were Not Significant.

We have questions about the methods used for the baseline migratory standwatch surveys for raptors and waterbirds. In addition to these questions, one major issue is the lack of baseline data collection at all proposed and preferred turbine sites as indicated in Package P5-8, including the Madrid site. For Doris and Boston sites, the data collected show that a substantial proportion of birds were observed within the wind turbine danger zone.

We recommend conducting additional spring migration surveys, at appropriate times to capture peak migration at Madrid, Boston, and Doris sites (early to mid-May) prior to construction. We also recommend that annual monitoring at wind turbines be conducted at appropriate times to capture peak migration periods for all bird VECs.

12.3.1 Importance of Issue

Although TMAC has included some baseline data from spring and fall migratory standwatch surveys in the FEIS, we have concerns regarding the methods used for these surveys, as well as TMAC's conclusions based solely on these survey results. Adequate baseline data are needed to evaluate the potential impacts of the proposed wind turbines on all bird VECs (raptors, waterbirds, and upland birds). Additional spring baseline data are required, which can be collected prior to construction.

12.3.2 Detailed Review Comment

Gap/Issue

During the DEIS review, the KIA requested baseline information on migratory flight paths, altitudes, and timing for relevant species; as well as an impact assessment and mitigation methods for the proposed turbines on migratory birds and other wildlife (KIA-DEIS-04). TMAC has now included migratory standwatch surveys as part of the characterization of baseline conditions for raptors, waterbirds, and upland birds at the Doris and Boston sites. However, Package P5-8 (Hope Bay Project: Wind Energy Project Preliminary Design) indicates that six wind turbines are proposed at three sites: Doris, Madrid, and Boston. In addition, Section 3.1 in Package P5-8 describes SRK Consulting's preferred turbine locations based on key siting criteria (Table 2.2): D2 for Doris, M3 and M4 for Madrid, and B5 and B6 for Boston. If this is the same set of codes used for the migratory standwatch surveys in FEIS Section 9.2.10.2, then these preferred turbine locations are not where the baseline migratory standwatch surveys were conducted. Furthermore, there appear to be data gaps in the seasonal migratory data that were collected (early spring migration period missing), and for spring migration information at the Boston site.

Disagreement with WL information/ conclusion

Baseline data collection should be performed at all proposed and preferred wind turbine locations. We request that TMAC confirm that six wind turbines are proposed for Doris, Madrid, and Boston sites; and specify which alternative locations (as described in Package P5-8) may be moved forward into construction.

The Methods section for migratory standwatch surveys describes three survey sites, one of which is no longer proposed (Doris, D-2), for the installation of wind turbines.

The timing of surveys is shown in Table 9.2-16, which shows that spring surveys took place from May 31 to June 5, while fall surveys occurred from September 2 to 7. (Note that the Boston B-1 survey site was added in the fall of 2017, meaning that no spring survey was conducted at this site.) According to the Government of Canada, the regional nesting period in the Project area is mid-May to mid-August (Government of Canada, 2017). This means that the spring standwatch surveys, which began two weeks after the early

breeding period, were likely 3 weeks to a month after the associated migration of these species. Hence, the early spring migration may have been missed.

TMAC also established a list of criteria to determine whether birds should be considered flying in the potential zone of interaction with wind turbine blades (p. 9-164). There are some inter-site contradictions in how these criteria were used, however. One criterion for potential interactions with turbines at the Doris site involved determining whether birds were "*flying within 750 m of the observer (horizontally)*". However, we are unclear as to why the criterion used at the Boston site predicts an interaction with the turbine if birds are "*flying within 3 to 5 km of the observer (horizontally)*". These criteria could use additional explanation or rationale/justification.

We also note that another criterion for inclusion is that birds are "*flying in a southerly direction in spring and a northerly direction in fall*". We believe this is a typo, but one worth correcting because the wording in this criterion would discount all migratory bird flights.

The timing of the surveys for spring migration leaves a gap in the data, as the peak migration may not have been captured. We are also concerned about the lack of spring migration surveys at the Boston B-1 site and suggest that conclusions cannot yet be drawn about the potential impacts of wind turbines at this site without adequate baseline data for spring migration. Further, we require clarification on why TMAC utilized different horizontal 'danger zones' for Boston (3-5 km) and Doris (750 m) sites.

Although we do not necessarily disagree with arguments made by TMAC regarding the relatively low collision risk of the proposed turbines, we recommend appropriate baseline data for spring and fall migratory periods be collected for liability reasons prior to construction and recommend annual monitoring for collision-related avian deaths to ensure that these predictions of non-significance are accurate and to enable adaptive management, where appropriate.

Reasons for disagreement

- There are insufficient baseline data to be able to assess the potential impacts of the proposed wind turbines at the Boston B-1 site. Fall migration survey data showed that a large number of waterbirds pass through the Boston area, in fact, 92% of all observations (3,325 of 3,611) were at the Boston site. Additional surveys are needed to assess the abundance of species and individuals that pass through the Boston site during spring migration, for which a survey was not conducted.
- There are insufficient baseline data to be able to assess the potential impacts of the proposed wind turbines at all turbine locations in Package P5-8, Tables 3.1 (Doris), Table 3.2 (Madrid), and Table 3.3 (Boston). In the FEIS, no migration survey data were collected for the Madrid site. There is also a disconnect between preferred turbine locations stated in Package P5-8 and migratory stand watch survey locations.

- Until TMAC provides further explanation/rationale, we are interpreting the different horizontal distance criteria used at Boston and Doris to mean that different distances between survey locations and proposed turbine sites were used between locations. It is unclear why this occurred and additional clarification is needed.
- The Government of Canada (2017) describes the general nesting period in the Arctic for migratory birds as being from mid-May to mid-August. Therefore, TMAC should likely have conducted spring migratory stand watch surveys in early to mid-May (rather than late-May to early-June), to capture peak migratory activity.
- TMAC proposes to monitor wind turbines for bird mortality for a period of two years of wind turbine operations during spring and fall migration, as per ECCC recommendations. Adaptive management will be triggered if mortality exceeds two raptors (p. 9-483), 14 waterbirds (p. 9-500), or 14 upland birds (p. 9-515) per year; or if mortality due to wind turbines is reported for any bird species of conservation concern. We recommend that the timing of monitoring of avian deaths due to wind turbines also be conducted to capture peak migration periods. If bird strikes are not found in a timely manner, the carcasses may act as an additional attractant to grizzly bear, wolverine, and carrion-consuming raptor species; consumption of carcasses by predators will also lead to an underestimation of collision events.

12.4 RECOMMENDATION/REQUEST

The KIA requests that TMAC:

1. Provide clarification on the proposed and preferred wind turbine locations;
2. Conduct migration surveys at the proposed Madrid sites;
3. Conduct additional spring migration surveys at Boston and Doris sites in early-to-mid May to capture peak migratory activity for raptors, waterbirds, and upland birds;
4. Provide further details about monitoring of wind turbines, including timing in relation to peak migration periods;
5. Provide clarification on the different horizontal distance criteria (3-5 km at Boston, 750 m at Doris) used to determine whether birds are flying within the potential zone of interaction.

12.5 TMAC RESPONSE FOR KIA-FEIS-12

To address concerns about birds and wind turbines, TMAC conducted stand-watch surveys during the spring and fall migration at the proposed wind turbine locations to quantify the number of birds that could potentially interact with the turbines. In this response, TMAC answers the technical questions posed by the KIA and makes commitments for future surveys to address the request by the KIA.

1. Clarification on the proposed and preferred wind turbine locations

Package P5-8 (Hope Bay Project: Wind Energy Project Preliminary Design) indicates that six wind turbines are proposed at three sites: Doris, Madrid, and Boston. Package P5-8 describes and maps SRK Consulting's preferred turbine locations based on key siting criteria (Package P5-8, Section 3.1; Figures 2-7): D2 for Doris, M3 and M4 for Madrid, and B5 and B6 for Boston. The preferred locations were selected as the approximate locations for the proposed wind turbines, and were mapped as Project components (Figure KIA-12-1).

2. Conduct migration surveys at the proposed Madrid sites

Migration surveys were conducted at Doris wind turbine sites in the spring (May 31 to June 4, 2017) and fall (Sep 5 to Sep 7, 2017) and at Boston wind turbine sites in the fall (Sep 2 to Sep 4, 2017).

Commitment: TMAC commits to conducting additional migration surveys at the proposed wind turbine pad locations prior to construction (for baseline purposes), and during the appropriate survey time period to capture peak migratory activity for raptors, waterbirds, and upland birds.

3. Conduct spring migration surveys in early-to-mid May

The spring migration standwatch surveys were conducted over a five day period (36 hours of survey effort) between May 31 to June 5, 2017 based on local knowledge. Although the ECCC guidelines for the timing of nesting in the region suggest that nesting begins as early as mid-May (ECCC 2017), local spring migration movements observed during baseline and monitoring studies, and Inuit TK of the site (Banci and Spicker 2016) indicate that local conditions at Hope Bay (i.e., freshet, ambient temperatures) typically warrant nest initiation dates that extend into June.

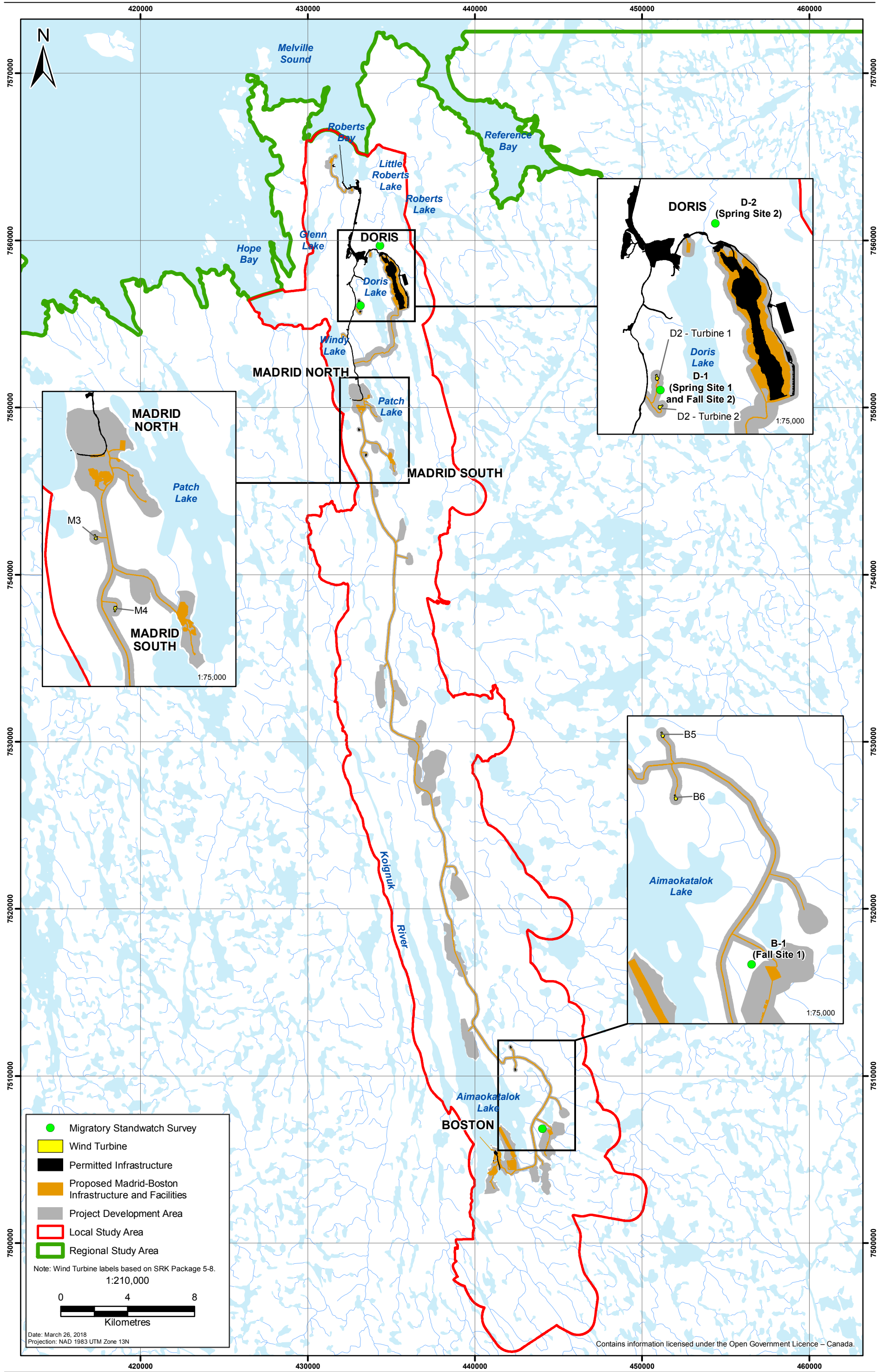
Cliff-nesting migratory raptor species typically arrive on the tundra in May, larger-bodied waterbirds arrive in mid-May to early June, and smaller-bodied waterbirds and upland breeding birds arrive in late May to early June.

Commitment: TMAC commits to conducting additional migration surveys at the proposed wind turbine pad locations (for baseline purposes), earlier in the season to meet ECCC (2017) guidance to capture peak migratory activity for raptors, waterbirds, and upland birds.

4. Monitoring of wind turbines

The FEIS describes that TMAC will monitor birds at the wind turbines for a 2-year period post-construction to determine if adaptive management is required. From the FEIS (Section 9.16.2.2):

Figure 1
Migratory Standwatch Survey Locations in the Regional Study Area, 2017



- monitoring of wind turbines for raptor mortality will be conducted for a period of two years during wind turbine operations during spring and fall migration, as per recommendations in Environment Canada (2007b).

The details of the monitoring plan will be finalized and presented in the WMMP prior to construction of the turbines for review and comment by the KIA. The monitoring program will adhere to ECCC's Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (ECCC 2007). To ensure that monitoring methods are of good quality, TMAC will consult with ECCC prior to construction of wind turbines, to discuss bird monitoring priorities, proposed surveys, objectives and permit requirements.

5. Clarify the horizontal distance criteria for the wind turbine zone of interaction

The horizontal distance criteria for the migration standwatch surveys was determined based on the surveyors proximity to the proposed wind turbine locations. The horizontal distance criteria was one of several criteria used to identify birds within the potential zone of interaction with wind turbines. Additional criteria included: flying at a height above the observer (vertically) between 50 m and 200 m, and flying in a northerly direction in spring, and a southerly direction in fall (based on the position of the survey site relative to the proposed wind turbine location (Volume 4, Chapter 9, Section 9.2.10.2). Survey locations for migratory stand watches are selected to provide the greatest unobstructed view of passing migrants. The survey locations are generally at a prominent feature on the landscape and have a clear line of site to turbine locations. Differences in the horizontal distance criteria at the Boston and Doris site are due to the selection of survey locations which meet the criteria of an unobstructed view and clear line of site to turbines.

At the Doris site, the D-1 migration survey site (Spring Survey Site 2 and Fall Survey Site 1 and Fall Site 2) was approximately 750 m from the proposed D2 wind turbine location, therefore a horizontal distance of 750 m was one criteria used to determine the potential zone of interaction (Figure KIA-12-1). At the Boston site, the B-1 migration survey site (Fall Site 1) was approximately 3 km from the proposed B6 wind turbine location and 5 km from the proposed B5 wind turbine location, therefore a horizontal distance of 3 to 5 km was one criteria used to determine the potential zone of interaction (Figure KIA-12-1).

TMAC has committed to conducting additional migration surveys at the proposed wind turbine locations prior to construction, during the appropriate survey time period (prior to the nesting period) in order to capture peak migratory activity for raptors, waterbirds, and upland birds. The additional surveys will be conducted in close proximity to the proposed wind turbine locations, whereby reducing the inconsistencies between horizontal distance criteria used at Doris and Boston sites.

13. ID #KIA-FEIS-13

13.1 SUBJECT/TOPIC

Habitat suitability mapping for furbearers (wolverine)

13.2 REFERENCES

FEIS Volume 4, Section 9.2.9.2, Table 9.2-37, Table 9.2-38, Figure 9.2-31a, Figure 9.2-31b.

13.3 SUMMARY

The KIA first noted issues with the wolverine habitat models in KIA-IR28. TMAC acknowledged typos and agreed to correct them. Issues rendering mapping information incorrect/opposite to results remain.

TMAC performed habitat suitability mapping for wolverine as a representative furbearer VEC. They calculated that most (81.1%) of the habitat in the LSA was "Not Suitable" for wolverine. Based on the habitat suitability mapping results, TMAC then calculated that 920 ha of suitable denning habitat would be lost due to the Project Development Area (PDA), corresponding to 8.6% of the 10,667 ha of suitable habitat available in the LSA, and only 0.5% of the total 173,360 ha available in the RSA. TMAC concluded that the residual effect was Not Significant for several reasons: no wolverine dens were found within the PDA, only a small amount of suitable denning area will be removed compared to the amount of habitat available in the LSA and RSA, and the local wolverine population is expected to have low sensitivity and good resilience.

Although we agree that the amount of habitat loss due to the PDA is small compared to the LSA and RSA, we note that Figure 9.2-31a showing wolverine denning habitat suitability does not at all correspond to the numbers calculated in Table 9.2-37. The figure (9.2-31a) has a lot of red (suitable) habitat, with disproportionately more red area in the LSA than the RSA. Unless the figure is wrong, rather than the table, the amount of direct habitat loss from the PDA is likely more than 920 ha, (indirect habitat loss on top of this would be quite high).

13.3.1 Importance of Issue

Habitat loss is a potential Project-related effect for all wildlife VECs, including wolverine and furbearers. It is important to characterize the amount of suitable habitat available at baseline, and the amount expected to be lost due to the Project. In the FEIS, there is a major discrepancy between the numbers calculated from habitat suitability modelling for wolverine, and the corresponding mapped figure shown in the FEIS.

13.3.2 Detailed Review Comment-Gap/Issue

In the FEIS, Table 9.2-37 shows habitat suitability modelling results for wolverine denning habitat. The Table shows that approximately 19% (10,667 ha) of the Project LSA is rated as suitable denning habitat for wolverine, while 81% (45,673 ha) is rated as not suitable. Similarly, approximately 35% (173,360 ha) of the Project RSA is classified as suitable denning habitat, and 64% (313,620 ha) is not suitable for wolverine. However, Figure 9.2-31a appears to show the opposite classifications because there is a disproportionately high amount of red (suitable habitat) in both the LSA and RSA, with disproportionately more red areas within the LSA.

In addition, Table 9.2-38 shows habitat suitability modelling results for grey wolf denning habitat. Although approximately 93% of the LSA is rated as moderate-low suitability, Figure 9.2-31b shows that the habitat in both the LSA and RSA is predominantly green (nil rating). Interestingly, the habitat calculations for the RSA appear to be correct in Table 9.2-38, where 93.5% was rated as nil. However, the effects assessment for grey wolf was not carried further by TMAC because of their close relationship with caribou.

Disagreement with WL information/ conclusion

Given the colour ratings in Figures 9.2-31a and 9.2-31b, we disagree with the calculated numbers in Tables 9.2-37 and 9.2-38. Therefore, we question the numbers used to calculate habitat loss in the Project's effects assessment.

Reasons for disagreement

We disagree with the numbers in Tables 9.2-37 and 9.2-38 because they do not match up with the colour schemes shown in Figures 9.2-31a and 9.2-31b.

13.4 RECOMMENDATION/REQUEST

The KIA requests that TMAC:

- Investigate the discrepancies between habitat suitability modelling tables and figures as shown in the FEIS;
- Provide an explanation of the true results of habitat suitability modelling for wolverine and grey wolf; and
- Re-evaluate the potential effects of habitat loss on wolverine using the corrected habitat suitability modelling results.

13.5 TMAC RESPONSE FOR KIA-FEIS-13

Habitat suitability modeling for the EIS was conducted using vegetation maps produced using Terrestrial Ecosystem Mapping (TEM) for the Project in the Local Study Area (LSA)

and a landsat-based vegetation map from the West Kitikmeot / Slave Study (WKSS) for the regional study area (RSA). The TEM mapping was used in the LSA so as to provide the most accurate estimate of habitat loss and alteration possible; the TEM mapping is more accurate than a satellite-based mapping product.

These two mapping products were combined for evaluation of Project effects, as noted in the FEIS (p-9-292) "To calculate the amount of good-quality habitat within the RSA using the best possible data, the results of habitat suitability mapping based on the ecosystem mapping in the LSA was combined with the suitability mapping produced with the ELC mapping in the RSA". The TEM was originally created in 1997 (Rescan 2011) and has undergone several reviews and adjustments based on field studies and air photo interpretation to ensure mapping of TEM polygons reflects current conditions, with the last adjustment made in 2015. The WKSS mapping was produced in 2001 based on the results of four year study (1997 to 2000) which included image analysis and fieldwork (Matthews, Epp, and Smith 2001).

The habitat loss and alteration values presented in the DEIS and FEIS are based on the TEM mapping. The maps presented in the DEIS and FEIS use the WKSS-based habitat suitability as a background image for the map. The results of the TEM and WKSS mapping was very similar in most cases. In the case of the wolverine mapping, the WKSS mapping erroneously showed more high quality habitat than the TEM map, leading to the observed difference between the map and the table.

Suitable habitat for wolverine is defined as terrain that could accumulate snow to maintain denning habitat over the early spring season. In the TEM mapping, this is considered as any polygons that contained rocky outcrops (RO), rivers (RI), drier heath tundra on hillslopes (Betula-Ledum-Lichen, BL), ponds (PD), and mine spoils (MS).

Note, if the habitat loss values were based on the WKSS instead of the TEM, the results of the habitat loss assessment would have been the same at the scale of the LSA and RSA.

References:

Rescan. 2011. Hope Bay Belt Project: 2010 Ecosystems and Vegetation Baseline Report. Prepared for Hope Bay Mining Ltd. by Rescan Environmental Services Ltd.: Vancouver, British Columbia.

Matthews, S., H. Epp, and G. Smith. 2001. Vegetation classification for the West Kitikmeot/ Slave study region. Final report to the West Kitikmeot/Slave Study. Yellowknife, NT.

14. ID #KIA-FEIS-14

14.1 SUBJECT/TOPIC

Fisheries Offsetting

14.2 REFERENCES

V5-S6 Freshwater Fish Section 6.5

Appendix V5-6AA

Appendix V5-6AB

V5-S10 Marine Fish Section 10.5

Appendix V5-10G

14.3 SUMMARY

TMAC has identified that there will be a loss of fish habitat in both the freshwater and marine environments because of Project Infrastructure and water taking. The FEIS relies in several places on the successful implementation of a Fisheries Offsetting Plan to mitigate potential residual effects resulting from Phase 2. However, both the Freshwater and Marine Conceptual Offsetting Plans only identify a procedural framework and potential offset options "should its development be deemed necessary by DFO". These offset plans provide little detail on area of potential habitat gains. As offsetting is used, as a key mitigation measure to avoid residual effects, potential gains to fish habitat should be explicitly outlined within the EIS to assess whether losses have the potential to be adequately compensated.

14.3.1 Importance of issue

It is important to understand the severity of the effects to fisheries productivity and to have supporting documentation that the proposed mitigation measures will sufficiently counterbalance these losses. Although a final determination on fisheries offsetting as required under the Fisheries Act will be determined by DFO, it is important to outline sufficient details of the offsetting in the EIS, particularly as offsetting is used as a key mitigation measure to reach the conclusion that there are no residual effects to fish and fish habitat.

14.3.2 Detailed Review Comment

Gap

During the technical review of the DEIS, the KIA indicated, "the EIS relies in several places on the successful implementation of a Fisheries Offsetting Plan to mitigate potential residual effects" resulting from Phase 2. The balancing of fisheries losses with offsetting is a key mitigation measure used in several sections of the Freshwater Fish and Fish Habitat effects assessment. Conceptual Fisheries Offsetting Plans were included in the draft EIS, however did not provide sufficient information to assess whether the fisheries losses would be balanced by fisheries gains. Both the Freshwater and Marine Conceptual Fisheries Offsetting Plans only identify a procedural framework and potential offset options for a Fisheries Offsetting Plan, "should its development be deemed necessary by DFO". The KIA requested that more detail be provided in the freshwater and marine fisheries offsetting plans to determine whether offsetting gains would counteract habitat losses as indicated in the EIS.

In response to the technical comment, TMAC made the following commitments:

- KIA-DEIS-34 Part 1: "As recommended/requested by DFO in their technical comments (refer to DFO-3.1.4 and DFO-3.2.2), TMAC will work as required with DFO and KIA as required to develop a freshwater and marine fisheries offsetting plan." Timeline – FEIS
- KIA-DEIS-34 Part 2: "TMAC commits to quantifying predicted habitat loss/alteration using area units (e.g. in m²) in the FEIS submission" Timeline - FEIS
- DFO-3.1.4: "TMAC will work with Fisheries and Oceans Canada's Fisheries Protection Program and local Inuit to develop a freshwater fisheries offsetting plan" Timeline – FEIS
- DFO-3.2.2: "TMAC will work with Fisheries and Oceans Canada's Fisheries Protection Program and local Inuit to develop a marine fisheries offsetting plan" Timeline – FEIS.

While the FEIS includes some updates to the requests made by the KIA and commitments made by TMAC, namely the inclusion of predicted habitat loss/alteration calculations using area units in m², the offsetting plans submitted in the FEIS have largely remained conceptual with little detail on the potential calculations for habitat gains. These preliminary calculations are essential for quantifying whether the potential for offset outlined in the conceptual offsetting plans are adequate to offset the losses indicated in the FEIS to reach the conclusion in the EIS of no residual effects due to habitat loss.

The FEIS indicates a total freshwater habitat loss area of **7,335.9 m²** (267 m² from culvert crossings; 2,837 m² from intakes/discharge infrastructure; and Total PAD of 4,231.9 m² resulting from water withdrawal/use). Without Offsetting, this would account for a residual effect, but the proponent makes the argument that through mitigation, including offsetting, there are no residual effects. For example the FEIS states: **"As a result of mitigation, balancing fisheries losses with fisheries offsetting, and monitoring plans there are no residual effects anticipated on the VEC freshwater fish habitat due to Madrid-Boston Project water withdrawal and use."**

The marine chapter in the FEIS also indicates habitat loss because of project infrastructure, but the proponent uses the argument that design of the infrastructure would negate effects, as it would in itself offset any loss of habitat.

14.4 RECOMMENDATION/REQUEST

Habitat losses have been identified and quantified during the FEIS and a DFO authorization is likely to be required since the proponent uses offsetting as a mitigation measure to conclude no residual effects. Thus, a commitment should be made by TMAC to develop a Conceptual Freshwater and Marine Offsetting Plan that includes preliminary gain calculations for potential offsetting options, in communication with DFO and KIA, prior to issuance of a Type A Water Licence during the NWB Licensing phase. This is critical to ensure that there are enough potential offsetting options to assess whether offsetting has the potential to counterbalance habitat losses predicted during the EIS to reach the conclusion of no residual effects. A detailed Freshwater and Marine Fisheries Offsetting Plan could then be submitted during the permitting phase prior to DFO authorization.

14.5 TMAC RESPONSE FOR KIA-FEIS-14

TMAC will work with DFO, the KIA and Inuit Environmental Advisory Committee to identify candidate offsetting options with a preference for developing a community-based offsetting program located near Cambridge Bay. Studies are planned for spring/summer 2018.

As described in Appendix V5-6AA, TMAC will work with DFO, the KIA and the IEAC to develop an offsetting plan that includes offsets commensurate with anticipated fisheries losses as part of regulatory processes. As indicated during the November 2017 meeting with DFO (refer to Appendix V5-6AB), TMAC is keen to investigate off-site community-based options for offsetting potential Project-related effects. Off-site, community-based offsetting can provide a broader range of benefits than just improvements to fisheries. TMAC is planning to identify potential offsetting options near Cambridge Bay during spring/summer 2018 which will provide the basis for calculating preliminary fisheries gains. TMAC's preference at this stage is to consider a Cambridge Bay-based project contributing to the overall objectives of the commercial Arctic Char fishery through the Arctic Char IFMP and/or to a subsistence fishery. TMAC will also consider the implementation of complementary measures (i.e., monetary contributions to existing research programs).

Estimated Fish Habitat Losses

In advance of the selection of suitable offsetting options, fish habitat losses were calculated based on anticipated project activities, as summarized in Section 6.5 of the FEIS. Estimated fish habitat losses are reproduced in Table 14-1 below, based on the

original Table 6.5-15 of the FEIS (Estimated PAD of Stream Fish Habitat from Water Withdrawal and Use for the Madrid-Boston Project). One correction from the FEIS was made and presented as a shaded cell in Table 14-1 reducing the total habitat losses of P.O. Outflow by 2,046 m² (only 16.7 m² of glide habitat is estimated to be lost, and not 2,063 m² as incorrectly reported in Table 6.5-15 of the FEIS where all cells (including year) had been summed).

Based on this correction, a total freshwater fish habitat area of **151,778 m²** or **15.18 ha** is predicted to be lost from the Madrid-Boston Project. Potential freshwater fish habitat loss in streams comprises 267 m² of in-water crossing footprints (culvert) and 2,131 m² (0.21 ha) resulting from anticipated water withdrawal/use and resultant drawdown. Streams predicted to be affected by culverts, are generally of low habitat value with only Ninespine Stickleback (fish that support CRA species) present. Only one crossing location, (representing 132 m²) had moderate habitat value with Slimy Sculpin and Arctic Grayling present in addition to Ninespine Stickleback. For streams predicted to be affected by drawdown, habitat losses were conservatively predicted based on the maximum modelled drawdown over the life of the project despite drawdown generally only being temporary in most streams (14 of 22 project years) and maximum drawdowns only occurring over one to two years. Additionally, fish densities in these streams are low, ranging from <0.01 fish/m² to 2.3 fish/m² for Ninespine Stickleback and <0.01 fish/m² to 0.10 fish/m² for Arctic Char (Doris Creek and Little Roberts Outflow only). Other large-bodied salmonids including Lake Trout, Lake Whitefish, and Cisco were occasionally captured but capture rates were too low to estimate density.

Potential freshwater fish habitat loss in lakes comprises 2,837 m² of in-water footprints (intakes/discharge infrastructure) and 146,543 m² resulting from anticipated water withdrawal/use and resultant drawdown in Imniagut Lake which contains only Ninespine Stickleback (fish that support CRA species); no large-bodied fish inhabit the lake likely due to its poor connectivity to Patch Lake, even during high flows.

In the Madrid-Boston Project FIES, a total marine fish habitat area of **9,675 m²** or **0.97 ha** is predicted to be lost resulting from the construction of the Roberts Bay Cargo Dock. Conversion of this fish habitat area loss to habitat equivalent units (HEU) using the habitat evaluation procedure (HEP) results in 4,766 HEU, although dock design and sizing remains to be finalized.

Table 14-1. Total Estimated PAD of Stream Habitat from Water Withdrawal and Use for the Madrid-Boston Project

Watershed	Stream	Total Stream Length (m)	Total Stream Area (m ²)	Max. Reduction in Hope Bay Project-affected September Streamflow*			PAD (m ²)					PAD (% of Total Stream Area)
				Streamflow (m ³ /s)	% Reduction from Baseline	Year	Glide	Pool	Riffle	Cascade	Total	
Doris	Imniagut Outflow ^o	30	120	N/A	N/A	N/A	120.0	-	-	-	120.0	100
Doris	Patch Outflow	155	1,810	0.084	18.4	2031	19.6	52.0	-	-	71.6	4.0
Doris	P.O. Outflow ^s	39	402	0.105	15.6	2031	16.7	-	-	-	16.7	4.2
Doris	Ogama Inflow	998	7,636	0.306	6.0	2031	258.3	47.7	33.6	1.4	341.0	4.5
Doris	Ogama Outflow	1,276	13,551	0.273	6.9	2031	97.1	59.2	38.9	-	195.2	1.4
Doris	Doris Outflow	4,469	25,521	0.283	18.4	2031	786.8	93.8	20.6	144.1	1,045.2	4.1
Doris	Little Roberts Outflow	1,310	19,132	1.053	20.3	2031	218.2	93.4	18.6	-	330.2	1.7
Aimaokatalok	Stickleback Outflow ^t	262	262	0.001	25.0	2031	61.1	4.3	-	-	65.4	25.0

Notes:

PAD = Potential alteration to, or destruction of, fish habitat; calculated as reduction in channel top width estimated from hydraulic modeling multiplied by channel length

* maximum reduction of simulated September Hope Bay Project-affected streamflow compared to simulated September baseline streamflow during the life of the Madrid-Boston Project (i.e., Years 1 to 22)

^o No hydraulic model; PAD is equal to total habitat area

^s No hydraulic model; PAD estimated based on relationship between streamflow reduction from baseline and glide habitat loss in Patch Outflow (nearest upstream channel)

^t No hydraulic model; PAD estimated as 25% of total habitat area)

The total combined freshwater and marine fish habitat loss area for the Madrid-Boston Project is therefore predicted to be **161,453 m²** or **16.15 ha**.

Fisheries Offsetting Precedence at the Hope Bay Project and in Nunavut:

To assess the potential feasibility for offsetting anticipated fisheries losses associated with the Madrid-Boston Project, consideration of the magnitude of predicted fish habitat losses from previously approved projects in Nunavut is warranted. Through the assessment, permitting, and development of the Doris North Project (part of the Hope Bay Project), losses of **76.657 ha** of freshwater fish habitat and **0.176 ha** of marine fish habitat were predicted and authorized (DFO Fisheries Authorizations NU-02-0117 and NU-02-0117.3), with compensation programs subsequently developed and undertaken (Golder 2007, ERM 2014, ERM 2016). Other projects in Nunavut, approved by the NIRB (i.e., Meadowbank, Meliadine, Mary River, and Back River), predicted freshwater and/or marine fish habitat losses during project-approval phases ranging from approximately **25 ha** to over **300 ha** (AEM 2012, AEM 2015, AEM 2016, Golder 2014, Baffinland 2012, Sabina 2015).

The predicted habitat area loss for the Madrid-Boston Project is equivalent to only 21% of the authorized loss of the Doris North Project, and between less than 5% and 65% of the habitat area losses predicted in the other approved projects across Nunavut provided as examples above. Therefore, predicted habitat losses from the Madrid-Boston Project are within an order of magnitude of (and up to 95% less than) those predicted for previously approved projects where offsetting commensurate with anticipated losses was considered technically feasible. In these cases there was limited concern that offsetting options would be unavailable or insufficient to counterbalance predicted habitat losses and projects were approved to proceed. There is thus precedence that a suitable offsetting plan may be developed to offset the predicted habitat losses associated with the Madrid-Boston Project, and within the framework of an EIS, offsetting is considered a suitable mitigation measure to prevent significant residual effects.

Preliminary gain calculations:

Multiple preliminary offsetting options were outlined in the Conceptual Fisheries Offsetting Plans submitted with the Madrid-Boston Project FEIS (Appendix V5-6AA and Appendix V5-10G). Given that TMAC's preference at this stage is to consider a Cambridge Bay-based project which seeks to enhance fish passage, preliminary habitat gain estimates and support that habitat gains associated with this option have the potential to counterbalance habitat losses predicted in the FEIS are described below.

Barrier Removal on Freshwater Creek, Kitiga Falls, or Other Rivers Identified

A proposed offsetting option identified in the FEIS includes enhancing fisheries productivity through removal of barriers (e.g., natural or anthropogenic) that prevent Arctic Char from reaching overwintering/spawning habitats in upstream lakes. A

preliminary option proposed in the FEIS (refer to Appendix V5-6AA) included Freshwater Creek where a poorly-constructed culvert (UTM coordinates, Zone 13 N 503818E 7672034N) along the road from Cambridge Bay to Ovayok Territorial Park was identified as a potential barrier to fish passage; other permanently or temporarily (i.e., during low flows) compromised natural areas may also exist. Another potential option identified was along the Kitiga River where Kitiga Falls may pose a partial barrier to migration during low flows.

During spring/summer of 2018, TMAC will engage with the IEAC, KIA, and HTOs through meetings in Cambridge Bay to confirm preliminary offsetting site options and/or to identify other offsetting options. TMAC will undertake field surveys in summer 2018 to ground-truth offsetting options, and refine objectives, constraints, and opportunities associated with each site. These activities will contribute to preliminary gain calculations in support of the development of a Fisheries Offsetting Plan.

An offsetting program involving barrier removal was applied for the Doris North Project through the enhancement of migratory channels through a low flow barrier (i.e., boulder garden) in Roberts Outflow to allow Arctic Char and Lake Trout that were previously getting stranded in the boulder garden to reach spawning and overwintering habitat in upstream Roberts Lake. Offsetting accounting for this project involved quantifying the total HU for Arctic Char in Roberts Lake as habitat gains, based on the successful passage of Arctic Char to use those habitats. The success of barrier removal has been demonstrated at the Roberts Outflow over three post-enhancement monitoring years. Survival of Arctic Char passing through the migratory channel in Roberts Outflow (i.e., avoiding stranding) has been demonstrated to be approximately 50% to 55% greater than in pre-enhancement years at comparable stream discharge (ERM 2016). It is assumed that this increase in access to upstream habitats will be translated into increased fisheries productivity over time, and therefore will more than offset anticipated losses associated with the Doris North Project.

The total lake area of Roberts Lake is 383 ha. Grenier Lake, located upstream of Freshwater Creek has a total area of > 3,500 ha and Kitiga Lake located upstream of Kitiga Falls has a total area of > 10,000 ha. Given the size of the upstream lakes in the two stream systems proposed as offsetting options for the Madrid-Boston Project, it is conceivable that HU gains and increased fisheries productivity resulting from an increase in access by Arctic Char (or other migratory salmonids) to upstream lake habitats after the removal of fish passage barriers would offset the relatively small amount of habitat area predicted to be lost from proposed Madrid-Boston activities.

References:

AEM. 2012. Agnico Eagle Mines Meadowbank Division - No Net Loss Plan. October 15, 2012.

AEM. 2015. Agnico Eagle Mines Meadowbank Division - Fish Habitat Offsetting Plan: Phaser Lake. July, 2015.

AEM. 2016. Agnico Eagle Mines Meadowbank Division – Conceptual Fish Habitat Offsetting Plan: Whale Tail Pit. June 2016.

Baffinland. 2012. Mary River Project Environmental Impact Statement - Volume 10, Appendix 10D7: Fish Habitat Compensation Plan.

ERM. 2014. Doris North Project: 2014 Windy Lake Shoal Compliance Monitoring Program. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd. Yellowknife, NT.

ERM. 2016. Doris North Project: 2015 Roberts Lake Fish Enhancement Monitoring Program. Prepared for TMAC Resources Inc. by ERM Consultants Canada Ltd.: Yellowknife, NT.

Golder. 2007. Doris North Project No Net Loss Plan. Prepared for Miramar Hope Bay Ltd. by Golder Associates Ltd. Edmonton, AB.

Golder. 2014. Conceptual Fisheries Protection and Offsetting Plan – Meliadine Gold Project, Nunavut. Prepared for Agnico Eagle Mines Ltd. by Golder Associates Ltd.

Sabina. 2015. Back River Project Conceptual Fish Offsetting Plan. November 2015.

15. ID #KIA-FEIS-15

Subject/Topic

Water Withdrawal PAD calculations

15.1 REFERENCES

V5-S6 Freshwater Fish Section 6.5.4.2

15.2 SUMMARY

Potential fish habitat losses (PAD) are calculated based on base case and not high groundwater sensitivity case scenarios. Adaptive mitigation, including additional offsetting should be indicated to compensate for the high groundwater sensitivity case should monitoring and subsequent habitat loss calculation indicate that the high sensitivity case is likely to be realized.

15.2.1 Importance of issue

It is important to compensate for the losses of fish habitat. If the FEIS is based on the base case groundwater scenario, the resulting areas of habitat loss (residual effects) will not take into account a high groundwater sensitivity case. Thus, it should be explicitly stated that adaptive management and additional offsetting would be applied in the case where a high groundwater sensitivity case is deemed likely through monitoring.

15.2.2 Detailed Review Comment

TMAC has indicated that potential habitat losses (PAD) in streams resulting from water withdrawal and use were calculated only for the base case scenario and not the high groundwater sensitivity case as this case is not anticipated until 2030. TMAC further indicates that the potential effects to fish habitat loss will be monitored on an ongoing basis and if data from these monitoring programs indicate that high groundwater sensitivity case is likely, appropriate measures to evaluate and quantify fish habitat losses under this case will be applied. However, it is also important that if these habitat loss numbers are greater than those reported in the FEIS are, that additional offsetting will be implemented to compensate for these losses.

15.3 RECOMMENDATION/REQUEST

Please indicate whether additional mitigation through offsetting will be applied in, the case where high groundwater sensitivity is likely and habitat losses are greater than those reported in the FEIS are.

15.4 TMAC RESPONSE FOR KIA-FEIS-15

TMAC will apply adaptive management processes during monitoring. Should a high groundwater sensitivity case result in habitat losses that exceed those predicted for the base case, TMAC would apply an offsetting plan (as required by DFO) that is commensurate with these losses.

16. ID #KIA-FEIS-16

16.1 SUBJECT/TOPIC

Marine Fisheries Methodology

16.2 REFERENCES

To the document being reviewed/discussed (i.e. Document name, volume, section/sub-section, page number, and if relevant, table or appendix)-V5-S10 Marine Fish Section 10.5.1 3rd paragraph

16.3 SUMMARY

This section discusses the Methodology Overview for the Marine Fish and Fish Habitat Effects Assessment. However, the 3rd paragraph discusses Freshwater Fish and Fish Habitat. This is likely a copy over error.

16.3.1 Importance of issue

It is important to ensure that we are in fact discussing the marine fish and fish habitat sections.

16.3.2 Detailed Review Comment

This section discusses the Methodology Overview for the Marine Fish and Fish Habitat Effects Assessment. However, the 3rd paragraph discusses Freshwater Fish and Fish Habitat. This is likely a copy over error.

16.4 RECOMMENDATION/REQUEST

Please verify whether this is indeed a copy over error.

16.5 TMAC RESPONSE FOR KIA-FEIS-16

TMAC confirms that the discussion of freshwater fish and fish habitat in the 3rd paragraph of subsection 10.5.1 of V5-S10 Marine Fish is a copy over error. The paragraph should read:

“After the identification of potential interactions and potential effects (Steps 1 and 2), mitigation and management measures (including fisheries offsetting, see Section 6.2.3.1) were considered (Step 3). Madrid-Boston Project-related residual effects to marine fish VECs were then identified through characterization of the effect (Step 4). If the application of these measures were considered to effectively mitigate or offset the

effect, the Madrid-Boston Project-related effects to marine fish VECs were characterized as negligible and not identified as residual effects. Potential effects of Madrid-Boston in combination with Approved Projects were also characterized to identify residual effects of the Hope Bay Project, and characterized as negligible if the mitigation and management measures were considered effective (Step 5)."

17. ID #KIA-FEIS-17

17.1 SUBJECT/TOPIC

Arsenic Site-Specific Water Quality Objective

17.2 REFERENCES

V5-S4, Table 4.5-2, Section 4.5.1.2.

Golder. 2017. Back River Project - Development of a Site-Specific Water Quality Objective for Arsenic.

Technical Memorandum Prepared for Sabina Gold & Silver Corporation by Golder Associates.

February 2017.

Hutchinson Environmental Sciences Ltd. 2018. Boston-Madrid Final Environmental Impact Statement and Water Licence Arsenic Site-Specific Water Quality Objective. Prepared for the Kitikmeot Inuit Association

17.3 SUMMARY

The proponent has chosen long-term freshwater site-specific water quality objective for arsenic was incorrectly derived and is not sufficiently conservative for application to the Hope Bay belt-receiving environment.

17.3.1 Importance of issue

A more conservative SSWQO than that proposed in the Boston-Madrid FEIS highlights a diminished difference between the modeled changes resulting from the project and a change that would constitute a significant impact to the aquatic environment. This more limited operational flexibility underscores the need for robust environmental monitoring through the Aquatic Effects Monitoring Program (AEMP) and Surveillance Network Program (SNP) to ensure any changes to the aquatic environment are in line with those presented in the FEIS and any divergences are effectively adaptively managed in a timely manner.

17.3.2 Detailed Review Comment

The proponent has included non-resident species and chosen a less conservative statistical model to derive a long-term freshwater site-specific water quality objective

(SSWQO) for arsenic for the Hope Bay belt. The proponent's approach has resulted in a proposed SSWQO of 0.028 mg/L for arsenic.

HESL has recalculated the arsenic SSWQO accounting for the concerns outlined in the accompanying technical memorandum. We have removed the amphibian species *Lithobates pipiens*, the Leopard Frog, from the derivation dataset and selected the resulting SSWQO from the model outputs based on a statistical determination of best fit and conservatism. HESL derived an arsenic SSWQO of 0.019 mg/L.

While HESL's SSWQO does not alter the conclusions as presented in the Boston-Madrid FEIS, it highlights a diminished difference between the modeled changes resulting from the project and a change that would constitute a significant impact to the aquatic environment. All modeled arsenic concentrations are below HESL's updated SSWQO. This more limited operational flexibility underscores the need for robust environmental monitoring through the Aquatic Effects Monitoring Program (AEMP) and Surveillance Network Program (SNP) to ensure any changes to the aquatic environment are in line with those presented in the FEIS and any divergences are effectively adaptively managed in a timely manner.

Please see "Hutchinson Environmental Sciences Ltd. 2018. Boston-Madrid Final Environmental Impact Statement and Water Licence Arsenic Site-Specific Water Quality Objective. Prepared for the Kitikmeot Inuit Association" for more details.

17.3.3 Recommendation/Request

HESL recommends that TMAC adopt a long-term total arsenic SSWQO of 0.019 mg/L for application throughout the freshwater environment of the Hope Bay belt. This objective was derived following accepted CCME protocols; considers newly generated, high quality, applicable toxicity data; and is sufficiently protective of the aquatic life in the Project area.

Please see "Hutchinson Environmental Sciences Ltd. 2018. Boston-Madrid Final Environmental Impact Statement and Water Licence Arsenic Site-Specific Water Quality Objective. Prepared for the Kitikmeot Inuit Association" for more details.

17.4 TMAC RESPONSE FOR KIA-FEIS-17

TMAC has re-considered applying an SSWQO for arsenic at this early juncture of the Madrid-Boston Project. Instead, it will monitor potential changes to arsenic in the Project lakes through the AEMP. If arsenic levels increase significantly over time in a Project lake relative to the reference condition, or increase to 75% of the CCME water guideline, the development of an SSWQO could be considered as a medium or high action level response through the Aquatic Response Framework within the AEMP (including using the 0.0019 mg/L put forth by the KIA). TMAC re-considered this position because increases in arsenic above the CCME guideline are only predicted for Doris Creek for approximately

one month per year during post closure and the maximum predicted concentrations for the rest of the Project lakes are less than 50% the CCME guideline (0.005 mg/L) during all Project phases and are therefore safe for aquatic life. It is also likely the maximum arsenic concentrations in Doris Creek during post closure are overestimates because in the water quality modelling exercise (Annex V1-7, Package P5-4) conservatively routed TIA overflow directly to Doris Creek instead of northern Doris Lake (which is actual pathway) where arsenic would be diluted before flowing into Doris Creek. Nonetheless, from a water quality effects standpoint, the maximum arsenic concentration modelled in Doris Creek during post-closure (0.00999 mg/L), is far below the 0.019 mg/L arsenic SSWQO recommended by the KIA and using the assessment criteria outlined in Table 4.5-12 of the FEIS water quality assessment (Volume 5, Chapter 4) this would be considered an infrequent, low to moderate magnitude residual effect that will not result in significant effects in Doris Creek, and more broadly, through the Madrid-Boston Project area.

TMAC appreciates the KIA's information regarding the updated arsenic SSWQO of 0.0019 mg/L and will consider this value if an SSWQO is developed as part of the Aquatic Response Framework within the Madrid-Boston AEMP. This AEMP is currently being revised and will be provided to interested parties prior to the Final Hearing.

18. ID #KIA-NIRB-18

18.1.1 Subject/Topic

AEMP Water Quality Sampling Frequency

18.1.2 References

P4-18 Section 3.2.2

V5-S4 Section 4.5.4.2; Table 4.5-6

18.1.3 Summary

AEMP sampling frequency is not sufficient to assess predicted changes to water quality associated with effluent discharges into Aimaokatalok Lake as presented in the FEIS.

18.1.4 Importance of issue

Failure to collect samples during freshet will preclude confirmation of seasonally specific modeled changes to the aquatic environment as presented in the FEIS.

18.1.5 Detailed Review Comment

TMAC has indicated that the AEMP “*design, indicators, methodologies, and sampling frequency have been selected based on anticipated or potential effects related to Madrid-Boston development*”. The AEMP is therefore intended to confirm whether the predicted changes to the aquatic environment resulting from project activities are accurate and allow for timely adaptive management of any diverging effects.

TMAC has proposed a monitoring frequency in the AEMP that is incongruous to the predicted effects as presented in the FEIS. The predicted effects to Aimaokatalok Lake as presented in Table 4.5-6 of V5-S4 of the FEIS indicates differing scenarios under ice (both in high and low current scenarios), during freshet and in open water conditions. However, Table 3.1-2 of P4-18, the AEMP, indicates water quality sampling will only occur twice per year – once in April under ice and once in August in open water conditions.

This sampling frequency is not sufficient to assess project impacts and evaluate the accuracy of water quality predictions as outlined in the FEIS.

18.2 RECOMMENDATION/REQUEST

Water quality sampling should be conducted during freshet as well as under ice and in the open water season through the AEMP to align the field program with the predicted effects as presented in the FEIS.

The occurrence of freshet in the arctic is relatively brief (approximately two weeks); the timing of the freshet field event should rely on indicative meteorological data and local flow measurements.

18.3 TMAC RESPONSE FOR KIA-NIRB-18

Water quality sampling for the Madrid-Boston AEMP will be conducted once during the under-ice season (April) and three times during the open-water season (July, August, September) at MMER-specific sampling sites and twice annually (April and August) at non-MMER sampling sites. This approach is consistent with other Nunavut AEMPs (e.g., Back River, Meliadine). Within Aimaokatalok Lake, sampling will be conducted four times per year along the MMER discharge pathway to assess potential effects related to the treated water discharge.

Sampling the Project lakes during freshet is not proposed as this has not been done during the historical baseline programs, as part of the former Doris North AEMP, nor the current Doris AEMP. Additionally, ice off varies from lake to lake during freshet affecting the timing of sampling (Plate 1) and there are inherent safety risks associated with sampling lakes during the freshet when the lakes are partially ice covered with exposed perimeters. Water quality sampling will be conducted in July in Aimaokatalok Lake and Reference Lake B, however, shortly after ice off and the freshet period.

The Madrid-Boston AEMP is currently being revised and will be available to the interested parties prior to the Final Hearing on April 27, 2018.



Plate 1. Hope Bay lakes during freshet period. A) Patch Lake on June 21, 2011 looking south (ice covered); b) Doris Lake on June 21, 2011 looking south (partially ice covered).

19. ID #KIA-NIRB-19

19.1 SUBJECT/TOPIC

AEMP Parameter Suite

19.2 REFERENCES

- V1 Section 3.3.1.6
- P4-18 Section 3.2.2; Table 3.2-1

19.3 SUMMARY

The AEMP does not include any form of cyanide in the monitoring parameter suite. Cyanide is a contaminant of concern associated with the cyanide leach process that will be used as part of gold extraction at the Boston site.

19.3.1 Importance of issue

Neglecting to assess cyanide in the freshwater receiving environment will preclude a determination as to whether the cyanide destruction circuit and other management practices have mitigated the risks associated with that parameter to the aquatic environment.

19.3.2 Detailed Review Comment

TMAC notes that "Processing of ore at Boston will consist of sorting, crushing, milling, gravity concentration, floatation, cyanide leach, and gold recovery. The Boston process plant is expected to be similar to that of the Doris process plant. The Boston process plant will produce two types of tailings, flotation circuit tailings and detoxified tailings." Cyanide is therefore a contaminant of potential concern in the freshwater receiving environment (Aimaokatalok Lake) associated with mining and milling at the Boston site.

We are concerned that cyanide (weak acid dissociable nor total) has not been included in the AEMP parameter suite TMAC will use to assess the freshwater aquatic environment. Neglecting to assess cyanide in the freshwater receiving environment will preclude a determination as to whether the cyanide destruction circuit and other management practices have mitigated the risks associated with that parameter to the environment.

19.4 RECOMMENDATION/REQUEST

The AEMP parameter suite should be updated to include:

- weak acid dissociable cyanide, the form of the compound for which a CCME water quality objective exists, and
- total cyanide, the form of the compound that will be regulated under the forthcoming Metal and Diamond Mines Effluent Regulations (MDMER)

For more details on the MDMER, see "Government of Canada. 2017. Regulations Amending the Metal Mining Effluent Regulations. Vol. 151, No. 19 — May 13, 2017."

19.5 TMAC RESPONSE FOR KIA-NIRB-19

TMAC agrees to add free cyanide which has a CCME water quality guideline of 0.005 mg/L and total cyanide to the AEMP parameter suite for Aimaokatalok Lake and Reference Lake B.

20. ID #KIA-NIRB-20

20.1 SUBJECT/TOPIC

Preparation for Metal and Diamond Mine Effluent Regulations

20.2 REFERENCES

- P4-7 Section 5.4; Table 5-3
- P4-8 Section 4.2; Table 4-1

20.3 SUMMARY

TMAC has not applied the updated MDMER discharge criteria to all contact water that will be discharged from the site.

20.3.1 Importance of issue

MDMER is expected to come into force in 2018 and may pose operational challenges for the discharge of contact water with elevated

20.3.2 Detailed Review Comment

Mining at Boston and Madrid will require continued (from mining the Doris North ore body) discharges to the marine environment and will require discharges to the freshwater environment. These discharges will be regulated under the existing Metal Mines Effluent Regulations (MMER); TMAC has used those regulations for discharges to Roberts Bay (P4-7), the tundra (P4-8) and Aimaokatalok Lake (P4-8).

These proposed criteria are as follows:

Table 5-3 Effluent limits during periods of discharge to Roberts Bay

Parameter	Units	MMER
pH		6 to 9.5
Total Suspended Solids	mg/L	15
Total Cyanide	mg/L	1
Arsenic	mg/L	0.5
Copper	mg/L	0.3
Lead	mg/L	0.2
Nickel	mg/L	0.5
Zinc	mg/L	0.5
Radium	Bq/L	0.37

We acknowledge that these discharge criteria are in line with the current MMER, but note that discharges associated with Madrid North, Madrid South and Boston will all be subject to the updated Metal and Diamond Mines Effluent Regulations (MDMER) which is expected to come into force in 2018 (Government of Canada, 2017).

Under MDMER, discharges throughout the Hope Bay Belt will be subject to the more stringent discharge criteria presented in the updated Schedule 4, Table 2:

Item	Column 1	Column 2	Column 3	Column 4
	Deleterious Substance	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a: Composite Sample	Grab Sample
1	Arsenic	0.30 mg/L	0.45 mg/L	0.60 mg/L
2	Copper	0.30 mg/L	0.45 mg/L	0.60 mg/L
3	Cyanide	0.50 mg/L	0.75 mg/L	1.00 mg/L
4	Lead	0.10 mg/L	0.15 mg/L	0.20 mg/L
5	Nickel	0.50 mg/L	0.75 mg/L	1.00 mg/L
6	Zinc	0.50 mg/L	0.75 mg/L	1.00 mg/L
7	Suspended Solids	15.00 mg/L	22.50 mg/L	30.00 mg/L
8	Radium 226	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
9	Un-ionized ammonia	0.5 mg/L expressed as nitrogen (N)	Not applicable	1.00 mg/L expressed as nitrogen (N)

More stringent discharge criteria will not alter the conclusions presented in the FEIS but may present operational challenges to comply with the new regulations when discharging from contact ponds with elevated concentrations.

We note that while most MDMER discharge criteria has been incorporated into the water and load balance model, cyanide has not.

For more details on the MDMER, see “Government of Canada. 2017. Regulations Amending the Metal Mining Effluent Regulations. Vol. 151, No. 19 — May 13, 2017.”

20.4 RECOMMENDATION/REQUEST

We recommend TMAC update the Water Licence and FEIS applications to reflect the discharge criteria that will come into force under the updated MDMER.

TMAC should also include a discussion as to the feasibility of meeting MDMER criteria in both ongoing and intermittent discharges to the marine and freshwater environments and any operational changes that will be required to comply ensure compliance.

20.5 TMAC RESPONSE FOR KIA-NIRB-20

The Madrid-Boston Project Water and Load Balance, Hope Bay Project (Annex V1-7, Package P5-4) indicates that with the proposed mitigation measures, TMAC will be able to meet the current MDMER and proposed MDMER regulations for all mine effluents.

The report compares key parameters for mine effluents to the current MMER and the proposed MDMER in the main body text, see Table 20.1 below for reference locations. The key parameters were selected based on the project effects relative to baseline and do not include all MMER or MDMER parameters, such as cyanide. However, all model parameters for each mine effluent are presented in Annex V1-7, Appendix C-2 of Package P5-4 and were compared to the current MMER and proposed MDMER. It was found that all mine effluents meet the current MMER and proposed MDMER regulations throughout all stages of the mine life.

The Doris-Madrid and Boston Water Management Plans (Annex V1-7, Packages P4-7 and P4-8) reference the current MMER regulations, however do not present the proposed MDMER regulations as part of the current monitoring plans. TMAC will update these documents to include the proposed MDMER regulations prior to the proposed regulations coming into effect.

Table 20.1. Comparison of Key Model Parameters to the current MMER and proposed MDMER regulations

Mine Effluent	Summary WQ Results
Doris TIA Closure Runoff	Table 7-1 of P5-4
Marine Mix Box Discharge	Table 7-2 of P5-4
Combined Boston Effluent	Table 7-3 of P5-4
Boston TMA Closure Runoff	Table 7-4 of P5-4

21. ID #KIA-NIRB-21

21.1 SUBJECT/TOPIC

Confirmation of Model Predictions – Water Quality Monitoring

21.2 REFERENCES

KIA-DEIS-46

P5-4 Section 3.7.10, Section 7.4.2

V5-S4 Table 4.2-2

P4-18 Figure 3.1-1a and 3.1-1b

21.3 SUMMARY

The water balance and load model does not use water quality source terms from individual modeled lakes in the Boston, Madrid and Doris areas. The AEMP should be adjusted to ensure water quality monitoring is sufficient to confirm all modelling results.

21.3.1 Importance of issue

Monitoring to confirm modeling results is required to ensure adaptive management can occur in a timely manner should predicted changes to water quality be more significant than expected.

21.3.2 Detailed Review Comment

We note that TMAC has complied with KIA-DEIS-46 and have collected water quality in 2017 from Doris, Patch, Windy, Wolverine, Aimaokatalok and Stickleback lakes. However, we express concern that lake specific data has not been used as background water quality inputs within the water and load balance model. *“Doris Lake water quality from 2012 to 2017 was selected as representative of background conditions and was applied to the remaining lakes and to all undisturbed surface runoff in the Doris or Windy watersheds upon model activation. The only exception to this was Tail Lake, which is used to store water collected in the Doris sedimentation pond... For the Boston background source term, Aimaokatalok Lake water quality collected between 2012 and 2017 was selected as representative of background conditions and was applied to all lakes and all undisturbed runoff in the Boston watershed except Stickleback Lake. A separate source term was developed for Stickleback Lake and was applied as the starting concentration for this lake upon model activation.”*

This approach introduces additional uncertainty into the model outputs for lakes other than the Doris, Aimaokatalok and Stickleback lakes.

This concern is exemplified in instances where these lakes will experience direct inputs of contaminants from local sources. For example, no lake specific source term was applied in the load balance model for Windy Lake. However, *"During operations, Windy Lake will receive a small amount of runoff from the Madrid North Mine surface infrastructure. However, the model results show that water quality in the lake is unaffected. Once Madrid North enters post-closure, additional loads from disturbed runoff that was previously captured in the Madrid North CWP and groundwater flow from the Madrid North Mine are predicted to enter the lake."* The model indicates that concentrations of key parameters such as arsenic and copper will be elevated because of these project interactions.

We acknowledge however, that the sensitivity analysis will likely address uncertainties in the modeled outputs and smaller divergences can be adaptively managed if they are detected through a robust monitoring program.

Recommendation/Request

We request TMAC include ongoing water quality monitoring through the AEMP in all modeled lakes in which impacts from project activities are predicted. Specifically, the AEMP should be amended to include water quality monitoring in Windy Lake. Water quality monitoring is already proposed for Aimaokatalok, Stickleback, Patch, Doris and Wolverine lakes as part of the AEMP.

21.4 TMAC RESPONSE FOR KIA-NIRB-21

The AEMP includes lakes in which effects from project activities are predicted during construction or operations phases of the Project. Windy Lake was excluded from the AEMP, as nearly every assessed water quality parameter was within predicted baseline concentrations as a result of the Project until the post closure period. The exception was mercury, which was predicted to change by a maximum of 25% over the operations phase (0.000001121 mg/L), yet remain 25 times lower than the CCME guideline for inorganic mercury (0.000026 mg/L). The greatest changes to water quality in Windy Lake are predicted more than 20 years into the Project during post-closure. Windy Lake can be added to the AEMP prior to this period, when potential changes due to the Project are expected, or if the potential for the Project to affect the lake changes due to updated Project design (e.g., alterations to operational water management plans resulting in Project activities near Windy Lake).

22. ID #KIA-NIRB-22

22.1 SUBJECT/TOPIC

Post-closure monitoring

22.2 REFERENCES

Package P4-19 Hope Bay Project Boston Conceptual Closure and Reclamation Plan, Section 9.2, Page 29.

TMAC states:

"Post-closure air quality, wildlife and vegetation monitoring is not planned, as once the Project site is closed there is not expected to be any activities occurring that would warrant continued monitoring."

Package P4-21 Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan, Section 4.7, Page 30.

22.3 SUMMARY

Post-closure monitoring is limited to stability of structures, seep sampling, and contact water ponds. Additional monitoring needs may be identified during closure.

22.3.1 Importance of Issue

It is important to anticipate issues and plan for monitoring options.

22.3.2 Detailed Review Comment

There may be additional need to monitor the site vegetation or wildlife during post-closure. For example, wildlife post-closure monitoring for overburden piles is recommended to determine if safe passage is occurring (MVLWB and AANDC 2013), which may be relevant for the remaining overburden piles. Alternatively, if other post-closure monitoring, such as water quality monitoring, determines that water quality objectives are not yet met it may be necessary to monitor wildlife use of the area.

It terms of vegetation, it may be prudent to monitor for invasive species, which could colonize in disturbed areas and soils. It may also be valuable to monitor regrowth of any revegetation as was proposed in areas of reclaimed rockfill pads backfilled with suitable overburden soils via of application of seeds collected from the surrounding vegetation. Monitoring these results would determine if closure activities were successful and would be a useful research opportunity to improve our understanding of

reclamation in northern environments. With expected climate change, vegetation considerations such as invasive species and reclamation may become more relevant.

22.4 RECOMMENDATION/REQUEST

Please revise to consider additional monitoring of vegetation and wildlife during post-closure if the need is identified at that time.

22.5 TMAC RESPONSE FOR KIA-NIRB-22

Post-closure there will be no ponded contact water on site that may be used as a drinking source by wildlife. In addition, there will be no waste rock piles on surface, and the overburden pile which will remain post-closure will have moderate slopes as defined in Annex V1-7, Package P4-19 (Hope Bay Project Boston Conceptual Closure and Reclamation Plan) and will not inhibit safe passage by wildlife as it resembles the surrounding landscape. As a result TMAC maintains its viewpoint that there would not be a need for any post-closure wildlife monitoring.

With respect to vegetation monitoring, TMAC does not currently propose any reclamation activities that may require revegetation given that proper contouring of substrates will allow for natural revegetation over time; however, as stated in the Boston Conceptual Closure and Reclamation Plan, should opportunities emerge where revegetation can be adopted, TMAC would consider it. As a result there is currently no post-closure monitoring of vegetation in the cost estimate; however, should that be included in the future, the Closure Plan and associated cost estimate would be updated.

23. ID #KIA-NIRB-23

23.1 SUBJECT/TOPIC

Boston Conceptual Closure and Reclamation Plan – Closure of Waste Rock Pile

23.2 REFERENCES

P4-19 Hope Bay Project Boston Conceptual Closure and Reclamation Plan

P4-20 Hope Bay Project Boston Conceptual Closure Plan, Detailed Cost Estimate

23.3 SUMMARY

Section 8.2 of Document P4-19 notes that 'there will be no ore and/or waste rock left on surface at closure.' The section goes on to note that if any ore and/or waste rock is left on surface at closure two potential contingency measures may include 'moving the piles to the TMA for placement' and 'consolidating, contouring and covering the piles with an impermeable liner and a 0.3 m thick protective layer of rock.'

23.3.1 Importance of Issue

In the event that waste rock remains on surface at closure, the presence of waste rock at surface will need to be addressed given the potential for metal leaching under neutral conditions. While a significant contingency amount is included in the reclamation cost estimate (P4-20), it is uncertain if the amount provided would be sufficient to cover either of the noted potential contingency measures.

23.3.2 Detailed Review Comment

Gap/Issue

Contingency measures for surface waste rock at closure listed, total contingency sum provided, but no direct comparison of cost of contingency measures against this sum is included.

Disagreement with WL information/ conclusion

Conceptual cost estimate for potential contingency measures should be provided.

Reasons for disagreement

This direct comparison should be included to provide a means of assessing the suitability of the proposed contingency amount.

23.4 RECOMMENDATION/REQUEST

TMAC to provide conceptual cost estimate for covering proposed Boston Waste Rock pile in place with liner and armour rock layer.

Similarly, TMAC to provide a conceptual cost estimate for transporting the waste rock pile to the TMA or the underground workings.

23.5 TMAC RESPONSE FOR KIA-NIRB-23

The contingency amount of \$4.73 million is to account for uncertainties attributed to the fact that the Closure Plan is only at the conceptual level. It is not intended to capture all possible contingency measures that may be adopted for the project, should the preferred closure alternative not be viable. As the project develops, the Closure Plan, and associated cost estimate are routinely updated in accordance with stipulated Water Licence conditions. During those updates, should there be a need to change the preferred closure alternative and implement one of the stated contingency measures that will be reflected in the updated Closure Plan and cost estimate. Therefore, TMAC does not agree that the conceptual cost of contingency measures as stated in the Closure Plan should be a measure to determine the overall cost contingency that needs to be applied to the Conceptual Closure Plan.

Notwithstanding these comments, as a point of reference, TMAC did calculate the cost of reclaiming the waste rock pile by covering with an impermeable cover incorporating an HDPE liner, as well as the cost of hauling the waste rock underground.

Unit rates for construction of the cover and haul rates are consistent with the unit rates as presented in the Closure Cost Estimate. For the purpose of the calculation, the maximum volume of waste rock on surface was considered, as per the Phase 2 Mine Plan (Package P5-4: Madrid-Boston Project Water and Load Balance, Hope Bay Project). The results are as follows:

- Cost of covering waste rock = \$2.92 million; or
- Cost of backhauling waste rock underground = \$4.91 million.

Considering that the cost of backhauling is almost two times the cost of covering the waste rock, it is reasonable to assume that covering would be the preferred contingency approach. The cost of covering the waste rock is well within the contingency amount of \$4.73 million, but more importantly, should the Closure Plan be implemented midway through the project when the bulk of waste rock has not yet been backhauled for mining purposes, it means that only half of the Boston Tailings Storage Facility has been constructed, and therefore the closure cost for that will be substantially smaller, effectively balancing out these costs.

24. ID #KIA-NIRB-24

24.1 SUBJECT/TOPIC

Madrid Interim Closure and Reclamation Plan - Waste Rock Piles

24.2 REFERENCES

P4-21 Hope Bay Project Doris-Madrid interim Closure and Reclamation Plan, Detailed Cost Estimate

P4-22 Hope Bay Project Doris-Madrid interim Closure and Reclamation Plan, Detailed Cost Estimate

24.3 SUMMARY

Section 4.8.3 of Document P4-21 notes that 'there will be no ore and/or mineralised waste rock left on surface at closure.' The section goes on to note that if any ore and/or waste rock is left on surface at closure two potential contingency measures may include 'moving the piles to the TMA for placement' and 'consolidating, contouring and covering the piles with an impermeable liner and a 0.3 m thick protective layer of crushed rock.'

24.3.1 Importance of Issue

In the event that waste rock remains on surface at closure, the presence of waste rock at surface will need to be addressed given the potential for metal leaching under neutral conditions. While a significant contingency amount is included in the reclamation cost estimate (P4-22), it is uncertain if the amount provided would be sufficient to cover either of the noted potential contingency measures.

24.3.2 Detailed Review Comment

Gap/Issue

Contingency measures for surface waste rock at closure listed, total contingency sum provided, but no direct comparison of cost of contingency measures against this sum is included.

Disagreement with WL information/ conclusion

Conceptual cost estimate for potential contingency measures should be provided.

Reasons for disagreement

This direct comparison should be included to provide a means of assessing the suitability of the proposed contingency amount.

24.4 RECOMMENDATION/REQUEST

TMAC to provide conceptual cost estimate for covering proposed Waste Rock piles at Doris, Madrid North and Madrid South in place with liner and armour rock layer.

Similarly, TMAC to provide a conceptual cost estimate for transporting the same waste rock piles to the TMA or the underground workings.

24.5 TMAC RESPONSE FOR KIA-NIRB-24

The contingency amount of \$7.8 million is to account for uncertainties attributed to the fact that the Hope Bay Project Doris-Madrid Conceptual Closure and Reclamation Plan (Annex V1-7, Package P4-21) is only at the conceptual level. It is not intended to capture all possible contingency measures that may be adopted for the project, should the preferred closure alternative not be viable. As the project develops, the Closure Plan, and associated Hope Bay Project Doris-Madrid Conceptual Closure and Reclamation Plan, Detailed Cost Estimate (Annex V1-7, Package P4-22) are routinely updated in accordance with stipulated Water Licence conditions. During those updates, should there be a need to change the preferred closure alternative and implement one of the stated contingency measures, that will be reflected in the updated Closure Plan and cost estimate (Annex V1-7, Packages P4-21 and P-22). Therefore, TMAC does not agree that the conceptual cost of contingency measures as stated in the Closure Plan (Annex V1-7, Package P4-21) should be a measure to determine the overall cost contingency that needs to be applied to the Conceptual Closure Plan.

Notwithstanding these comments, as a point of reference, TMAC did calculate the cost of reclaiming the waste rock piles by covering with an impermeable cover incorporating an HDPE liner, as well as the cost of hauling the waste rock underground.

Unit rates for construction of the cover and haul rates are consistent with the unit rates as presented in the Closure Cost Estimate (Annex V1-7, Package P4-22). For the purpose of the calculation, the maximum volume of waste rock on surface was considered, as per the Phase 2 Mine Plan (Annex V1-7, Package P5-4 Madrid-Boston Project Water and Load Balance, Hope Bay Project). The results are presented in Table 24.1.

Table 24.1: Summary of contingency waste rock pile reclamation costs

Area	Cost of Covering Waste Rock (\$ Million)	Cost of Backhauling Waste Rock Underground (\$ Million)
Doris	\$2.06	\$ 3.62
Madrid North	\$2.47	\$ 4.87
Madrid South	\$2.24	\$ 4.90

However, when considering the mine plan, the peak waste rock volumes stored on surface won't occur at Doris, Madrid North and Madrid South Mines at the same time as illustrated in Table 24.2 (Annex V1-7, Package P5-4 Madrid-Boston Project Water and Load Balance, Hope Bay Project). Based on this, the peak volume of waste rock stored on surface will occur in Year 14, which coincides with the peak waste rock storage at Madrid South Mine. The peak cover cost would however occur in Year 4 due to the geometry of the Madrid Waste Rock. Therefore, at any given period, should an alternate closure technology such as an HDPE cover or backhauling of waste rock be required, it would at most be \$2.47 million for covering waste rock and \$4.90 million for backhauling that waste rock underground. Given this cost differential, it is conceivable that covering of the waste rock would be the preferred strategy and therefore this cost is well within the current contingency amount of \$7.80 million.

Table 24.2. Waste Rock Stored on Surface over the life of the project

Project Year	Doris Mine	Madrid North Mine	Madrid South Mine	Total
-6	102,000	-	-	102,000
-2	112,000	-	-	112,000
-1	115,000	-	-	115,000
1	102,000	-	-	102,000
2	267,000	-	-	267,000
3	125,000	2,000	-	127,000
4	-	359,000	-	359,000
5	62,000	206,000	-	268,000
6	62,000	-	-	62,000
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-
13	-	-	115,000	115,000
14	-	-	361,000	361,000
15	-	-	75,000	75,000
16	-	-	-	-

25. ID #KIA-NIRB-25

25.1 SUBJECT/TOPIC

Doris Interim Closure and Reclamation Plan – Tailings Impoundment Area

25.2 REFERENCES

P4-21 Hope Bay Project Doris-Madrid interim Closure and Reclamation Plan, Detailed Cost Estimate

P4-22 Hope Bay Project Doris-Madrid interim Closure and Reclamation Plan, Detailed Cost Estimate

25.3 SUMMARY

Section 4.8.2 of Document P4-21 notes that a 'In the case that water quality monitoring indicates that tailings will become a source of contamination, the contingency of a low permeability cover was considered.'

25.3.1 Importance of Issue

While a significant contingency amount is included in the reclamation cost estimate (P4-22), it is uncertain if the amount provided would be sufficient to cover the noted potential contingency measures.

25.3.2 Detailed Review Comment

Gap/Issue

Contingency measures for Doris TIA at closure listed, total contingency sum provided, but no direct comparison of cost of contingency measures against this sum is included.

Disagreement with WL information/ conclusion

Conceptual cost estimate for potential contingency measures should be provided for comparison purposes.

Reasons for disagreement

This direct comparison should be included to provide a means of assessing the suitability of the proposed contingency amount.

25.4 RECOMMENDATION/REQUEST

TMAC to provide conceptual cost estimate for including a suitable liner in the tailings cover for the Doris TIA.

25.5 TMAC RESPONSE FOR KIA-NIRB-25

The contingency amount of \$7.8 million is to account for uncertainties attributed to the fact that the Hope Bay Project Doris-Madrid Interim Closure Plan (Annex V1-7, Package P4-21) is only at the conceptual level. It is not intended to capture all possible contingency measures that may be adopted for the project, should the preferred closure alternative not be viable. As the project develops, the Doris-Madrid Closure Plan, and associated Hope Bay Project Doris-Madrid Interim Closure Plan, Detailed Cost Estimate (Annex V1-7, Package P4-22) are routinely updated in accordance with stipulated Water Licence conditions. During those updates, should there be a need to change the preferred closure alternative and implement one of the stated contingency measures, that will be reflected in the updated Closure Plan and cost estimate (Annex V1-7, Packages P4-21 and P4-22). Therefore, TMAC does not agree that the conceptual cost of contingency measures as stated in the Closure Plan (Annex V1-7, Package P4-21) should be a measure to determine the overall cost contingency that needs to be applied to the Conceptual Closure Plan.

Notwithstanding these comments, as a point of reference, TMAC did calculate the cost of adding a HDPE liner to the existing TIA cover using unit rates as presented in the Closure Cost Estimate (Annex V1-7, Package P4-22). This additional cost would be \$57.5 million.

26. ID #KIA-NIRB-26

26.1 SUBJECT/TOPIC

Boston Surface Infrastructure – Sediment Water Pond

26.2 REFERENCES

P5-28 Hope Bay Project Boston Surface Infrastructure Preliminary Design

26.3 SUMMARY

Section 4.1.2 Notes that the overburden pile may contain up to 37,000 m³ of overburden soils. It is also noted that the Madrid-Boston all-weather road will act as a sedimentation berm for the overburden pile, by allowing water to filter through the road and depositing entrained sediments upstream of the road.

26.3.1 Importance of Issue

Stickleback lake is downstream of the overburden pile. Given the likely fine-grained nature of the sediments that will be stored in the overburden pile, it is possible that run-off high in total suspended solids will reach Stickleback Lake if the road is not effective in retaining entrained sediments.

26.3.2 Detailed Review Comment

Gap/Issue

The referenced document notes the effectiveness of the berm in retaining entrained sediments. The design of the road only notes the use of run of quarry material and does not mention the use of any filter fabric or filter materials.

Disagreement with WL information/ conclusion

The ability of the run of quarry material to filter out fine-grained sediments entrained in surface run off from the overburden pile is uncertain and may not be effective.

Reasons for disagreement

Run of quarry material can have variable grain size distribution and may be sufficiently coarse that it may be ineffective in acting as a filter for fine grain soils entrained in surface run off.

26.4 RECOMMENDATION/REQUEST

TMAC to provide comment on the use of filter materials including geotextiles and or natural materials in the portion of the Boston-Madrid access road that may be expected to filter out sediments from run off from the overburden stockpile area.

26.5 TMAC RESPONSE FOR KIA-NIRB-26

At TMAC's Doris Mine, two overburden stockpile areas have been constructed: one at Quarry #1 near Roberts Bay and a second at Quarry #2 adjacent to the Doris Camp. These overburden stockpiles were constructed between 2007 and 2010, and both of these have Run of Quarry (ROQ) all-weather roads that act as sediment control structures downstream of them, similar to what is proposed at Boston. The overburden contained in these stockpiles are also similar to what will be encountered at Boston. With over a decade of on-site experience at Doris, TMAC has never observed any release of sediment through these structures demonstrating the efficacy of this strategy. Therefore, TMAC is confident that no additional engineering mitigation measures would be required to ensure acceptable sediment control.

27. ID #KIA-NIRB-27

27.1 SUBJECT/TOPIC

Boston Tailings Management Area – Erosion of side slopes

27.2 REFERENCES

P5-26 Boston Tailings Management Area Preliminary Design, Hope Bay Project

27.3 SUMMARY

Section 4.2.4 notes that 'at any given time there will be exposed tailings that might be susceptible to overland run off erosion.' That same section also notes that eroded tailings will be contained within the contact water pond and the tailings will be removed if it compromises the pond design capacity.

27.3.1 Importance of Issue

Because of the potential impact on run off water quality, any tailings eroded from the face of the dry stack facility and deposited at the base of the facility will likely need to be addressed in closure either by extension of the tailings cover or excavation and relocation within the dry stack prior to covering.

27.3.2 Detailed Review Comment

Gap/Issue

The conceptual closure plan for the Boston Project (P4-19) does not directly address the issue of eroded tailings from the dry stack that may become contained with contact water pond footprint.

Disagreement with WL information/ conclusion

Periodic erosion of the exposed slopes of the tailings dry stack is likely given the particle size and the non-cohesive nature of the materials. This may be particularly evident during the spring melt when snow deposited at the base of the interbench slopes melts and creates run-off.

Reasons for disagreement

Given the likelihood of erosion of the tailings faces occurring, a plan to address tailings eroded within the footprint of the contact water pond at closure should be developed.

In addition, a contingency plan to address the erosion during the operation of the facility should also be developed.

27.4 RECOMMENDATION/REQUEST

TMAC to provide comment on addressing the erosion of the side slopes of the dry stack tailings facility at the Boston Project during operation, should excessive erosion be observed. In addition, TMAC to provide comment on addressing eroded tailings contained within the footprint of the contact water pond at closure.

27.5 TMAC RESPONSE FOR KIA-NIRB-27

TMAC recognizes the importance of surface run-off management from the Boston Tailings Management Area (TMA). While the facility is under active operation, every effort will be made to prevent concentrated flows that could cause erosion. When issues do occur, TMAC will be conducting repairs as part of routine operations.

TMAC also believes that the TMA is a good candidate for progressive reclamation, and as such the final cover could be constructed following completion of each 5 m intermediary bench. This would significantly reduce the side-slope area exposed to erosion. Implementation of such progressive reclamation will be considered by TMAC at an opportune time, once mining has started, and would be reflected in any updated Closure and Reclamation Plans.

At final closure, small amounts of eroded tailings that may be located within the contact water ponds will be removed and placed on the TMA prior to final cover construction. If it is found that the residual tailings cannot be removed for whatever reason, a cover could be extended over the affected area.

The contact water ponds consist of three areas, with a total footprint of approximately 37,300 m². The portion of the contact water ponds where tailings are found could be covered with the same cover as the TMA which consist of an HDPE liner covered with 0.3 m protective gravel. No Run of Quarry (ROQ) shell is needed because the areas in question is flat or gently sloping areas, and does not require armouring.

Using the same cost basis as the TMA cover, this additional cover would be \$1.76 million, which is well within the contingency amount of \$4.73 million. However, as stated, TMAC will be implementing appropriate operational measures to avoid this additional remediation cost.

28. ID #INAC-FC-1

28.1 SUBJECT/TOPIC

Hydrodynamic Modelling of Discharge to Aimaokatalok Lake

28.2 REFERENCES

- DEIS Volume 5, Section 3.2.4.1
- INAC TRCs 01 & 02 and TMAC's commitment to further validate the 3D hydrodynamic modelling in the FEIS
- FEIS Appendix V5-4B Aimaokatalok Lake Plume Mixing Memo
- FEIS Appendix V5-4E Aimaokatalok Lake Hydrodynamic Mixing Model
- FEIS Annex V1-7 Package P4-18 Hope Bay Project Aquatic Effects Monitoring Plan

28.3 SUMMARY

During the under-ice season, effluent can build up near the diffuser in Aimaokatalok Lake. The three-dimensional hydrodynamic model completed by TMAC predicts that the concentration of chromium in Aimaokatalok Lake can reach 80% of the Canadian Council of Ministers of the Environment (CCME) guideline value, up from a background concentration in the lake of around 30% of the criterion.

While the predicted concentration of chromium appears to remain below the CCME guideline, uncertainty in the modelling exercise, its inputs, and the background concentration, may mean that chromium concentrations could reach or exceed the guideline value during the under-ice season, specifically April – May.

The proposed Metal Mining Effluent Regulations (MMER) Environmental Effects Monitoring (EEM) water quality monitoring plan may be sufficient to detect such an eventuality. However, the monitoring results should be presented in such a way that they show the dilution performance of the diffuser in April, the sampling month that is predicted to generate under-ice chromium buildup.

28.4 DISCUSSION

28.4.1 Importance of Issue to the Impact Assessment Process

Seasonal buildup of chromium concentrations in the lake may potentially lead to concentrations in the vicinity of the diffuser that reach or exceed CCME water quality guideline value and become harmful to aquatic life.

28.4.2 Detailed Review Comment

As originally noted during the DEIS review and now in the FEIS, there is potential for effluent build up near the diffuser in Aimaokatalok Lake during the under-ice season.

TMAC has completed a three-dimensional hydrodynamic modelling for the FEIS, as requested by INAC, to simulate potential contaminant buildup processes. The hydrodynamic conceptual model, model grid, meteorological inputs and hydrological inputs all appear to be appropriate for the task.

The minimum modelled dilutions, represented by a colour scale in Figure 5-2 (Appendix V5-4E), appear to be close to 40:1 near the discharge point in the simulation of May 2023. "Average Dilutions" are presented in Figure 5-2 but it is not clear what is being averaged. If this is a vertical average then potentially lower water quality at depth would be obscured by averaging.

Thus, the maximum concentration (worst dilution) in the water column should be plotted rather than the average concentration.

Furthermore, the colour of the worst grid cell in Figure 5-2 is the same as the 40:1 colour contour, which is the lowest value on the colour scale. This makes it impossible to visually determine whether dilution in the worst modelled cell is lower than 40:1 due to the colour scale.

The highest modelled chromium concentration of about 0.0008 mg/L (80% of the guideline value 0.001 mg/L) appears to occur in spring 2025 or 2027 at a depth of 15 m (Appendix V5-4E, Figure 5-11). This value is presumably mostly due to buildup of denser effluent-containing water in the bathymetric depression, as cryo-concentration draws from surface waters which contain minimal effluent. When background is taken into consideration, the predicted dilution needed to produce the estimated 0.0008 mg/L is 22:1, nearly half as effective as previously indicated.

INAC disagrees with certain numbers presented in Table 3-1 of Appendix V5-4E, and believes that they show uncertainty in the background values for chromium in the lake. The table states that 11.6:1 dilution is needed to bring the predicted Boston effluent median chromium concentration of 0.012 mg/L down to the CCME guideline criterion of 0.001 mg/L. If there were zero background concentration of chromium, then a dilution of 11:1 would be sufficient to reduce the effluent concentration to the guideline value.

Multiple non-zero background chromium concentrations for Aimaokatalok Lake are given or observed, one observed 75th percentile (0.00030 mg/L) and a predicted median (0.00025), both differing from the later discussion of background being 37% of the guideline value. The initial value used in the modelling was 0.00025 mg/L, the lowest and least conservative of the three concentrations.

Since any background concentration reduces effective dilution, the actual required dilution to reach the CCME chromium guideline criterion was recalculated as 15.71 and 14.67:1 for the observed 75th and modelled median backgrounds, respectively, and 17.5:1 for the unreferenced 37% (0.00037 mg/L) background value. Many of the "dilution required" values for other parameters appear to have the same issue with not considering background, although chromium remains the worst and limiting case.

Regarding model validation, the temperature profiles at Station 6 indicate a degree of stratification, although the modelled gradient is not as sharp as the observed. Similarly, the modelled temperature profile at Station AIM-3 is smoother than observed, potentially indicating too much vertical mixing in the model and artificial improvements in the dilution results.

In addition to temperature stratification, the water column density 250m from the discharge location displayed in Figure 5- 4 of Appendix V5-4E shows continuous and increasing stratification during the critical under-ice season.

It is recognized that limited time-series or profile calibration data would be available for this lake.

Although Table 3-1 appears to have errors, the modelled dilution is sufficient in the years considered for chromium to remain below guideline values. However, the values produced by the model are 80% of the guideline value, up from background of 30% of the guideline.

There is a clear trend of concentrations building up around the outfall during the winter. Thus, a small change in effluent chemistry, seasonal timing of effluent flow relative to ice-off, or weather unfavourable to lake mixing could produce chromium concentrations of concern.

The likelihood of such an exceedance depends on future water management and climate, and appears unlikely during those circumstances considered in the model. Since uncertainty in the model inputs, future water management, and results exist, are undefined, and are difficult to reduce given the available data, robust field monitoring is necessary to confirm model predictions and protect the environment.

In FEIS Package P4-18 Table 3.1-1, TMAC commits to a Metal Mining Effluent Regulations (MMER) Environmental Effects Monitoring (EEM) sampling transect in Aimaokatalok Lake in April, July, August and September during each year when discharge from the Boston processing plant occurs.

The sampling frequency is appropriate to detect potential buildup of chromium in the water column under the ice. The sampling sites are located at appropriate distances north and south of the diffuser, and INAC assumes that the exact locations of the "north samples" are to the north-northwest along the deepest portion of the lake, which

corresponds with the likely plume position as predicted by the hydrodynamic model. INAC notes that whilst the over-winter background buildup process and effective dilution is critical for protection of the environment, the current effective dilution table contains errors, and models and future conditions pose inherent uncertainties.

As a result, it is important that updated background, dilution requirements, and observed dilution information be properly calculated and included in future monitoring program reports. These reports should also include a comparison of monitoring data to the buildup predicted in the model for the April sampling period.

28.5 RECOMMENDATION/REQUEST

- a) INAC recommends that the Proponent commit to comparing the field water quality sampling results collected in April for chromium with modelled dilution results and report in terms of effective dilution, taking into account background for chromium and then correcting and updating the background and "dilution required" calculations in a table similar to FEIS Appendix V5-4E Table 3-1 as the monitoring program progresses.
- b) INAC recommends that in the event that April chromium concentrations are higher than predicted in the FEIS, the Proponent implement further adaptive management steps such as discharge curtailment until seasonal ice breakup.

28.6 TMAC RESPONSE FOR INAC-FC-1

- a) Water quality will be evaluated annually during the AEMP, which will include an Aquatic Response Framework with a low action level trigger of 75% of a respective CCME water quality parameter. Therefore, if chromium concentrations exceed 0.0075 mg/L (or 75% of hexavalent chromium guideline of 0.001 mg/L) in Aimaokatalok Lake at any time of the year, a low action level response will be triggered to investigate potential causes and recommend adaptive management options, if warranted. Part of the low action response can be reporting the effective dilution as recommended above and comparing the results to the corrected 'dilution required' calculations from the modelling exercise.
- b) Several water quality parameters, including chromium, will be evaluated annually under the Madrid-Boston AEMP. This program contains an Aquatic Response Framework with a specific water quality trigger, where parameter concentrations that reach 75% of the CCME water quality guideline will trigger a low action response to investigate potential causes and recommend adaptive management options, if warranted. For chromium, the trigger level will be 0.0075 mg/L (based on hexavalent chromium guideline of 0.01 mg/L), which is lower than

the maximum total chromium concentrations predicted in Aimaokatalok Lake using the hydrodynamic model.

The Madrid-Boston AEMP is currently being revised and will be available to the interested parties prior to the Final Hearing on April 27, 2018.

29. ID #INAC-FC-2

29.1 SUBJECT/TOPIC

Discrepancy in Project Site Lake Evaporation Amount

29.2 REFERENCES

- FEIS Annex V1-8 Concordance Table for Commitments
- FEIS Annex V1-7 Package P5-9 Geochemical Source Term Predictions for the Proposed Madrid-Boston Project, Hope Bay Project
- FEIS Annex V1-7 Package P5-2 Climate and Hydrological Parameters Summary Report, Hope Bay Project
- INAC-IR 18
- INAC-TRC 08 and TMAC's commitment to address inconsistencies in the evaporation data in the FEIS
- Rouse et al. 2005. Journal of Hydrometeorology 6(3):291- 305 June 2005.

29.3 SUMMARY

INAC-TRC 08 addressed discrepancies in the annual lake evaporation amounts presented in the DEIS for the Project site. This INAC TRC requested TMAC to provide:

an opinion as to whether it is reasonable to assume that about 115 mm of annual lake evaporation, representing 40% of the total, occurs during periods when the lake is covered by ice.

INAC was not satisfied with the response provided to the above, resulting in the issue being carried forward to the FEIS. TMAC's commitments for the FEIS included:

Inconsistencies in the Evaporation data will be resolved and the updated evaporation results will be used in the updated water and load balance for the FEIS.

The FEIS largely repeats the same information on lake evaporation amounts provided in TMAC's initial response to INAC-TRC 08, and does not resolve the inconsistencies or satisfy INAC's concerns.

29.4 DISCUSSION

29.4.1 Importance of Issue to the Impact Assessment Process

The FEIS review process should challenge the use of suspect methods or assumptions so that the present regulatory approval process does not result in inadvertent acceptance or approval of such methods or assumptions. This is important to avoid setting a precedent that would justify their continued use in future assessments.

29.4.2 Detailed Review Comment

INAC-IR 18 and subsequent INAC-TRC 08 both sought to determine whether lake ice cover conditions would affect lake evaporation amounts. INAC-IR 18's request included the statement requiring TMAC to:

Confirm the typical period of ice-cover conditions for the Project site and discuss whether an ice cover would substantially limit lake evaporation losses to less than the amounts computed from local climate data.

TMAC's response, which also appears in FEIS Annex V1-7 Package P5-2, was:

The snowmelt model for the site presents full ice cover from October - April, melting conditions in May and June with an open water season between July and September. Ice-covered lakes will affect the seasonality of evaporation and therefore the overall local energy and water balance; however, the implications of ice-cover conditions go beyond simply limiting lake evaporation losses.

INAC-TRC 08 included a request that TMAC provide:

An opinion as to whether it is reasonable to assume that about 115 mm of annual lake evaporation, representing 40% of the total, occurs during lake ice cover conditions.

TMAC's Concordance response to INAC-TRC 08 stated:

TMAC acknowledges that the evaporation data utilized in the water and load balance model (DEIS Appendix V3-2D) differs from the data presented in DEIS Appendix V3-2B, as illustrated in Table 9. This will be updated in the water and load balance for the FEIS submission.

The Concordance response referenced FEIS Annex V1-7 Package P5-9 for the response. FEIS Annex V1-7 Package P5-9 is a November 2017 report by SRK Consultants, titled "Geochemical Source Term Predictions for the Proposed Madrid-Boston Project, Hope Bay Project." Climate data, including monthly evaporation amounts, are presented on Pages 6 and 7, Section 3.2, Climate Data.

Positive (non-zero) evaporation amounts are given for the months of April through September, with an annual total of 192 mm. Monthly precipitation amounts are given with an annual total of 209.6 mm. The report indicates that the values were obtained from another SRK report - Climate and Hydrological Parameters Summary Report, Hope Bay Project, prepared for TMAC Resources Inc., November 2017.

This report was located in the FEIS submittal materials under Volume 1 Annex V1-7 Type A Water License Applications, Package P5-2.

INAC assumes that the concordance information presented for INAC-TRC 08 is in error and that the other cited report (Climate and Hydrological Parameters Summary Report, Hope Bay Project, prepared for TMAC Resources Inc., November 2017) was the intended reference.

Section 6.8 of The Climate and Hydrological Parameters Summary Report is titled "Effect of Ice cover on Lake Evaporation." This section was added as a response to INAC's concern. The section relies largely on SRK's interpretation of a referenced report - "The Influence of Lakes on the Regional Energy and Water Balance of the Central Mackenzie River Basin" by Rouse et al. (2008).

INAC was unable to locate a copy of the Rouse et al. (2008) report, but did access a report with the same author and title, published in the Journal of Hydrometeorology 6(3):291-305 · June 2005.

Key information in the Rouse et al. (2005) report includes:

- *Lakes are categorized by size. The study defines large lakes as having surface areas greater than 100 km², such as Great Slave Lake, Great Bear Lake, and Lake Athabaska.* - This categorization does not support the statement in FEIS Package P5-2, page 38 that "the site does include many large lakes and as a result in accordance with Rouse et al. . ."
- *During fall and early winter heat exchange continues as long as there is open water. A complete winter ice and snow cover effectively restricts heat and mass exchanges.* - This description of ice effects on evaporation amounts does not support the statement in FEIS Package P5-2, page 38 that "ice cover conditions will not reduce the overall estimations of lake evaporation at the site".

The Hydrological Atlas of Canada (1978) provides national scale charts with isolines, including evaporation and lake ice conditions derived from data collected prior to 1980. The Atlas notes that mapped values for freezeup and breakup are based on a relatively sparse data network and do not reflect small scale local variations.

Lake evaporation data reflect an assumption that free water evaporation is zero at the time of total ice coverage. With the above context, the Atlas yields the following information for the vicinity:

- Plate 17, Mean Annual Lake Evaporation: 150 mm
- Plate 19, Freeze-up and Break-up of Rivers and Lakes; Lake Freeze-over: October 1
- Plate 19, Lake Ice-free: July 15

Considering the above, INAC disagrees with TMAC's apparent opinion that a significant amount (in the order of 40%) of annual lake evaporation occurs during lake ice cover conditions when credible published sources indicate that no lake evaporation should occur.

Although the Project water and load balance model may have used questionable lake evaporation amounts, the same values are presumably used in all scenarios. Project impacts determined by comparing the model results from the various scenarios are expected to be insensitive to the accuracy of inputs that are consistently applied. In this context, INAC does not request that the water balance be re-calibrated and re-run for the present EIS review process.

Rather, the Department requests that TMAC provides clarifications and revisions to the information presented in the FEIS.

29.5 RECOMMENDATION/REQUEST

- a) INAC requests that the Proponent confirm the correct report to be referenced in the Concordance information for INAC-TRC 08 and include this in an errata summary for the FEIS as applicable.
- b) INAC requests that the Proponent revise the 2017 climate and hydrological parameters report provided as Package P5-2 and provides an update for all parties to review prior to the Final Hearing.
- c) The revisions should include confirmation of the typical period of ice-cover conditions for the Project site based on actual observations and modify or remove references to Rouse et al (2008).

29.6 TMAC RESPONSE FOR INAC-FC-2

- a) TMAC acknowledges the reference error in the concordance table. The reviewer has correctly assumed the intended reference was the Climate and Hydrological Parameters Summary Report, Hope Bay Project, prepared for TMAC Resources Inc., November 2017, provided as FEIS Annex V1-7 Package P5-2.

- b) & c) Rouse et al. (2008) is an overarching publication which references the Rouse et al. (2005) paper obtained by the reviewer. Because of copyright requirements, TMAC cannot provide the reviewer with a copy of the 2008 paper but it is readily available for purchase through many reputable scientific and academic agencies. TMAC can however confirm that the information contained in Rouse et al. (2005) and Rouse et al. (2008) is consistent. Notwithstanding this, TMAC agrees that this information is misleading and does not add value to the discussion regarding lake water evaporation in the context of the Hope Bay Project. As a result, TMAC will remove all reference in this regard, which entails removal of Section 6.8 from Document P5-2, Climate and Hydrological Parameters Summary Report.

Volume 5, Section 3 (Limnology and Bathymetry) of the FEIS states: *"Lakes in the LSA and RSA were typically covered with landfast, consolidated first-year ice from October into May, with ice thicknesses that usually ranged between 1.5 m and 2.0 m in early spring. Ice thickness on sampled lakes varied little year to year (e.g., Windy Lake, April 27, 2009: 1.87 m; April 19, 2010: 1.80 m) and over the spatial extent of lakes (e.g., 2009 Doris Lake North: 2.0 m, Doris Lake South: 2.0 m, Rescan 2010; 2010 Aimaokatalok Lake, Stn 5: 1.8 m, Stn 6: 1.6 m, Stn 11: 1.8 m, Rescan 2011b). Ice-off usually commenced in mid-June with the presence of liquid water along the perimeter of lakes, with fully open waters in early July."*

This statement is however somewhat generalized when compared against the detailed information from which this statement is borne. Specifically:

- Rescan (2002) presents historical (1995-2000) records for lake evaporation from August to September in 1995, June to September in 1996, 1997, 1998 and 2000, and ultimately concludes the open water season is 124 days (4 months). This estimation is based on pan evaporation measurements and are stated to be incomplete;
- Rescan (2009, 2010) states that based on site micro-metrological measurements the open water season length is 105 to 120 days (3.5–4 months). It is however acknowledged that the measurements are incomplete based on the operating period of the micro-metrological station which is operated for periods shorter than actual open water season for logistical reasons;
- Rescan (2011) and ERM (2014) states that based on micro-metrological measurements the open water season can start from early to mid-July. However, these reports clearly outline that the length of the open water season varies from year to year. Also, it is important to note that once again the measurements are incomplete based on the operating period of the micro-metrological station as stated above.

- Rescan (2012) talks about an open water season between June and September as it refers to peak freshet flows. Specifically, the report talks about peak freshet flows from Tail Lake and Wind Lake in the beginning of June.

Therefore, based on the site-specific measurements pertaining to the open water season, as documented in the FEIS, it is reasonable to conclude that the open water season is at least 120 days long, and occurs approximately June through September. The corresponding open water season (i.e. lake evaporation) presented in Document P5-2 are listed in Table 29-1.

Table 29-1. Hope Bay Project Lake Evaporation as Presented in Document P5-2

Location	May	Jun	Jul	Aug	Sep	Annual
Doris and Madrid	36	84	89	56	19	284
Boston	32	87	93	59	20	291

By comparison, stated lake evaporation numbers for other Nunavut projects, with similar climate regimes and stated open water seasons are as listed in Table 29-2. It is important to note that there are no consistent methodologies by which these estimations are made, and therefore the dataset should be carefully considered to not provide a false sense of accuracy.

Table 29-2. Lake evaporation for other Nunavut projects with equivalent open water seasons

Location	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Back River Project (Sabina 2017)	0.1	5.9	25.9	96.4	106.7	65.8	22.4	0.4	323.6
Jericho Project (SRK 2004)	0	0	15.0	79.0	96.0	58.0	25.0	0	273.0
Kiggavik Project (Areva 2014)	0	0	0	30.4	49.8	47.1	39.0	0	166.3
Meliadine Project (Agnico 2015)	0	0	0	60.4	124.4	95.6	42.7	0	323.1
Meadowbank Project (Agnico 2014)	0	0	0	8.8	99.2	100.4	39.5	0.1	248.0

The reviewer has requested justification for assigning 42% and 41% respectively of the Doris-Madrid and Boston annual lake evaporation to the months of May and June, when

in their opinion lakes are ice covered and therefore should have zero evaporation. Table 29-3 summarizes the percentage of total annual lake evaporation outside of the months of July through September, for the Hope Bay Project and all reference projects listed in Table 29-2, which suggest that although the numbers used for Hope Bay is on the high end, it is not disproportionate.

Table 29-3. Lake evaporation components outside of the months July through September

Location	Outside July-September
Doris and Madrid	42%
Boston	41%
Back River Project (Sabina 2017)	40%
Jericho Project (SRK 2004)	34%
Kiggavik Project (Areva 2014)	18%
Meliadine Project (Agnico 2015)	19%
Meadowbank Project (Agnico 2014)	4%

In consideration of the information presented, TMAC believes that the lake evaporation estimates as presented in Supporting Document P5-2 (Climate and Hydrological Parameters Summary Report, Hope Bay Project) for the month of June is appropriate; however, the values presented for the month of May is not entirely justified. Some evaporation will occur in May as evidenced by the radiation balance using continuous site-specific climate data, as presented in Supporting Document P5-2, but the Morton methodology used to calculate lake evaporation does not accurately reflect ice covered conditions and therefore will overestimate evaporation. TMAC therefore proposes to update Supporting Document P5-2 to remove lake evaporation for May as listed in Table 29-4.

Table 29-4. Revised Hope Bay Project Lake Evaporation to be Updated in Document P5-2

Location	May	Jun	Jul	Aug	Sep	Annual	Outside July-September
Doris and Madrid	0	84	89	56	19	248	34%
Boston	0	87	93	59	20	259	34%

TMAC will update Supporting Document P5-2 in accordance with the discussion presented here and re-issue the document on April 20, 2018.

TMAC reran the Water and Load Balance model (presented in P5-4 Madrid-Boston Project Water and Load Balance, Hope Bay Project) using the updated lake evaporation numbers as presented in Table 29-4. The differences in lake levels, water flows and water quality between the Baseline conditions, and the Base Case conditions in all cases are insignificant, and therefore the effects assessment as presented remain valid.

References:

Areva Resources (2014). Kiggavik Project Final Environmental Impact Statement, Tier 3 Technical Appendix 4A: Climate Baseline, September

Agnico Eagle (2015). Meliadine Gold Project, Water Management Plan, Version 1, April

Agnico Eagle (2014). Meadowbank Gold Mine, Updated Mine Waste Rock and Tailings Management Plan, March

ERM Rescan. 2014. Doris North Project 2013 Compliance Monitoring Program – Meteorology. Prepared for TMAC Resources. Project No.: 0194098-0002. February 2014.

Rescan Environmental Services Ltd. 2002. 1993 - 2002 Data Compilation Report for Meteorology and Hydrology. Prepared for Hope Bay Joint Venture. May 2002.

Rescan Environmental Services Ltd. 2009. 2009 Meteorology Baseline Report, Hope Bay Belt Project. Prepared for Hope Bay Mining Limited. Project No.: 1009-002-02. December 2009.

Rescan Environmental Services Ltd. 2010. Doris North Gold Mine Project 2010 Meteorology Compliance Report. Prepared for Hope Bay Mining Limited. Project No.: 1009-002-02. November 2010.

Rescan Environmental Services Ltd. 2011. Doris North Gold Mine Project. 2011 Meteorology Compliance Report. Hope Bay Mining Limited.

Rescan Environmental Services Ltd. 2012. Doris North Gold Mine Project: Hydrology Compliance Report 2012. Prepared for Hope Bay Mining Limited. Project No.: 1009-008-04. December 2012.

Sabina Gold & Silver Corporation (2017). Back River Project, Water Management Plan, Revision 1, October.

SRK Consulting (Canada) Inc. (2004). Sote Water Management, Jericho Project, Nunavut. Report prepared for Tahera Diamond Corporation, August.

30. ID #INAC-FC-3

30.1 SUBJECT/TOPIC

Inconsistent Commitment Regarding the Use of Silt Curtains during Marine Construction

30.2 REFERENCES

- FEIS Volume 1 (Main Volume), Section 6.2, Table 6.1.4 – Summary of Freshwater and Marine Residual Effects
- FEIS Volume 5 (Freshwater and Marine Environments), Section 10.5.3.2 (Best Management Practices)
- FEIS Annex V1-7, Package 5-10 – Hope Bay Project: Roberts Bay Cargo Dock Preliminary Design
- INAC-IRs 30 & 31

30.3 SUMMARY

The Marine Water Quality section of Table 6.1.4 in FEIS Volume 1 includes an inconsistent mitigation statement (with the remainder of the FEIS), suggesting “*the discretionary use of silt curtains during marine construction as appropriate to reduce turbidity from in-water works*”. This statement makes it difficult for INAC to determine TMAC's intention regarding the use of silt curtains during in-water construction.

30.4 DISCUSSION

30.4.1 Importance of Issue to the Impact Assessment Process

It is important that TMAC's commitment to install a silt/turbidity curtain around the cargo dock area, which will remain in place throughout the marine construction period, be consistently demonstrated throughout the FEIS and supporting documents as appropriate, to eliminate any possible confusion and assure reviewers that potential impacts on marine water quality will be effectively mitigated.

30.4.2 Detailed Review Comment

The Marine Water Quality mitigation section of Table 6.1.4 in FEIS Volume 1 states that “silt curtains will be used **as appropriate** to reduce turbidity from in-water works (emphasis added)”.

This statement is inconsistent with the remainder of the FEIS and supporting documents which state “that a silt curtain will be installed around the cargo dock area and remain in place throughout the marine construction period.”

This and related commitments to mitigate potential impacts on marine water quality are summarized in FEIS Volume 5, Section

10.5.3.2 as follows:

- *Prior to construction, a silt/turbidity curtain will be installed around the cargo dock and remain in place throughout construction (Annex V1-7, Package 5-10). It will limit the area impacted by turbidity to an area slightly larger than the construction footprint.*
- *The curtain will be inspected regularly during the course of construction and all necessary repairs will be made if any damage occurs.*
- *The curtain and all other associated materials will be removed from the site after the end of construction.*
- *Turbidity will be monitored inside and outside the barriers on a daily basis with an electronic meter. These measurements will be recorded and reported to regulatory agencies.*
- *If turbidity increases above CCME guideline limits outside the turbidity barrier, then additional prevention and control measures will be applied. These may include changes in size of infill material, altered methods of infill, or suspension of infilling until turbidity decreases.*

INAC is of the view that it is important for TMAC to address this inconsistency regarding their commitment to install and retain a silt/turbidity curtain around the cargo dock area throughout the marine construction period, to eliminate any possible confusion and assure all parties that potential impacts on marine water quality will be effectively mitigated.

30.5 RECOMMENDATION/REQUEST

- a) INAC recommends that the commitments related to installation of the silt/turbidity curtain and associated marine water quality monitoring as presented in FEIS Volume 5, Section 10.5.3.2 and summarized in the Detailed Review comment section of this Final Comment, be captured in final commitment list, should the project be approved.
- b) INAC also recommends that the Proponent highlight the application of this best management practice during the Roberts Bay Cargo Dock in-water construction period, in its Final Hearing presentation.

30.6 TMAC RESPONSE FOR INAC-FC-3

- a) TMAC expects that the construction of the cargo dock will require an authorization from DFO. The authorization will include provisions for construction methods, monitoring and reporting. Therefore, a regulatory process is already in place and the DFO authorization (if granted post project approval) would include any requirements. Therefore, it is not appropriate to duplicate requirements outside of DFO's regulatory process.
- b) TMAC can outline our proposed construction methods for INAC at the hearings but reminds INAC that it will be DFO who outlines the required construction mitigation methods in any authorization that is issued post project approvals.

31. ID #INAC-FC-4

31.1 SUBJECT/TOPIC

Waste Rock and Ore Management Plan, Surface Water Management – Annual Audit at Freshet, Clarification

31.2 REFERENCES

- DEIS Volume 8. Environmental Management System
- FEIS Volume 1. Annex V1-7, P4-11 Hope Bay Project Waste Rock, Ore and Mine Backfill Management Plan

31.3 SUMMARY

TMAC indicates in the DEIS and reiterates in the FEIS that seep surveys will be conducted once per year at freshet (spring seep survey) in order to characterize metal leaching (ML) and confirm appropriate capture of waste runoff.

Within the FEIS, TMAC also indicates that environmental personnel will undertake visual inspection for seepage twice a year, and if water is present, water samples will be collected and analyzed. It is currently unclear if the proposed visual surveys will include the sampling of seepage from waste rock stored on the surface, or what will be the difference between the proposed annual seep survey and the bi-annual visual surveys.

Limiting the seep survey to once a year will not provide adequate data on the seasonal variability of potential metal leaching concentrations.

31.4 DISCUSSION

31.4.1 Importance of Issue to the Impact Assessment Process

Freshet is the period of highest flow and would result in the most dilution of metal leaching within the year.

Completing seep surveys biannually is important to accurately characterize the variability in extent of metal leaching throughout the year. If sampling is limited to freshet, it could lead to an underestimation of total annual ML and thus prevent TMAC from taking appropriate measures to mitigate potential ML issues on the site.

31.4.2 Detailed Review Comment

TMAC indicates that the seep survey will be undertaken annually, and that twice a year Environmental personnel will do visual inspections for seepage and if present, water samples will be submitted for analysis of parameters specified in the water licence. It is not clear if the "twice-annual survey" will inspect the same areas as the annual seep survey.

Limiting seepage survey to once annually will not fully characterize ML in site seepage. Water quality changes throughout the year are dependent upon climate and availability of precipitation and flow. In times of high precipitation and snow melt, high flow in streams and seeps dilute metals in the water.

During the summer, warmer temperatures result in more active geochemical reactions which break down and liberate metals and particulates from rock. In the fall, precipitation will interact with the liberated metals and may result in water quality which is higher in metals and particulates.

Limiting characterization of metal leaching to once per year at freshet will result in biasing the samples to the time of highest flow and greatest dilution of metals within seeps and runoff.

Consistent sampling twice a year, once at freshet during highest flow, and once in late fall, when highest metal concentrations would be expected, would provide a more realistic range of values for more accurate characterization of the ML from mine waste rock.

The proposed biannual sampling approach is consistent with current practice at other northern mines.

31.5 RECOMMENDATION/REQUEST

- a) INAC requests that the Proponent clarify the difference between the proposed "twice annual survey by Environmental personnel to do visual inspections for seepage and if present water samples submitted for analysis of parameters specified in the water licence" and the annual seep survey.
- b) INAC further requests that the Proponent revise their Waste Rock and Ore Management Plan, Surface Water Management component to include biannual sampling events, once at freshet (as currently stated) and once in late fall prior to freeze up. Any additional monitoring and management plans relevant to seepage management should include, at a minimum, biannual sampling events.

31.6 TMAC RESPONSE FOR INAC-FC-4

- a) The annual seepage survey during freshet is in reference to the waste rock

stockpile on surface. The bi-annual seepage survey is in reference to the underground backfill seepage monitoring program. Both programs are currently conducted at Doris as conditions of the Water Licence 2AM-DOH1323.

- b) All seepage and runoff from the waste rock and ore stockpile pads are directed to downstream, lined collection ponds and managed according to the Water Management Plans (P4-7 Hope Bay Project Doris-Madrid Water Management Plan, P4-8 Hope Bay Project Boston Water Management Plan). Contact Water Ponds will be monitored as part of the Surveillance Network Program (SNP) monitoring network. Therefore, drainage from the waste rock stockpiles will be monitored more frequently than twice per year and accordingly, a seepage monitoring program in the late fall is not warranted.

32. ID #INAC-FC-5

32.1 SUBJECT/TOPIC

Inconsistent Commitment to the Use of Revegetation as a Reclamation Option

32.2 REFERENCES

- INAC-TRC 18 and TMAC's commitment to consider revegetation of areas of disturbed overburden in the FEIS
- FEIS Volume 1 (Main Volume),
- FEIS Volume 3 (Project Description and Alternatives)
- FEIS Annex V1-7, Package 4 (Management and Other Plans; P4-19 Hope Bay Project Boston Conceptual Closure and Reclamation Plan; P4-21 Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan)

32.3 SUMMARY

Section 5.1.2 (Post Closure Goal) in FEIS Volume 3 indicates that natural re-vegetation would be promoted and enhanced but there is no mention of the commitment to incorporate more deliberate means of revegetation (e.g. seeding) into reclamation efforts under certain circumstances.

The use of active revegetation options is only mentioned in the Conceptual Closure and Reclamation Plans for the Boston and Doris-Madrid properties.

This sends an inconsistent message to the reader as to whether or not TMAC is fully committed to utilizing a full complement of reclamation options, which includes both natural and, where appropriate, active revegetation.

32.4 DISCUSSION

32.4.1 Importance of Issue to the Impact Assessment Process

FEIS Volumes 1 and 3 comprise the primary documents that describe the Project and the means for managing environmental issues. It is important that TMAC clearly states its commitment to incorporate more deliberate means of revegetation into reclamation efforts, along with measures to enhance vegetation re-establishment in these primary volumes and throughout the FEIS to assure reviewers of their intent to pursue all revegetation options.

32.4.2 Detailed Review Comment

There is an inconsistency in the Proponent's intentions to pursue active revegetation during mine closure. Currently the commitment to incorporate deliberate revegetation strategies into reclamation is mentioned in a single paragraph in the conceptual closure and reclamation plans for the Boston and Doris-Madrid Projects (Annex V1-7 Package 4, Volume P4-19 and P4-21, respectively).

INAC would like to see this information stated whenever natural revegetation is mentioned in the main FEIS documents, so that the intention to incorporate deliberate - revegetation into the overall reclamation program is clear.

Failure to include this information in the cited FEIS documents introduces ambiguity as to TMAC's intention to incorporate natural vs active revegetation during final closure.

INAC would like to note that excluding deliberate revegetation as reclamation option removes this as a potential mitigation measure to offset Project disturbances to vegetation. While the natural recovery of arctic vegetation is very slow following disturbance, it can be facilitated and encouraged through deliberate revegetation efforts.

32.5 RECOMMENDATION/REQUEST

- a) INAC requests that the Proponent clearly state their commitment to use active revegetation strategies in addition to measures that will enhance natural recolonization of disturbed areas. This commitment could be achieved as either an erratum to the FEIS or through a commitment made on the public record as part of the Final Hearing.
- b) INAC recommends that the Proponent commit to and initiate the design and implementation of active re- vegetation studies that are applicable to the reclamation of comparable northern developments.

32.6 TMAC RESPONSE FOR INAC-FC-5

- a) TMAC does not currently propose any reclamation activities that may require revegetation, and as such, cannot make a commitment to use active revegetation strategies. However, as stated in Annex V1-7, Packages P4-19 Hope Bay Project Boston Conceptual Closure and Reclamation Plan and Annex V1-7, P4-21 Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan, should opportunities emerge where revegetation can be adopted TMAC will consider it. Revegetation of rock fill pads and roads will occur naturally. Native species will colonize areas where they are well adapted to live. Areas reclaimed with

overburden will allow for the native soils, peat and gravel substrates to revegetate naturally with wind blown seeds providing local seeds, lichen and fungal spores.

- b) If and when revegetation is specifically selected as a reclamation strategy, TMAC will implement appropriate monitoring.

33. ID #INAC-FC-6

33.1 SUBJECT/TOPIC

Alternatives Assessment – Socio-Economic Components

33.2 REFERENCES

- FEIS Volume 3, section 7
- NIRB Final EIS Guidelines for Hope Bay Phase 2 Project, December 2012, section 6.4
- FEIS Volume 1, Executive Summary
- INAC-TRC# 20 – Alternatives Assessment

33.3 SUMMARY

The analysis of project design alternatives should take public input into consideration, and should describe the process that TMAC used to determine interactions between alternatives and excluded VSECs. The FEIS does not do these two things.

33.4 DISCUSSION

33.4.1 Importance of Issue to the Impact Assessment Process

In general, projects can be carried out through a variety of alternative means, and a sound environmental assessment (EA) process should identify the most optimal project design from the perspective of stakeholder concerns and valued components.

33.4.2 Detailed Review Comment

The current discussion of closure goals, principles, and objectives is currently inconsistent between plans. The Doris-Madrid ICRP does not discuss a closure goal.

Volume 3, Section 7, p. 7-1 identifies the criteria noted in Section 6.4 of the Project EIS Guidelines, and pp. 7-2 to 7-12 explore a wide range of design options in reference to some of the evaluation criteria. In the cases of two design issues, the proponent used tables to effectively capture the advantages and disadvantages of options.

However, gaps remain with respect to fulfilling the commitments TMAC made to the NIRB in summer 2017 with respect to describing how public input informed the alternatives assessment, and with respect to describing the process TMAC used to examine possible interactions between alternative project designs and VSECs:

1) The proponent committed to explaining how public input was used in the evaluation of alternative means of carrying out the project, yet TMAC provided no discussion of such public input where they indicated this content would be in their Table of Concordance of Commitments (directing readers to Volume 3, Section 7), and INAC did not find this information elsewhere in the FEIS. This gap in the FEIS contravenes an explicit requirement of such in Section 6.4 of the guidelines as well as the proponent's own explicit statement of consideration of community acceptability on page cxi of the FEIS Executive Summary. This is an important gap, as in many places in Canada design issues such as mining method (e.g., open pit vs. underground) and environmental footprint are very important to stakeholders.

2) The proponent committed to describing the process used to determine that there were no interactions between project design alternatives and excluded VSECs, but no such description is provided in the location of the application identified by the proponent in the Table of Concordance of Commitments as addressing this issue (the reader is directed to Volume 3, Section 7) and INAC did not identify this information elsewhere in the FEIS.

33.5 RECOMMENDATION/REQUEST

- a) INAC requests that the Proponent should provide feedback on design options (given that the Proponent stated that public engagement would continue following the pre-hearing conference in summer 2017).
- b) INAC requests that the Proponent should provide a detailed explanation of the process that was used to determine that there were no interactions between project design alternatives and excluded VSECs.
- c) INAC recommends that the proponent will monitor for potential impacts as part of its participation in the Kit- SEMC and that it not scope-out those excluded VSECs from future discussions with the Kit SEMC; should the Kit SEMC decide they need to be addressed. If problems are found, then solutions should be sought in coordination with regional organizations. These solutions will be discussed with the NIRB so that it may take appropriate measures.

33.6 TMAC RESPONSE FOR INAC-FC-6

- a) The FEIS describes the results of public consultation in Volume 2, Section 3 (Public Consultation and Engagement). This includes input received through a range of engagement methods undertaken by TMAC between 2010 and November 15, 2017. Key issues raised by stakeholders are identified in Table 3.4-1 and include comments on mine design and operations. As described in Table 3.4-1, consultation in 2017 in relation to Project design/alternatives included comments on avoidance of archaeological sites and artifacts, inquiry about use of green

technologies, fate of infrastructure at mine closure, treatment and storage of tailings, extent of road development, removal of permafrost, and storage of waste rock. Table 4.3-1 identifies the topics raised and TMAC's response. Community meetings and consultations resulted in a number of inquiries about Project design, with comments seeking clarification on design details.

The following table identifies topics of interest that pertain to design options, noting the related design consideration, as per Volume 2, Section 3.7 of the FEIS.

Topic	Design consideration											
	Access to orebody	Mining method	Mine waste disposal (tailings and mine)	Madrid South Surface Development	Boston Site Layout	Robert's Bay Cargo Dock	Sourcing of Aggregate	Water Supply	Water Management Alternatives	Power Generation and Distribution for	Fuel Storage Alternatives	Closure and Reclamation Activities
Location of and impacts on archaeological sites near the Project, such as tent rings at mouth of Angimajuk	X	X	X	X	X	X	X					
Avoidance of archaeological sites and artifacts, especially burial sites	X	X	X	X	X	X	X					
Contamination of marine environment by commercial ships discharging bilges						X						
Treatment and storage of tailings			X						X			X
Location of processing at Boston and transportation of ore to Doris	X		X									
Store or canteen needed on site for workers to purchase small items				X	X							
Design of all-weather road, and sourcing of surface material (quarries)	X											
Mining process		X										
Safety and management of cyanide use and use of other chemicals		X										
Removal of permafrost at Boston, replacement with quarried rock					X							
Storage of waste rock, and length of time it will remain on surface			X									
Handling of waste generated underground (brought to surface or left underground)			X									
Explanation and implementation of green technology										X		
Fate of mine infrastructure (buildings, roads) once operations and closure are complete												X
Clean-up process following closure												X

With regard to feedback on Project design, TMAC identifies design and mitigation measures including but not limited to:

- Avoiding archaeological sites by relocation or redesign where possible;
- Removing and/or reclaiming structures and facilities at closure, in consideration of discussion with KIA regarding right of refusal for any Hope Bay Surplus Asset;
- Implementing a tailings management systems including intercepting and preventing contact water from contacting the freshwater receiving environment;
- Implementing of cyanide and hazardous chemicals management to prevent their entry into the environment (e.g., cyanide will be used in a closed circuit in the process plant at Doris and will be destroyed in tailings prior to leaving the process plant);
- Implementing of an Oil Pollution Prevention/ Oil Pollution Emergency Plan (OPEP) that includes measures to respond to oil spill scenarios at the Roberts Bay facility, in accordance with requirements of the Canada Shipping Act (2001);
- Prohibiting excavation of permafrost soils, wherever possible; should excavation be required, any excavated areas will be immediately backfilled with geochemically suitable rock to act as a thermal blanket;
- Sourcing quarry materials from within approximately 5 km to minimize haul distance; therefore, quarries are approximately 10 km apart along the road alignment;
- Using the existing canteen on site, and consideration for additional canteen as required, as the Madrid-Boston Project becomes more established; and
- Designing roads to include crossing structures for wildlife (developed in consideration of input from Inuit elders at wildlife workshops in Cambridge Bay and at the Hope Bay site).

TMAC has and continues to consult with the public regarding the Project. Public consultation and engagement was also used in baseline and existing environmental studies, effects assessment and impact prediction, and the development of mitigation and monitoring programs.

- b) As described in the alternatives assessment (Volume 3, Section 7.3) for each alternative investigated, the evaluation considered technical feasibility, economic feasibility, environmental acceptability, amenability to reclamation, community acceptability or preference, and, socio-economic effects and benefits. Criteria are only considered and explicitly discussed in the alternatives assessment *as appropriate and where applicable*. For example, socio-economic criteria used in a Multiple Accounts Analysis for the Tailing Management Area included archaeological sites, Inuit employment, Inuit economic opportunities, traditional land use, community response and regulatory response. For other Project design alternatives assessed, these criteria were not considered because they were not applicable.

Consistent with the established impact assessment methodology, the alternatives assessment does not consider the Valued Environmental Components (VECs) or Valued Socio-economic Components (VSECs) since it is not the purpose of an FEIS to contemplate potential effects for every scenario of a project not under consideration by the proponent. Identification of potential interactions between the Project and VECs/VSECs is only completed for the preferred design as described in the Project Description. Based on the preferred Project design, interaction tables (Volume 3 - Table 2.5-1, Table 3.5-1, and Table 4.5-3) describe interactions between Project components or activities and VSECs. This method is in keeping with accepted standard practice.

- c) The Hope Bay Socio-economic Monitoring Program (SEMP) is designed using assessment VSECs and identified potential effects as the framework from which monitoring indicators are identified. The establishment of a real, potential cause-effect link between the Project and a valued component is essential to the design of a meaningful monitoring program. If no potential interactions between the Project and a VSEC are identified, then inclusion of that VSEC in the monitoring program is not warranted nor advisable. However, this does not preclude the potential for addition of a VSEC and associated monitoring indicators should, at a later date, an interaction be identified as a viable concern. TMAC does and will consider the input of the Hope Bay Socio-economic Monitoring Working Group and the Kitikmeot Socio-economic Monitoring Committee to help ensure that the Hope Bay SEMP remains valid and robust. The monitoring program is designed to support ongoing mitigation and adaptive management to ensure that adverse effects are avoided or minimized, socio-economic benefits are enhanced, and that the Project's real impacts are measured and reported. The basic principles of the monitoring program are founded on a process of predicting impacts, monitoring changes, interpreting the Project's influence, and adjusting management measures accordingly.

The Hope Bay SEMP is currently being updated. The draft updated monitoring program (March 2018) is based on the outcomes of the socio-economic impact assessment presented in the FEIS for the Madrid-Boston (Phase 2) Project. It has been constructed with reference to the existing monitoring program established

for Doris (2007), to broader socio economic monitoring activities in the Kitikmeot and across Nunavut, and to the results of the Territorial Socio economic Monitoring initiative led by the GN Department of Economic Development and Transportation. TMAC remains committed to the Hope Bay SEMP as an important mechanism to monitor and address the socio-economic effects of the Project with stakeholders.

34. ID #INAC-FC-7

34.1 SUBJECT/TOPIC

Impact Prediction – Competition for Local Labour

34.2 REFERENCES

- DEIS Volume 6, Section 3.5.6.3 Characterization of Residual Effects for Employment,
- NIRB Guidelines, Section 8.2.2.2 Socio-economic Environment and Impact Assessment – Impact Assessment – Employment
- FEIS, Volume 6, Section 3.5.2
- FEIS Volume 6. Section 3.5.6.3,
- FEIS, Volume 6, Section 3.5.5.2 - business opportunities
- FEIS, Volume 6, Section 3.5.5.3 Employment
- V8-5 Community Involvement Plan
- V8-7 Human Resource Plan
- INAC-TRC# 32 – Impact Prediction – Competition for Local Labour

34.3 SUMMARY

TMAC provided insufficient information and evidence with regards to competition for local labour in the FEIS. However, the Proponent is committed to participating in the Kit-SEMC to follow up on socio- economic issues including competition for local labour.

34.4 DISCUSSION

34.4.1 Importance of Issue to the Impact Assessment Process

A thorough consideration of the potential impacts of new mine employment on existing public and private sector employers within the regional study area is essential for accurately determining the impacts of the Project on local labour.

34.4.2 Detailed Review Comment

The Proponent notes through the course of its baseline that labour competition already exists due to such factors as a history in the region of employers struggling to find and retain labour, limited availability of mining skills, and the high wages paid in mining

(Volume 6). In the impact assessment the Proponent reiterates these issues but also discusses how the Project would contribute further to labour competition by offering more high-paying jobs, how there are many in the region with skills transferable to mining, and that overlap between Doris operations and Madrid-Boston construction would heighten competition for labour. In characterizing the Project's anticipated effects on labour competition, the Proponent then presents a series of statements leading to a conclusion that while the Project will cause adverse effects of this nature () these effects will not be significant. This argumentation is lacking in evidence. For example,

*There is potential for some currently employed residents of the Kitikmeot region to leave their employment for mine-related employment. However, employment with the Madrid-Boston Project is finite in nature and individuals who have invested in their education to obtain employment (skilled workers) are, **not expected** to leave their permanent employment for temporary employment, particularly during the Construction Phase, which has a limited duration of four years.... The Madrid-Boston*

*Project also **has the potential** to increase employment levels and reduce the unemployment rate. This is because **it is expected** that a number of currently unemployed and underemployed will find employment with the Madrid-Boston Project or associated with spin-off employment in the communities. Further, those who transition from current employment to employment with the Project **may be** replaced by the currently unutilized labour. (Volume 6 emphasis added).*

In the above and other cases (see page references), and elsewhere in the FEIS, the Proponent expresses their expectations but provides little to no rationalization or evidence to support these expectations. In the case of competition for labour, this lack of evidence is potentially very serious given the dependence of the community on available labour and the already high costs to do business in the region. Without evidence backing up TMAC's stated expectations it is not possible to validate their conclusion of 'no significant' effect.

With regards to the second issue of participation in the Kit-SEMC, the Proponent did state in the FEIS that it is committed to participating in the Kit-SEMC, and that through this participation there is an opportunity for ongoing monitoring of socio-economic effects, including potential changes to labour competition, caused by the Project and/or other development in the region.

34.5 RECOMMENDATIONS/REQUEST

INAC requests that To address outstanding gaps in the Proponent's assessment of potential effects on labour competition, INAC recommends that the Proponent provide further clarification of the evidence it has to support its assertions and conclusion in the labour competition impact assessment. The Proponent should provide literature

references, interview data, assumptions made, and/or other inputs underlying its conclusions.

- a) Regardless of where this clarification leads, and given the limited mitigation measures proposed by the Proponent to address this effect (Volume 6 p3-116), INAC recommends that
 - i. during hiring for construction and operations the Proponent track former employers of new recruits and report these data quarterly to the Kit-SEMC;
 - ii. the Proponent identify a list of potentially vulnerable private and public employers, based on former employers of new recruits but also including other plausible employers, engage with these employers on the subject of labour competition, and provide an annual report on the results of this engagement to the NIRB and Kit-SEMC; and
 - iii. the Proponent explore additional mitigation measures that it might take to address the project's competition for labour.

34.6 TMAC RESPONSE FOR INAC-FC-7

As stated in the FEIS, the effect of competition for local labour in Kitikmeot communities is rated as likely (socio-economic trends indicate the effect is likely to occur) and of medium confidence (socio-economic trends are currently changing). The effect is, however, rated as not significant as determined by applying the assessment methodology and the criteria explicitly used to characterize the effect. The characteristics of the effect that were important in making the determination of not significant included consideration of the local barriers to employment, the composition of the local labour force (shortages of workers with skills required for mine work, Section 3.2.5.4, 3.2.5.5 and 3.5.5.3), and the few businesses that would be affected by this competition. TMAC notes that although efforts are made to maximize Inuit and Nunavummiut employment, the majority of workers are expected to be sourced from outside of the Kitikmeot region and Nunavut.

In 2016, TMAC provided 335 full-time equivalents (FTEs) for contract and direct staff, with approximately 43 FTEs held by Kitikmeot Inuit; this represented about 14% of total workforce effort that year (2016 SEMP). The total number of Inuit that were involved in the Project, either from the Kitikmeot or outside, was 91 with many working on as per needed basis (2016 SEMP). Main areas of employment included general labour positions in construction and maintenance (23%), site services (34%), and underground mining (12%; 2016 SEMP). In 2017, with the initiation of production, the workforce effort totaled 392 FTEs for Project employees and contractors; approximately 54 FTEs (14%) were held by Kitikmeot Inuit (2017 SEMP). In total, there were 107 Inuit workers, with most employed in site operations (28%) and site services (52%), and to a lesser degree underground mining (14%; 2017 SEMP). A number of Project on-site contract staff, with extensive heavy

equipment experience, worked previously for the Hamlets of Kugluktuk and Cambridge Bay on a casual basis (2016 SEMP). Also, some on-site contract staff may have previously been employed with other local businesses.

The Project estimates that during operation, it will require 1,100 workers at various skill levels (10% of workers are expected to be required to have skill level A, 45% skill level B, 35% skill level C, and 10% of workers to have skill level D). The high-low Kitikmeot workforce scenario analysis presented in the FEIS assumes that there could be between 115 to 347 Inuit workers at the Project (Table 3.5-11, Section 3.5.5.3 of Volume 6 in the FEIS).

Project jobs at skill level A and B require university and college education. Based on 2016 Census, and as classified by a major of study, of the 2,900 individuals 25 to 64 years of age (this also represents the size of the labour force), 57% had no postsecondary degree and 29% were unemployed. Less than 1% had a degree in social sciences, less than 0.5% were science technologists or technicians, 2% had a degree in engineering, 5% in construction trades, and 3% transportation. Because of skill shortage and low educational attainment in required fields, the majority of workers at skill level A and B will be sourced from outside of Nunavut. The level of sourcing from the Kitikmeot region for these positions may increase over time as the capacity of the labour force improves.

Project jobs at skill level C require training that can be obtained within a relatively short period of time. However, there are limited post-secondary options available locally. High school representatives indicated that typical graduation rates fluctuate between about 25% and 40% (The Community Research Report, Volume 6, Appendix V6-3A). There is also a struggle to gain trades credentials; community members often obtain skills in professions such as mechanics, carpenters, electricians, and other trades as a result of learning from family or other mentors (E. Cameron, and C. Gabel 2015; Section 3.2.5.5).

Additional barriers to employment for Kitikmeot residents that limit the availability of skilled local labour include having a criminal record, and particularly for the mining industry, failing drug and alcohol testing. A lack of motivation that can affect follow through with a job application, hiring processes, and job retention, as well as unwillingness to leave home and family for jobs or training are also common. The unwillingness to leave home for work creates a barrier for employment at mines, such as TMAC, which operate using a fly-in/fly-out (FIFO) rotational schedule (The Community Research Report, Volume 6, Appendix V6-3A).

There is strong correlation between the evidence in the Community Research Report and actual TMAC experience recruiting for the Doris Mine workforce. A large number of job offers to Kitikmeot residents were rescinded due to a failures in passing pre-employment medical screening including drug testing. Other job offers to Kitikmeot residents were rescinded due to unacceptable criminal histories. Significantly, almost all Kitikmeot residents who rejected job offers for Doris Mine work did so in favour of job opportunities in their home communities. Also in 2017, a number of Kitikmeot residents choose to end

their employment at Doris Mine. The reasons for voluntary terminations also agree with the conclusions of the Community Research Report. Labour competition between a mine site and impacted communities operates both ways.

The shortage of skilled local labour is also noted by contractors and housing organizations in Kitikmeot communities. In the absence of local tradespersons, local companies bring in skilled workers including mechanics, electricians and heating specialists. This is particularly the case for government contracts, which require certified tradespersons for project development (Community Research Report, Volume 6, Appendix V6-3A). The Local Housing Organizations (LHOs) contract tradespeople (e.g. plumber, electricians) from outside of communities to provide services when they are not available locally. Outsourced contractors bring in all labour and specialists for a development, with some local construction companies being subcontracted for services and supplies (Community Research Report, Volume 6, Appendix V6-3A).

Other challenges that local businesses face for retaining staff include low wages as well as the high cost of living, even in the case of living in subsidized government housing. Some staff prefer to be retained as contract workers (rotating in and out of the community, rather than residing permanently in the community), as this allows for accommodation costs to be covered while workers are in town (Community Research Report, Volume 6, Appendix V6-3A). Consequently, as with workers at skill level A and B, majority of workers at skill level C are also expected to be sourced from outside of the territory.

Local business and organizations fulfill their needs for skilled tradespeople not only from the local labour pool, which is insufficient, but from the broader Canadian labour pool, similar to TMAC. Skilled labour is highly mobile in Canada. The national labour pool is capable of meeting the relatively small needs of Arctic communities and underground mining operations through minimal competition and without need of specific mitigation. This assertion is supported by direct recruitment evidence.

Finally, workers at skill level D require on the job training. The hiring of workers at skill level D is not expected to cause competition for local labour as such workers can come from the large unutilized labour pool (Table 3.2-13, Section 3.2.5.5). Although it is expected that some workers at skill level D currently employed by other businesses in the Kitikmeot region will seek employment at the Project, workers at skill level D require relatively little training, and rehiring and retraining for those occupations is feasible for a local business. As noted, mostly those with skill level D currently have the potential to be sourced from the Kitikmeot region (Section 3.2.5.3).

With respect to business impacts, of the approximately 63 Registered Inuit businesses (NTI) in the Kitikmeot region, several firms hired workers with skills transferable to the mining industry. Kugluktuk had three businesses related to construction and contracting in 2016. Gjoa Haven had one business providing engineering services; one providing services in

heavy equipment and one in general construction. Cambridge Bay had five businesses involved in various construction activities, one related to drilling and underground drilling, three in expediting, one in underground mine development, and a few related to trades and other services.

In 2016, 21 Inuit-owned and Kitikmeot Qualified Businesses (many of which were in construction, expediting, heavy equipment and mine development) benefited from Project contracts, with an average value of contracts of \$2.6 million, and a median value of \$892,000. TMAC's contractor spending totalled \$47.7 million to Kitikmeot Qualified Businesses in 2016, plus \$5.9 million to other Inuit-owned Businesses. In 2017, the Project provided \$48.8 million in business contracts to Kitikmeot Qualified Businesses, with \$5.0 million awarded to other Inuit-owned businesses (2017 SEMP). The average value of contracts awarded in 2017 to Inuit-owned businesses was \$3.0 million and a median value of \$1.2 million (2017 SEMP). As evidence suggests, the overall economic benefit to local businesses in the Kitikmeot region is substantial, supporting increases to business capacity, including workforce and business revenue. This specifically includes businesses that have workers with skills transferable to mining and that provide services directly to the industry.

While the availability of workers with the skills and experience needed by the Project is currently limited within the Kitikmeot region, the capacity of the local labour force will improve over time. TMAC will contribute to this, not just for the benefit of the Project but for other businesses in the region and Nunavummiut.

TMAC is committed to increasing the capacity of the local labour force through its support of training and career development programs, as well as provision of Project employment and on-the job training. These commitments are set out in the Inuit Impact and Benefit Agreement (IIBA), the Human Resource Plan, as well as in other commitments related to ongoing engagement with local communities. This will allow a greater proportion of Nunavummiut to meet the requirements for employment with the Project; they will contribute to the skill level and experience of the local and regional labour force, increase the size of the skilled labour force available and, consequently, increase the availability of skilled labour for local businesses.

The IIBA sets out principles to maximize Inuit employment and business opportunities arising from the operation of the Project, and provide a mechanism through which effective communication and cooperation can take place. Key features of the IIBA include provisions for, among others: setting annual and long-term Inuit training targets; setting annual Inuit employment targets; first opportunity to resident Kitikmeot Inuit for employment, followed by non-resident Inuit; establishment and administration of a Training and Education Fund; promotion of Inuit content in procurement, including requirement to engage Kitikmeot Qualified Businesses for certain types of goods and services; and establishment, under certain conditions, of a Business Development Fund.

The Human Resources Plan supports the provisions of the IIBA and, more broadly, provides a framework for human resources management at the Hope Bay Project which ensures that the needs of all TMAC personnel are addressed throughout the life of the Project. The Plan addresses human resources, Inuit employment, education and orientation and employee wellness. In conjunction with the IIBA, specific measures include, among others: to build cultural awareness and enforce harassment policies; promote awareness of employment opportunities within Kitikmeot communities; collaborate with training institutions; develop and implement a recruitment strategy; career development plans for Inuit employees; collaborate and partner with relevant agencies and contractors to ensure skill requirements are being met; and collaborate with education and training providers to develop training programs geared toward the long-term employment of women in non-traditional occupations.

TMAC will also host a community information and career awareness session in all Kitikmeot communities at least annually. Information will be provided to communities on: labour needs of the Project; skills, behaviours and qualifications required for employment at the Project; available training opportunities and educational support programs; and career opportunities in related fields. During Operations, TMAC will also sponsor competitions and achievement awards at the secondary school level in fields relevant to or related to mining sector careers. TMAC will also maintain communications with Kitikmeot communities over the life of the Project, and share information to assist in the development of collaborative adaptive management measures, should unanticipated impacts arise and mitigation be required. Detailed description of mitigation and enhancement measures is provided in Volume 6, Section 3.5.4 of the FEIS.

In consideration of this context, including the number of workers demanded by the Project, the availability of skilled local labour, the number of businesses potentially affected, and the initiatives of TMAC to increase the skills and capacity of the local labour force, the competition for local labour is expected to be not significant. TMAC does not believe that additional research and analysis is required to support the conclusions of this assessment.

With respect to monitoring, TMAC maintains that the Hope Bay Socio-economic Monitoring Program (SEMP) should be the primary mechanism, in addition to the mechanisms provided through the Hope Bay IIBA, through which Project-specific socio-economic performance information is shared and discussed with stakeholders. TMAC will continue its involvement in the Hope Bay Socio-economic Monitoring Working Group and the Kitikmeot Socio-economic Monitoring Committee, and will remain open to considering additional mitigation measures should Project impacts of competition for local labour emerge as a significant concern.

The SEMP is designed in collaboration with the Hope Bay Socio-economic Monitoring Working Group, including representation from the Government of Nunavut, Indigenous and Northern Affairs Canada, and the Kitikmeot Inuit Association, and is to reflect the

priorities and interests expressed by the Kitikmeot Socio-economic Monitoring Committee, which has a larger community-based representation. The specific socio-economic indicators that are to be monitored and reported on will be defined under the SEMP and its processes. Specific monitoring indicators should not be defined by Project Certificate Terms and Conditions.

35. ID #INAC-FC-8

35.1 SUBJECT/TOPIC

Impact Prediction – Competition for Access to Local and Regional Businesses

35.2 REFERENCES

- DEIS Volume 6, Sections 3.5.5.2 Business Opportunities, & 3.5.5.3 Employment
- NIRB Guidelines, Section 8.2.4.2 Socio-economic Environment and Impact Assessment – Impact Assessment – Contracting & Business Opportunities
- DEIS, Volume 6, Sections 3.2.3.5 Territorial Economy and Economic Development and 3.2.3.6 Business Opportunities
- FEIS, Volume 6, Sections 3.2.3.5 Territorial Economy and Economic Development (which now includes business opportunities) and 3.5.5.2. Business Opportunities
- V8-5 Community Involvement Plan
- V8-7 Human Resources Plan
- IIBA (Schedule F)
- INAC-TRC# 33 – Impact Prediction – Competition to other Business Needs

35.3 SUMMARY

Information provided on "business capacity trends" in the FEIS is insufficient. The issue of whether TMAC's demand for goods and services may exceed local and regional businesses' capacity to serve existing customers has not been addressed.

35.4 DISCUSSION

35.4.1 Importance of Issue to the Impact Assessment Process

In order to fully assess the potential socio-economic impacts from the Project, effects on competition for access to local and regional businesses with existing customers' needs to be assessed (NIRB Guidelines 8.2.4.2).

35.4.2 Detailed Review Comment

The Proponent anticipates a positive effect on local businesses in terms of developing their capacity and new business creation. Regardless, the Proponent proposes several

measures to ensure that local and regional businesses will be prioritized (e.g., IIBA - Schedule F includes a qualified business registry and a business development fund) and TMAC states that the IIBA Implementation Committee will oversee this process. TMAC indicates that these issues will also be monitored by the Socio-Economic Monitoring Committee (SEMC).

However, the Proponent has not included additional information on "business capacity trends" in the FEIS. The issue of whether TMAC's demand for goods and services from local and regional businesses may exceed these businesses' capacity to serve their existing customers has not been addressed in the FEIS. It is possible that many local and regional businesses will shift their focus to serving the Proponent, leaving existing customers without access to necessary goods and services.

35.5 RECOMMENDATIONS/REQUEST

- a) INAC requests that the Proponent should provide additional information regarding business capacity trends, and should provide an assessment of how the project may affect competition for access to local and regional businesses with existing customers.
- b) INAC recommends that the Proponent will monitor competition with other business needs as part of its participation in the Kit-SEMC. If problems are found in terms of the capacity of local and regional businesses to serve their existing customers, appropriate solutions should be sought in coordination with regional organizations.

35.6 TMAC RESPONSE FOR INAC-FC-8

- a) In assessing effects on competition for access to local and regional businesses with existing customers, it is important to understand that within the 2015 Hope Bay Inuit Impact and Benefit Agreement (IIBA), procurement preference is provided to local Kitikmeot Based Business services, not commodities, and in only 15 areas or scopes of work:
 - Air Regional and Site Specific Services (all types)
 - Expediting
 - Freight Shipping (all types)
 - Infrastructure Planning, Financing, and related Advisory - other than engineering, procurement and construction management services
 - Catering and Housekeeping

- Drilling - Surface and Subsurface
- Blasting Services
- Earthworks and Earthworks Construction
- Surface Mining
- Underground Mining
- Environment Services
- Tire Services (but not including supply of tires).
- Medical/First Aid
- Translation and Cultural Services
- Heavy Equipment Maintenance

Given that there is a focus on specific contract areas for regional Inuit business development stemming from the Project, this in itself will constrain to some degree the amount of competition for access to local business services as a result of the Project. Several of these contract categories are specific to the mining industry. As Doris Mine is the only operating mine in the Kitikmeot, those services are currently restricted to a single customer. Local business wishing to provide services in areas other than those indicated above at Hope Bay must do so based on open market competition.

Data presented by the NTI registry of Inuit firms and TMAC's Hope Bay Socio-economic Monitoring Program (SEMP) indicate that there is increasing business capacity in the region, and supports the anticipated positive effect on local businesses in terms of providing local benefits and developing capacity and new business creation. In consideration of the business registry maintained by NTI, the FEIS (Volume 3, Section 3.5.5.2) reports that there were 53 registered Inuit firms in 2014, 61 in 2015, and 63 in 2016. As reported in the Hope Bay SEMP, TMAC has been highly successful in awarding work to Inuit-owned firms in the Kitikmeot region, including Kitikmeot Qualified Businesses as defined under the IIBA and other Inuit-owned firms. Local contract awards have increased from \$8.3 million in 2013 to \$53.6 million in 2016. There is no evidence that this increase in work for Kitikmeot business has adversely affected the ability of local businesses to continue to serve Kitikmeot communities - rather, there has been an increase overall business activity.

With respect to the concern that TMAC's demand for goods and services may exceed local and regional businesses' capacity to serve existing customers, it is important to consider the economic context of the region. The Kitikmeot region, as for the territory as a whole, has a mixed economy, with the Government of Nunavut

and local government dominating the service sector and serving as the major economic driver of the local communities (Volume 3, Section 3.2.5.4 and Appendices V6-3A and V6-3B). The region is strongly dependent on the public sector as documented in the socio-economic baseline (Appendix V6-3A), with the public sector, namely public administration, health care, and education related employment, representing more than 50% of jobs. As concluded in the FEIS (Volume 6, Chapter 3), the public sector's ability to provide services to the region will not be significantly, negatively impacted by the Project.

Notwithstanding, the local economy also includes private sector market economies (e.g., construction, tourism/accommodation, retail, trades and services). Cambridge Bay is the largest and most diversified economy, while other Kitikmeot communities have relatively few private sector businesses. Mining is a focus for businesses based in Cambridge Bay and, to a lesser extent, Kugluktuk. Mining does not have a major business presence in the eastern Kitikmeot communities (Appendix V6-3B).

One of the major suppliers of mining services in the region is the Kitikmeot Corp., which has established businesses to deliver mining services in Nunavut and across Canada. Kitikmeot Corp. businesses provide services including road construction/maintenance, civil works, heavy machinery supply, underground mine development, catering and janitorial services (Appendix V6-3B, Section 3.3.4). Kitikmeot Corp. businesses have performed works at the Hope Bay site, as well as working at Diavik and Ekati mines. Notably, Kitikmeot Corp. has diversified its holdings and investments to reduce its dependency on mining, and has made advances into commercial and residential housing and real estate. This again indicates that businesses are increasing their activities and investment in the Kitikmeot communities, not moving away from providing goods and services locally.

In consideration of this context, it is not predicted that TMAC's demand for goods and services may exceed local and regional businesses' capacity to serve existing clients. In the instance where a demand for products or services emerge, such as during the construction of the Canadian High Arctic Research Station (CHARS), it was noted in community research (FEIS Volume 6, Appendix V6-3B) that much of the work went to large contractors, and some local businesses formed joint ventures in order to meet the demand. For other businesses that currently do not focus on the mining sector (for example, local firms focused on construction of public housing and building maintenance), there is no evidence to indicate that these firms would reduce or eliminate the services they provide in the communities for mining sector business. Rather, the expectation is that if more businesses move towards mining services, this will be largely done as an addition to their current book of business, in a measured way that manages their business risks.

- b) TMAC has and continues to participate in the Hope Bay Socio-economic Monitoring

Working Group (SEMWG) and the Kitikmeot Socio-economic Monitoring Committee (Kit-SEMC). The Kit-SEMC brings together territorial and federal governments (Government of Nunavut, INAC), industry proponents, Inuit organizations, hamlet representatives and other stakeholders to engage in discussions and information-sharing among all parties to understand socio-economic changes in the region. In consideration of information provided by TMAC and other Kit-SEMC participants, TMAC will continue to monitor economic and business indicators. If local and regional business capacity challenges arise in relation to serving existing clients as a result of TMAC pressure on products and services, TMAC will work with regional organizations and governments to develop appropriate solutions. Specific socio-economic indicators that are to be monitored and reported on will be defined under the Hope Bay Socio-economic Monitoring Program (SEMP) and its processes. Specific monitoring indicators should not be defined by Project Certificate Terms and Conditions.

36. ID #NRCAN-2.1.2

Baseline Permafrost and ground ice conditions in the Madrid and Boston project areas and along the All Weather Road

36.1 SUMMARY OF NRCAN'S REVIEW

Guidelines for the Preparation of an Environmental Impact Statement for Hope Bay Mining Ltd.'s Phase 2 Hope Bay Belt Project (NIRB File No. 12MN001), December 2012, Sections 6.1, 6.6, 7.6, 7.10, 8.1.4

36.2 DOCUMENTS REVIEWED

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol. 1 (sec. 4.2.3), Vol. 3 (sec. 3, App. V3-2C, 2E, 2F, 3H, 3I, 3J), Vol 4 (Ch. 4, 6, 7, App. V4-7A) Information Requests for the Madrid-Boston Project: NRCAN IR 1, INAC IR 34(2), KIA IR175 FEIS Vol. 1 Main Volume, Annex V1-7 Packages P5-3, 11, 14, 16, 17, 17, 22, 26, 28 16 TMAC response to NRCAN's technical review comments NRCAN 2.1.2 Final Commitment Table

36.2.1 Issue

Permafrost is found throughout the project area and will provide a foundation of project components such as the all weather road (AWR) and facilities at the Madrid and Boston sites. Surface disturbance associated with infrastructure construction or extraction of borrow resources can lead to alterations of the ground thermal regime which can lead to thawing of permafrost. Where sediments are ice-rich, ground instability, ponding of water and changes in drainage can occur which can have implications for infrastructure performance and the surrounding terrain. Adequate knowledge of baseline permafrost and terrain conditions is therefore required for appropriate design of project infrastructure and to also assess the impacts on the environment.

36.2.2 Proponent's Initial Conclusions

The Proponent has summarized the geotechnical conditions at the project site in Appendix V3- 2E of the DEIS, and provides terrain maps for the project area in App. V4-7A (App. 1) of the DEIS. Geotechnical boreholes have provided information such as ground ice conditions for the mine sites (Vol. 4, sec. 6.3.2 Figure 6.3-1 to 6.3-3, Table 6.3-4). There have however, been no detailed geotechnical investigations along the AWR (response to NRCAN IR 1). Additional geotechnical investigations will be conducted in the project area prior to detailed design that will provide further characterization of foundation conditions and ensure environmental effects will be minimized.

36.2.3 NRCan's Initial Conclusions

Limited site-specific geotechnical investigations have been conducted particularly along the proposed AWR. However, NRCan agrees that for this stage of design the terrain mapping and geotechnical investigations are generally sufficient. However, additional geotechnical investigations including information on ground thermal and ground ice conditions will be required to support detailed engineering. NRCan agrees with the approach outlined by the Proponent in response to NRCan IR 1 and 2, which includes additional geotechnical investigations at all sites prior to detailed engineering to further characterise the foundation conditions and to collect information on ground thermal conditions. With respect to the AWR, additional geotechnical investigations and thermal monitoring will focus on bridge abutments only (particularly where not founded on bedrock) in order to update the engineering analysis and confirm bridge performance (Response to NRCan IR1, INAC IR34 (2), KIA IR 175). For other sections of the AWR, more detailed air photo interpretations will be done to confirm terrain conditions. This approach appears to be reasonable and is similar to that used for other roads on the site as well as other projects.

36.2.4 NRCan's Initial Recommendations

NRCan recommends that the Proponent conduct further site specific investigations (such as geotechnical boreholes indicated in response to NRCan IR 1), to better characterize ground ice conditions and identify sensitive terrain in the project area. 17

36.2.5 NRCan's Final Conclusions

In its response to NRCan's technical comment 2.1.2, TMAC acknowledged agreement with their proposed approach. TMAC also indicated that the proposed additional work to better characterize ground ice conditions would be conducted during detailed design. Commitments made in response to NRCan's recommendation (and also commitments in response to KIADEIS- 55,56,57,58) further indicate that the Proponent will be conducting additional geotechnical site characterization after completion of FEIS stage (post-water licence) to support detailed engineering. The data acquired from these investigations would be used to update any engineering design analysis. NRCan is in agreement with TMAC's approach and recommends that they follow through on their commitments.

36.2.6 NRCan's Final Recommendation

NRCan recommends that the Proponent conduct the additional site investigations and geotechnical site characterization, as outlined in their commitments, to support detailed design of project infrastructure and facilities.

36.3 TMAC RESPONSE FOR NRCAN-2.1.2

TMAC maintains its plan that prior to detailed engineering additional field characterization studies will be conducted, and all engineering analysis will be updated to reflect site specific conditions.

37. ID #NRCAN-2.1.3

Design of Doris Tailings Impoundment Area

37.1 SUMMARY OF NRCAN'S REVIEW

37.2 DOCUMENTS REVIEWED

- Guidelines for the Preparation of an Environmental Impact Statement for Hope Bay Mining Ltd.'s Phase 2 Hope Bay Belt Project (NIRB File No. 12MN001), December 2012, 6.6.3.2,
- 7.6.1, 8.1.5, 9.4.6
- Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol 3
- (App. V3-2D,2F,2E,3F);
- Information Requests for the Madrid-Boston Project: NRCAN IR 3, 4, KIA IR 168, 169, 172,
- 172, 181
- FEIS Vol. 1 Main Volume, Annex V1-7 Package P4-9
- TMAC response to NRCAN's technical review comments NRCAN 2.1.3
- Final Commitment Table

37.2.1 Issue

The Phase 2 project will make use of the approved Doris North Tailings Impoundment Area (TIA) for disposal of tailings resulting from development of the Madrid North and South mines. However, to accommodate the substantial increase in the volume of tailings, the facility will need to be expanded. An understanding of the characteristics of the subsurface materials that will underlie all structures required for the expanded facility is required to inform the design and stability assessments required to ensure the facility operates as intended and to ensure impacts on the environment will be minimised. Freezing of the tailings will enhance performance of the facility and this will require an assessment of the thermal evolution of the pile. 18

37.2.2 Proponent's Initial Conclusions

The expansion of the Doris TIA will require a modification to dams, including enlargement and raising of the South Dam and construction of the West Dam (Vol. 3, sec. 4.4.4.1, App. V3-3F). While there is adequate knowledge of foundation conditions for the North and South Dams that were part of the approved facility, the Proponent indicates that the foundation conditions for the West Dam are less understood due to the minimal

subsurface investigations (App. V3-2D, 3F). For the new or enhanced structures that will be required, foundation conditions are assumed to be similar to the foundation conditions beneath the approved structures. Based on their analysis, the Proponent expects that the North Dam will stay frozen over its extended life to 2050 and the South and West Dam liners will stay frozen in perpetuity (App. V3-2F, sec. 4.8, App. C, H). They have also determined that tailings freeze-back will occur in 2-13 years depending on the thickness of the tailings (App. V3-2F, sec. 4.8, App. H). Little deformation of the tailings pile is expected so there should be no issues with respect to deformation and performance of the tailings cover (App. V3-2F, sec. 4.9, App. I).

37.2.3 NRCan's Initial Conclusions

Although the Proponent has conducted detailed site investigations to support the Phase 1 TIA design, NRCan notes that these investigations such as those for the North Dam occurred at a more advanced design stage. For the new components such as the West Dam, information on foundation conditions comes from one borehole and design is largely supported by the information collected for the North Dam. In 2006, the Proponent conducted ground-penetrating radar (GPR) surveys around the lake but the survey line is located about 200 m to the east of the West Dam (App. V3-2F, sec. 4). For the South Dam raise, there is also lack of geotechnical data (App. V3-2F, App. B). In response to NRCan IR3 and KIA IR169, the Proponent has indicated that additional geotechnical investigations will be conducted prior to detailed engineering to characterize foundation conditions and to update the engineering analyses (thermal, seepage, stability) required for the Phase 2 TIA. NRCan agrees with this approach. The Proponent has conducted a thermal analysis for the Phase 2 TIA including the West and South Dams and their foundations and also for the extended life time for the North Dam (App. V3-2F, App. C and H). The analysis is similar to that conducted for the Phase 1 project and also incorporates thermal monitoring data collected for the core and foundation of the already constructed North Dam (App. V3-2F, App. C). The results of these analyses also support the stability and seepage analysis (e.g., App. V3-2F, App. B, D, I). The Proponent has been fairly conservative in their approach. For the North Dam the analysis indicates that the core and the foundation temperatures will remain below the design values of -2 and -8°C respectively over the 40 year lifetime. The ground temperature data collected in 2014-15 indicates that the observed thermal conditions are in agreement with those predicted (App. V3-2F, App. C). For the West and South Dams, which will not be water retaining at closure, the thermal analysis also indicates that the critical part of the dams (the liner in the key trench) will remain frozen and tailings are expected to freeze-back (App. V3-2F, App. H). NRCan agrees that the Proponent has conducted an adequate thermal analysis for this stage of the project design. NRCan suggests that the Proponent continues to update this analysis as 19 additional data is generated through the monitoring program for the North Dam. Since the thermal response of the North Dam and foundation will be slow, any variance from predicted response can be identified through analysis of the monitoring data. NRCan suggests that a similar approach can be followed for the other components of the Phase 2 TIA to ensure that the facility maintains its

integrity over its intended life time. During its review of the amended Phase 1 Doris project and in NRCan IR4, NRCan expressed some concern regarding the potential for warmer conditions at the north end of the tailings pile, both within the tailings and foundation, due to the presence of the reclaim pond. This could result in variable thermal conditions and potential for differential heave or settlement and deformation of the cover. Freeze-back of the foundation beneath the tailings pile would generally be expected to be slow with a potential for ice lens formation and frost heave and would occur at variable rates given the warmer conditions at the north end of the pile. NRCan had recommended in its review of the amended Phase 1 project that 2D thermal modelling might be considered for the assessment of differential movements and potential effects on the tailings cover integrity. The Proponent indicated that the thermal analysis would be revisited as design advances but that it was premature at the preliminary stage to suggest 2D thermal analysis is the appropriate approach. For the Phase 2 project the Proponent presents a similar thermal analysis and qualitative analysis with respect to frost heave potential. In response to NRCan IR 4, the Proponent indicated that there has been no sensitivity analysis regarding the thermal conditions in the tailings pile. Thermal monitoring during operation would provide data to confirm the closure design and the post-closure monitoring plans will be provided in detail in an updated tailings operation, maintenance and surveillance manual. Further stability analysis will be done prior to final closure. NRCan agrees that further thermal analysis can be revisited during detailed design.

37.2.4 NRCan's Initial Recommendations

With respect to the Doris TIA, NRCan recommends that the Proponent:

- Continue to utilize the data generated through the North Dam monitoring program to update thermal analysis, to improve characterization of the thermal evolution of the dam and its foundation, and to determine if mitigation is required should actual conditions deviate from those predicted.
- Conduct the additional site investigations, as outlined by the Proponent in response to NRCan IR3, to better characterize foundation conditions for structures required for the Phase 2 TIA (West Dam and South Dam raise) and to support the thermal, seepage and stability analysis required for their detailed design.
- Revisit the thermal modelling for the tailings during detailed design to confirm the potential for differential movements that may have impacts on the cover integrity.
- Adopt an approach similar to that taken for the North Dam with respect to monitoring of the dams required for the Phase 2 TIA, and use the data collected to update the thermal analysis and to determine if mitigation is required should actual thermal conditions deviate from those predicted. 20

37.2.5 NRCan's Final Conclusion

In its response to NRCan's comments, TMAC acknowledged NRCan's general agreement with their approach. TMAC also acknowledged NRCan's recommendations and indicated that they would consider these in future design and monitoring stages. TMAC's commitment in response to NRCan-2.1.3 states that they will be conducting additional geotechnical site characterization studies after completion of the FEIS as part of detailed engineering (post water licence). Data collected as part of these characterization studies will be used to update any engineering design analysis. NRCan agrees with the approach with respect to geotechnical site investigations and incorporation of the data acquired into the engineering analysis and recommends they follow through on these commitments. NRCan also agrees that TMAC should consider other NRCan recommendations in future design stages and also in the development of monitoring and management plans for the Phase 2 TIA to determine if it is performing as intended and to guide the implementation of mitigation measures if required. NRCan also suggests that this may include more detailed thermal modelling for the tailings, such as 2-D modelling, to support stability assessments and potential for differential movements of the tailings. NRCan also suggests that TMAC consider adopting an approach similar to the North Dam with respect to the monitoring of the Phase 2 TIA dams.

37.2.6 . NRCan's Final Recommendations

With respect to the Doris Phase 2 TIA, NRCan recommends the following to support final design and development of environmental monitoring and management plans:

- The Proponent follow through on commitments for additional site investigations to better characterize foundation conditions for structures required for the Phase 2 TIA (including West Dam and South Dam raise) to support and update their engineering analysis.
- The Proponent consider revisiting the thermal analysis to confirm potential for differential movements that may have an impact on tailings cover integrity.
- Continuing monitoring of the North Dam and utilize these data to update thermal analysis and also adopt a similar approach with respect to the development of monitoring plans for Phase 2 TIA dams.

37.3 TMAC RESPONSE FOR NRCAN-2.1.3

TMAC maintains its plan that prior to detailed engineering additional field characterization studies will be conducted, and all engineering analysis will be updated to reflect site specific conditions.

38. ID #NRCAN-2.1.4

Configuration of Taliks and Permafrost in the Project Areas

38.1 SUMMARY OF NRCAN'S REVIEW

38.2 DOCUMENTS REVIEWED

Guidelines for the Preparation of an Environmental Impact Statement for Hope Bay Mining Ltd.'s Phase 2 Hope Bay Belt Project (NIRB File No. 12MN001), December 2012, Sections 7.3, 7.6.1, 8.1.4, 8.1.6

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol 3 (App. V3-4B, Vol. 4 (sec. 6.3.4)

Hope Bay 2010 West Bay Program Report; Geotechnical and Hydrogeological Assessment for the Boston Open Pit and Madrid Open Pit and Underground 21

Information Requests for the Madrid-Boston Project: Response to NRCAN IR5, IR6

FEIS Volume 1 Main Volume, Annex V1-7 Package P5-13

TMAC response to NRCAN's technical review comments NRCAN 2.1.4 Final Commitment Table

38.2.1 Issue

Although permafrost is continuous in the region, unfrozen ground or taliks may be found beneath large water bodies that do not freeze to the bottom during the winter. Where lakes exceed a critical size, taliks may be open and provide a hydraulic connection between surface and ground water. Knowledge of the extent of taliks is important to determine whether mining will take place in frozen or unfrozen conditions and to determine mine inflows and whether mining operations will have an effect on water quantity and quality in the project area.

38.2.2 Proponent's Initial Conclusions

The Proponent has conducted an analysis to determine lakes in the project area that are likely to have open taliks (App. V3-4B, Figure 20, App. A, sec. 4, Table 4 and 5). For the underground mine sites, a more detailed thermal analysis has been conducted (App. V3-4B, App. A). The Proponent has determined that the Boston underground mine will be entirely in permafrost (App. V3-4B, Figure 21). At Madrid North, the Suluk and Rand underground mines will be within an open talik beneath Patch Lake (App. V3-4B, Figure 22). The lower portion of the Naarotok mine, below 430 m depth will be below the permafrost (App. V3-4B, Figure 22). The Madrid South mine will also intercept unfrozen ground at the edge of an open talik formed by Wolverine and Patch Lake (App. V3-4B, Figure 23).

38.2.3 NRCan's Initial Conclusions

The Proponent has utilized acceptable methods to delineate lakes likely to have open taliks (App. V3-4B). NRCan requested clarification regarding whether consideration of warmer ground conditions would lead to identification of additional lakes potentially having open taliks (NRCan IR5). In their response to NRCan IR5, the Proponent indicated that while it is possible that additional lakes might have open taliks, they were outside the hydrogeological domain for the project. NRCan agrees that the Proponent has adequately identified lakes potentially having open taliks to support their groundwater modelling.

The Proponent has utilized observed ground temperatures and thermal modelling to determine the extent of taliks at the mine sites to determine whether the underground mines will be in frozen or unfrozen ground (App.V3-4B). The Proponent's approach is reasonable. NRCan does, however, offer a few observations regarding the analysis for consideration by the Proponent. For the Madrid and Boston mine sites, information on deep ground temperatures has been acquired from inclined boreholes drilled at these sites (Vol 4, Figure 6.3.2, 6.3.3). The Proponent has presented ground temperature profiles derived from the data collected at these boreholes (App. V3-4B, App. A Figure 7 and 15). NRCan would note that the reconstruction of vertical temperature profiles based on data from inclined holes may not provide a true picture of the ground thermal regime beneath a specific point, especially where there is a significant variation in the surface conditions above the area traversed by the borehole (i.e. in some cases the shallow temperatures were measured beneath the land surface while the deeper temperatures in the borehole were measured beneath the water body).

For the Boston site, there are three deep inclined wells that extend beneath Aimokatalok Lake. Temperatures are cold ($<-5^{\circ}\text{C}$) at depths of 241-247 m below the ground surface (App. V3-4B, App. A Figure 6 and 7). Below the lake the -2°C isotherm occurs between 201 and 224 m depth between 17 and 115 m from the shore (App. V3-4B, App. A). The Proponent concludes that these low temperatures cannot be explained by the present day lake configuration and suggest there has been a more recent submergence of this area and temperatures are still warming at depth. This has been incorporated in the talik modelling and they have concluded that the underground mine, which for the most part is beneath the land surface, will be entirely within permafrost. NRCan notes that a small portion of the mine will extend a short distance offshore (App. V3-4B, App. A, Figure 6). Although ground temperatures a short distance offshore are about -2°C at depths of about 200 m, NRCan suggests that above this altitude, temperatures may be warmer due to ground warming at depth following submergence of this area. Temperatures at the lake bed could be close to or above 0°C and it is possible that a small portion of the mine may occur within an unfrozen zone, based on a freezing point depression of -2°C . At the detailed design stage the Proponent may want to give further consideration to the potential for a portion of the mine to intersect a talik. NRCan also notes that one of the recommendations made by SRK (2009 Assessment Report for the Boston Open Pit)

was for consideration of additional thermistor installations to better characterize the thermal regime under the lake and to confirm whether the lake freezes to the bottom.

38.2.4 NRCan's Initial Recommendations

NRCan recommends that during final design, further considerations be given for the potential of a portion of the Boston underground mine to intersect a talik beneath the Aimokatalok Lake.

38.2.5 NRCan's Final Conclusions

In response to NRCan's comment regarding the potential for the Boston underground mine to intersect a talik beneath Aimokatalok Lake, TMAC acknowledged NRCan's comment regarding the analysis and indicated they would consider this in detailed design. TMAC indicates in their response to ECCC 4.9, that the Boston mine is expected to be entirely within permafrost and no groundwater flow is expected. Measures such as pilot drilling and risk zone mapping, as undertaken at Doris, will be used to ensure mining stays within the permafrost zone, and their assessment does not consider any mining at Boston outside of permafrost. In FEIS Annex V1-7 package P4-6, TMAC states (sec. 1.1) that an objective is to avoid taliks or unfrozen zones beneath permafrost in areas where mining is planned to remain encapsulated in permafrost. Regardless of this objective, TMAC has indicated (response to ECCC 4.9 and commitment to NRCan 2.1.4) a groundwater management plan will be prepared for the Boston Mine that is consistent with those to be developed for other Phase 2 mines. Contingency measures for small quantities of water will be in place that can be handled within the existing water management structures and framework at Boston. However if larger quantities should be encountered, TMAC plans include temporary isolation and cessation of specific mining areas until suitable water management strategies can be put in place. As indicated in commitments to NRCan 2.1.4 and ECCC 4.9, a ground water management plan for Boston was provided in the FEIS (P4-6 Module C). This plan includes triggers and mitigation measures (Table C-1) and also outlines specific responses, such as reviewing thermal measurements and permafrost models to assess correlation between modeled and observed inflow. NRCan agrees that the Proponent has presented a reasonable approach to deal with uncertainty with respect to delineation of permafrost and taliks at the Boston mine and the potential for any groundwater flow should mining intersect the talik.

38.2.6 NRCan's Final Recommendations

NRCan agrees with the plans and approach outlined in their response to NRCan's technical comments, commitments made and also in the groundwater management plans provided in the FEIS. NRCan agrees that these plans are sufficient to deal with potential uncertainties regarding the configuration of taliks and permafrost zones in the Boston Mine area and has no further recommendations with respect to this issue.

38.3 TMAC RESPONSE FOR NRCAN-2.1.4

TMAC acknowledges that: NRCan agrees with the plans and approach outlined in TMAC's response to NRCan's technical comments, commitments made and also in the groundwater management plans provided in the FEIS. NRCan agrees that these plans are sufficient to deal with potential uncertainties regarding the configuration of taliks and permafrost zones in the Boston Mine area and has no further recommendations with respect to this issue

39. ID #NRCAN-2.1.5

Design of the Boston Tailings Management Area and Associated Contact Water Pond

39.1 SUMMARY OF NRCAN'S REVIEW

39.2 DOCUMENTS REVIEWED

Guidelines for the Preparation of an Environmental Impact Statement for Hope Bay Mining Ltd.'s Phase 2 Hope Bay Belt Project (NIRB File No. 12MN001), December 2012, Sections 6.1, 6.6.1, 6.6.3.2, 7.3, 8.1, 9.4.6

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol 1, Vol 3 (App. V3-2A, 2C, 2E, 2F, 3J), Vol 7 (Ch. 2), Vol 8 (Appendix 27)

Information Requests for the Madrid-Boston Project: Response to INAC IR 36, 39; KIA IR 165 FEIS Volume 1 Main Volume, Annex V1-7 Package P5-3

TMAC response to NRCAN's technical review comments NRCAN 2.1.5

Final Commitment Table

39.2.1 Issue

The Boston tailing management facility (TMA) will be a dry stack tailing facility. The TMA and associated contact water pond must be designed to limit seepage of contact water to the surrounding environment. Adequate knowledge of foundation materials is required to ensure stability of the facility, including contact water pond berms, during operation. Long-term physical stability of the TMA is required to meet closure objectives and to ensure that long-term water management is not required. A key to ensuring these objectives are met is the stability of the TMA cover system in order to limit potential for seepage through tailings and potential leaching. 24

39.2.2 Proponent's Initial Conclusions

The Boston TMA will be a dry stack tailing facility that will be built on permafrost and the facility is expected to freeze following deposition (V1, sec. 3.3; V3, sec. 3.8.11). The closure plans will include a low permeability cover (consisting of a geomembrane with crushed rock on top) that will mitigate against long-term water quality concerns associated with metal leaching (App. V3-2F). Although water management, including a contact water pond will be required during operation, there will be no need for water management under the proposed closure plans (V8 Appendix 27).

39.2.3 NRCAN's Initial Conclusions

The Proponent has presented a detailed analysis to support their conclusions regarding the proposed Boston TMA. This includes thermal analysis and stability analysis for the dry

stack, including the geosynthetic closure cover (V3 sec 3.1.11, App. V3-27 App. A, B; V7 sec. 2.9). Although there is potential for heave or settlement of the dry stack which could lead to deformation of the cover, the analysis indicates that stability of the cover will be maintained over the long-term (App. V3-2E, 2F App. A). The design for the contact water pond includes thermal modelling for the berms over a 20 year operating period, including climate change, to ensure that thawing does not occur that could have an impact on the performance of the berms (V3 sec, 3.8.5; App. V3-2C). The analysis conducted by the Proponent is reasonable for this stage of the design. NRCan notes that there is currently a lack of geotechnical site investigations to support the design of the Boston TMA and contact water pond. The analysis utilized foundation properties based on site-wide geotechnical properties (App. V3-2F App. A). The Proponent has indicated in response to KIA IR165, that additional site investigations will be conducted to support detailed design and to refine the engineering analysis. NRCan agrees with the approach proposed by the Proponent. The monitoring plan outlined in Appendix V3-2F, including temperature cables installed beneath and along containment berms and monitoring of deformation of dry stack facility, will facilitate assessments of facility performance and inform final closure plans.

39.2.4 NRCan's Initial Recommendations

NRCan recommends that additional site investigations, as suggested in response to KIA IR165, be conducted to support detailed design and final closure plans for the Boston tailings management area.

39.2.5 NRCan's Final Conclusions

In its response to NRCan's comments and recommendations, TMAC acknowledged NRCan has confirmed agreement with the approach proposed by TMAC. TMAC's commitment with respect to NRCan 2.1.5, states that TMAC will be conducting additional geotechnical site characterization studies as part of detailed engineering (post water licence) and data collected will be used to update any engineering design analysis for the Boston TMA. In addition, the Proponent has indicated in Annex V1-7, Package P5-3 (sec. 2.3) that additional geotechnical site investigations will be carried out prior to final design to better characterize conditions of 25 foundations for berms required for the contact water ponds. NRCan also notes that additional thermal modelling has been completed to support design of the berms for the contact water ponds (Attachment 1, P5-3 and response to KIA-DEIS-54) in which a conservative approach has been taken with respect to pond water temperatures. NRCan assumes that based on TMAC's response, this analysis will be updated with information obtained in future geotechnical site investigations.

39.2.6 NRCan's Final Recommendations

NRCan is in agreement with the approach TMAC has outlined for its detailed and final design of the Boston TMA and associated contact water ponds, and also the commitments made in response to NRCan's review of the DEIS. NRCan therefore recommends that the Proponent follow through on commitments for additional geotechnical site investigations to support final design and use data collected to update the engineering analysis associated with the Boston TMA and associated contact water ponds.

39.3 TMAC RESPONSE FOR NRCAN-2.1.5

TMAC maintains its plan that prior to detailed engineering additional field characterization studies will be conducted, and all engineering analysis will be updated to reflect site specific conditions.

40. ID #NRCAN-2.2.2

Mine inflow salinity

40.1 SUMMARY OF NRCAN'S REVIEW

40.2 DOCUMENTS REVIEWED

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol. 1 (sec. 3, sec. 4.3.2, 4.4.1), Vol.3 (sec. 4.3.2, 4.4.5, 7.3.10, App. V3-2D,4B), Vol. 5 (sec. 2, App. V5-8A,8B)

Information Requests for the Madrid-Boston Project: Responses to NRCAN-IR10,-IR12,-IR13, ECCC-IR5

Hope Bay 2010 Westbay Program Data and Installation Report – SRK Feb. 2011

Hope Bay 2011 Groundwater Quality Report – SRK April 2014

FEIS Vol. 1 Main Volume; Vol. 3, Sect. 4.4.5; Vol. 4, Sect. 4; Vol. 5, Sect. 2; Annex V1-7 Packages P1, P2, P4, P4-6, P4-7, P4-8, P4-9, P4-11, P5-4, and P5-24.

TMAC. 2017. Hope Bay Project: Proponent's Response to Technical Comments on the Draft

Environmental Impact Statement for the Madrid-Boston (Phase 2) Proposal: Toronto, Ontario. Response to comment NRCAN 2.2.2

Final List of Commitments for the Madrid-Boston Proposal.

40.2.1 Issue

If groundwater salinity is higher than expected, discharge of mine waters to Roberts Bay via the marine outflow mixing box (MOMB) or to the Doris Tailings Impoundment Area (TIA) may be problematic and require careful management. The salinity of groundwater inflow into the mine is important for two reasons. First, saline mine inflow will be discharged primarily to the marine environment in Roberts Bay via the MOMB. Secondly, saline mine inflow could be diverted to the TIA if discharge of mine water via the MOMB is not possible due to high salinity.

The salinity of the water discharged from the MOMB to Roberts Bay is important because discharge to the marine environment relies upon its buoyancy for appropriate mixing. Consequently, there is a maximum limit to the salinity that can be discharged to Roberts Bay and "all groundwater that have salinities above 27 ppt (15,000 mg chloride/l) will be conveyed to the TIA" (App. V5-8A, sec. 3.3.2.2). The MOMB mixes water from the TIA and the intercepted groundwater. However, the plan is to discharge TIA water to the MOMB

only during the open water season (App. V3-2D, Sec 6.3.1). Therefore, mine water is the only source of water to the MOMB and Roberts Bay during the ice-covered season. So, if the mine water salinity is above the MOMB discharge concentration, it will be discharged to the TIA. However, as noted in the 27 water and load balance sensitivity analysis, the high salinity of mine inflow would impact the performance of the TIA (App. V3-2D, sec. 8) "the 180 day pumping duration resulted in a significant increase to the chloride predictions, excluding Madrid North intercepted groundwater, which could have a significant impact on process performance." This section also stated that "prolonged use of the Doris TIA for storage of intercepted groundwater should be avoided for the Doris and Madrid South mines."

40.2.2 Proponent's Initial Conclusions

The mixing modelling (of MOMB water and marine water) in Roberts Bay (App. V5-8A, 8B) uses the groundwater modelling results (App. V3-4B) as inputs to their modelling and include both high salinity (25.3 ppt) and a low salinity (15.3 ppt) scenarios. Although the water and load balances for the Hope Bay project (App. V3-2D) can include groundwater inflows to the TIA, it appears that the balance and load results do not include any groundwater input to the TIA (except for the sensitivity analysis discussed above) since intercepted groundwater is assumed to be pumped directly to the MOMB. Therefore, the models on which the water management is planned rely on the predicted groundwater fluxes and concentrations results from the groundwater models. The proponent recognizes the potential limitations of the groundwater modelling (App. V3-4B, sec. 4.2.7) and addresses the models' sensitivities by comparing the model results of various scenarios (App. V3-4B, sec. 5.4). All scenarios predict that intercepted groundwater concentrations are below the 15 000 mg/l chloride discharge limit, except for Madrid North in 2019-20 for all scenarios.

In response to ECCC-IR5, the proponent states that "the rationale for using Doris groundwater samples (10WBW001) is driven by the extreme difficulty of obtaining good quality groundwater quality samples in a low K and frozen environment that would be representative of the true formation water" and adds "salinity which is not expected to differ between the sites because it is not a function of the mineralogical make-up".

40.2.3 NRCan's Initial Conclusions

NRCan recognizes the significant challenges and costs involved in collecting hydrogeological data from sub-permafrost groundwater environments such as for the Hope Bay Project. As a result, there is necessarily more uncertainty in any hydrogeological modelling and assessment than might be expected for more accessible non-permafrost sites. The goal of the following comments is not to request additional sample collection or modelling. Rather, it is to illustrate the nature of the uncertainties in mine inflow salinity (as measured by groundwater chloride or total dissolved solids (TDS)).

Intercepted groundwater could have chloride concentrations that are higher than predicted for several reasons. First, the characterization of groundwater chloride concentrations with depth is based on the results from one multilevel piezometer (3 depths) located at the Doris site (ECCCIR5). Despite the Proponent's claim that salinity is not expected to differ between the sites, there is no data to support this claim. Data compiled from other sites (Figure 17, V3-4B) show that 28 total dissolved solids (TDS) concentrations (chloride being the dominant ion in most cases) can vary widely at any given depth. Chloride (and TDS) concentrations could be higher (or lower) at the Madrid sites.

Second, the groundwater models may underestimate chloride. As noted above, the chloride concentrations vs. depth profiles used in the groundwater modelling are based on the characterization from one location at the Doris site (Figure 18, App. V3-4B). The groundwater models have both initial and boundary conditions based on this profile (Figure 18, App. V3-4B; NRCAN-IR10). The resulting vertical stratification of initial chloride concentrations (Figures 26 and 27 in V3-4B and Figures IR-10-1 and -2) may not be appropriate. For example, the TDS concentrations from the Hope Bay site are much higher than those at comparable depths at other sites (Figure 17, V3-4B) which may suggest that the proximity of the Hope Bay site to the ocean (on a regional scale) may result in regional groundwater upwelling and higher chloride concentrations originating from deeper groundwater flow. Higher groundwater chloride concentrations at shallower depths could produce higher concentrations in mine inflow, particularly at early times when most groundwater originates from storage.

Finally, the goal of the groundwater model sensitivity analysis was to put emphasis (V3-4B sec. 5.4) "on scenarios that could result in increased inflow to the underground mine compared to the base model." Consequently, these scenarios often produced greater flows of fresh water towards the mine with resulting lower chloride concentrations. A high permeability zone that intercepts the mine at depth could result in higher inflows of more saline water.

In conclusion, several interconnected aspects of water management across the site could be affected by the presence of higher salinity groundwater flowing into the mine. Although higher salinity groundwater is not necessarily anticipated, there is enough uncertainty in the characterization and modelling that it is nonetheless a possibility.

40.2.4 NRCAN's Initial Recommendations

NRCAN recommends that water management plans should consider how groundwater would be managed if mine water chloride concentrations (i.e. salinity) were consistently in excess of the limits for discharge to Roberts Bay via the marine outflow mixing box. Although some statements in the DEIS suggest that saline groundwater inflow to the TIA is not desirable beyond a short term diversion, it is not clear if there are the potential consequences to the operation of the TIA should longer term groundwater flow to the

TIA be necessary. NRCan recommends that potential effects of higher groundwater salinity should be assessed across the water management system and assessed for significance if necessary.

40.2.5 NRCan's Final Conclusions

In its response to NRCan's technical comment 2.2.2, TMAC acknowledged the possibility of higher mine water chloride concentrations (i.e. salinity). However, they consider it "very unlikely that high concentrations would be associated with consistently high mine inflows" claiming that the source of the high salinity water is storage in the fractured rock. TMAC 29 indicates (TMAC, 2017, p. 308) that "groundwater management and monitoring plans are in place and will be further refined as the Project moves through the review and water licensing process. Where appropriate, groundwater management plans may consider mine water salinity trigger levels and thresholds."

NRCan's assertion is that groundwater chloride concentrations (and by extension salinity and density) could be above the marine discharge limits. As noted above, dealing with this discharge could become an issue during the ice-covered season when mine water is the only source of discharge to the MOMB. This issue does not necessarily require the Proponent's scenario of high inflow of intercepted lake water that makes its way into mine drainage. A deep, extensive enhanced permeability zone could contribute moderate water fluxes with high salinity. Although it is beyond the scope of NRCan's review to assess the potential effects of saline mine water inputs to the functioning of the TIA, NRCan does note that the DEIS responses (TMAC, 2017) and the FEIS (both the GWMP and the Water Management Plan; Annex V1-7, P4-6, P4-7) do not seem to address these potential effects. NRCan recommends to the NIRB to follow up on this potential issue with the Nunavut Water Board.

A Groundwater Management Plan (GWMP) for the Hope Bay Project has been developed with specific Mine Inflow Management Programs (MIMP) for the Doris, Madrid and Boston mine sites as part of the Water Licence Application (P4-6). The specific MIMPs for the Madrid and Boston Mines have not been subject to peer review as they have recently been added to the Water Licence Applications' GWMP (Annex V1-7, P4-6). The following comments pertain to the GWMP and the included MIMPs:

- 1) Although the GWMP recognizes the mine inflow chemistry (section 2.2) as a groundwater management issue and includes mine inflow quality monitoring (section 5.2), the MIMPs do not seem to include any considerations related to mine inflow chemistry. No Specific Performance Thresholds (SPT) are specified for chloride concentrations or salinity although TMAC acknowledges that these could be considered.
- 2) The Boston mine is being developed on the premise that it will be entirely contained in the permafrost and there will be no discharge of (mostly saline) groundwater to the environment. The GWMP and the MIMP for the Boston mine are designed to limit

groundwater inflow to the Boston mine but implicitly acknowledge that some mine inflow from groundwater may occur. In contrast to the MIMPs for the Doris and Madrid mine sites, no SPTs are specified for the total mine pumping rate from the Boston mine (Annex V1-7, Package P4-6, Module C).

Consequently, there is no stated limit on total groundwater inflow to the mine. Numerous small point sources and/or larger point sources that cannot be fully sealed with grout could add up. The potential impacts of this source of saline water (e.g. to the Boston contact water ponds) do not appear to have been considered (see next comment).

3) The Water Management Plan for the Boston mine (Annex V1-7, Package P4-8, Section 2.3.3) states that "The management of any unplanned groundwater interception is presented in the Hope Bay Groundwater Management Plan." However, the GWMP does not discuss how intercepted groundwater from the Boston mine would be managed. The action in the MIMP 30 specified in response to a groundwater inflow in excess of 360 m³/day for the Boston mine (Annex V1-7, Package P4-6, Table C1) indicates pumping "excess groundwater to surface water contact ponds or directly to water truck for transport to Doris Marine Mixing Box." This source of water does not appear in the Boston conceptual water balance (Annex V1-7, Package P5-4, figure 2-4) nor in the water and load calculations to Aimaokatalok Lake (Annex V1-7, Package P5-4, section 7.1.3 and TMAC, 2017, response to ECCC-4.15). The potential implications of the discharge of unplanned intercepted saline groundwater to the contact water ponds (and ultimately to Aimaokatalok Lake) do not appear to have been considered. Furthermore, the treatment process for water contact ponds will not affect chloride concentrations (Annex V1-7, Package P5-4, section 3.7.6). Combined effluent to Aimaokatalok Lake is already predicted (Annex V1-7, Package P5-4, Table 7-3) to be above the CCME guidelines (Annex V1-7, Package P5-4, Table 4-3) without including any saline groundwater discharge to the contact water ponds (and ultimately to Aimaokatalok Lake).

4) Although the Boston mine is expected to have no groundwater inflow, a threshold value of 360 m³/day for 30 days (Annex V1-7, Package P4-6, Table C1) must be exceeded before mining of the concerned area should stop. This threshold is not supported by any justification and seems excessive, particularly since there does not appear to be a clear management action for groundwater inflows to the Boston mine (see previous comment). NRCAN is of the opinion that the GWMP can provide an effective means to ensure proper management and monitoring of mine inflows and water chemistry subject to the resolution of comments provided above.

40.2.6 NRCAN's Final Recommendations

NRCAN provides the following recommendations for the Groundwater Management Plan (GWMP):

1a) the adaptive management (section 6) within the GWMP should also include consideration of water chemistry indicators and related specific performance thresholds (SPTs) and specific responses (numbering in relation to comments above);

1b) the MIMPs could also include the re-assessment of flow and water chemistry monitoring programs (e.g. frequency, locations, water chemistry parameters) under the "Evaluation" heading of the Specific Performance Threshold, SPT-2;

2a) the Boston mine MIMP should include the review of records of mine pumping rates and discharge chemistry under the "Review" heading of SPT-1 as is the case for the Doris and Madrid MIMPs (this is only applicable if there is groundwater pumped from the mine but ensures that records are kept and reviewed);

2b) the Boston mine MIMP could also include SPTs for total mine inflow (SPT-2 and SPT-3);
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3a) the GWMP should explicitly state how any groundwater inflows into the Boston mine would be managed (e.g. discharge locations, treatment, discharge criteria, monitoring) to ensure that they do not impact receiving water bodies;

3b) if warranted, the NIRB and Nunavut Water Board may request the Proponent to consider the potential impacts of discharging saline groundwater to the Boston contact water ponds (and ultimately to Aimaokatalok Lake) at the rates identified in the MIMP;

4) the Proponent and Nunavut Water Board should reconsider and justify the 360 m³/day threshold (SPT-3) for point source inflow for the Boston mine MIMP. The Proponent's final commitment for the groundwater salinity issue is the implementation of the GWMP. Notwithstanding the assessment of potential issues related to the discharge of saline water to the MOMB, TIA or Aimaokatalok Lake which are beyond the scope of NRCAN's review, NRCAN is of the opinion that the GWMP (subject to the resolution of comments discussed above) should provide an effective means to ensure proper control and monitoring of saline mine inflows. The success of the GWMP to manage uncertain groundwater inflows and groundwater chemistry conditions will require the responsible employees (GWMP, Table 1.3) to implement all the monitoring and measures specified in the plan vigilantly and use adaptive management to update the GWMP as new information emerges and reduces the uncertainty. NRCAN recommends to the NIRB that the Proponent revise and implement the GWMP; we expect that this would be done under the authority of the Nunavut Water Board.

40.3 TMAC RESPONSE FOR NRCAN-2.2.2

TMAC remain confident that appropriate and conservative modeling has been presented (Annex V1-7, P5-13 Hydrogeological Characterization and Modeling of the Proposed Boston, Madrid South and Madrid North Mines, Hope Bay Project). The modeling results has been benchmarked, and a detailed Groundwater Management

Plan (GWMP) (Annex V1-7, P4-6 Hope Bay Project Groundwater Management Plan) has been developed that will allow for continuous learning and adaptation as mining advances and more information about the system behavior is obtained. As is clearly stated in the GWMP, should mine water quality not allow for direct discharge to Roberts Bay, mine water will first be pumped to the Doris TIA before being discharged to Roberts Bay with TIA discharge water. TMAC however acknowledges that the current GWMP does not include Specific Performance Thresholds (SPTs) in the Mine Inflow Management Plans (MIMPs) pertaining to inflow chemistry. Therefore, TMAC proposes to update the GWMP to specifically add SPTs as listed in Table 40.1. Table 40.2 subsequently list the proposed additions the Specific Responses in the MIMPs related to the proposed new inflow chemistry SPTs.

Table 40.1. Proposed additions to SPTs in the MIMPs of the GWMP

	Doris and Madrid MIMP	Boston MIMP
SPT-1	- Point source chloride concentration exceeds the predicted chloride concentration profile by more than 20%: - From 0 to 60 mbgs: $[\text{Predicted Cl in mg/L}] = 0.5012 + [\text{vertical depth in mbgs}] / 0.0043$ - Greater than 60 mbgs: $[\text{Predicted Cl in mg/L}] = 1215.6 + [\text{vertical depth in mbgs}] / 0.0909$	- Total mine pumping rate exceeds 60 m³/day - Point source chloride concentration exceeds the predicted chloride concentration profile by more than 20%: - From 0 to 60 mbgs: $[\text{Predicted Cl in mg/L}] = 0.5012 + [\text{vertical depth in mbgs}] / 0.0043$ - Greater than 60 mbgs: $[\text{Predicted Cl in mg/L}] = 1215.6 + [\text{vertical depth in mbgs}] / 0.0909$
SPT-2	Total mine water chloride concentration exceeds 15,000 mg/L, during a period when TIA mine water is being discharged	- Total mine pumping rate exceeds 180 m³/day - Total mine water chloride concentration exceeds 15,000 mg/L, during a period when TIA mine water is being discharged
SPT-3	Total mine water chloride concentration exceeds 15,000 mg/L, but TIA mine water is not being discharged	- Total mine pumping rate exceeds 360 m³/day for > 7 days - Total mine water chloride concentration exceeds 15,000 mg/L, during a period when TIA mine water is not being discharged

Table 40.2. Proposed additions to Specific Responses in the MIMPs of the GWMP

	SPT-1	SPT-2	SPT-3
Notification	No change	INAC Inspector	No change
Review	Review records of mine pumping rates and discharge chemistry	No change	No change
Evaluation	Review of mine inflow chemistry data to be undertaken by qualified professional and appropriate recommendations to be developed	Review of mine inflow chemistry data to be undertaken by qualified professional and appropriate recommendations to be developed; and Confirm chloride concentration of the combined mine water and TIA discharge water being discharged to Roberts Bay does not exceed 15,000 mg/L	Confirm available storage capacity in Doris TIA; and Consider timing to initiate TIA discharge assuming the combined mine water and TIA discharge water being discharged to Roberts Bay chloride concentration is below 15,000 mg/L
Action	No change	No change	Pump mine water to Doris TIA

Detailed analysis has demonstrated that TMACs premise that Boston mine will be developed entirely within permafrost is well supported (P5-13 Hydrogeological Characterization and Modeling of the Proposed Boston, Madrid South and Madrid North Mines, Hope Bay Project). However, TMAC understands that uncertainty exists when doing such analysis, and therefore the interface where the talik is predicted to occur is not precise. As a result, TMAC has developed a GWMP for Boston that recognizes that as the mine gets developed and new areas are opened, especially near the predicted talik edge, mine water might be encountered. However, TMAC anticipates that should any such water be encountered, the point source inflow would be sealed as soon as practical and mining in that area will be reconsidered if it is confirmed that the area is in a talik zone. As a result, the GWMP for Boston has been designed as a proactive contingency to ensure safety of mine workers.

TMAC also recognized that any such point source mine water encountered will have to be managed. To that end TMAC's primary strategy is to pump that water to a water truck for transport to the Doris Marine Mixing Box, or the Doris TIA if there is no active discharge to Roberts Bay taking place. As a result, TMAC did not include this water into the Boston

water and load balance, as it is a contingency allowance and does not form part of the operational water management.

TMAC however does have about 26,000 m³ storage capacity in their two Boston Contact Water Ponds (CWPs). Based on the SPTs as listed in the GWMP and the proposed additions listed in Table 40.1 and Table 40.2 above, the total volumes of water that may have to be managed for SPT-1, SPT-2 and SPT-3 is 90, 180 and 2,520 m³, which translates to approximately 0.3%, 0.7% and 10% of the available CWP volumes. As a result, TMAC stated that another option could be to pump contingency Boston mine water to the CWPs and if that water meets treatment or discharge criteria, it can be managed as part of the Boston Water Management circuit. Again, this has not been included in the Boston water and load balance, as it is a contingency allowance and does not form part of the operational water management.

Finally, the point source inflow of 360 m³/day was based on what TMAC believes can reasonably be trucked to the Doris TIA using a single 60 m³ capacity water truck. The cycle time for transporting a load from Boston to the Doris TIA was assumed to be 3 hours. Therefore, in a 24-hour period 8 trips can be completed which would translate to 480 m³. However, to account for unforeseen delays, a 25% contingency was applied yielding an upper limit of 360m³/day.

41. ID #NRCAN-2.2.3

Uncertainties of groundwater model predictions

41.1 SUMMARY OF NRCAN'S REVIEW

41.2 DOCUMENTS REVIEWED

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol. 1 (sec. 4.3.2), App. V3-4B, Vol. 5 (sec. 2)

Information Requests for the Madrid-Boston Project: Responses to NRCAN-IR7,-IR8,-IR9,IR10,-IR11,-IR12,-IR13

Hope Bay 2010 Westbay Program Data and Installation Report – SRK Feb. 2011

Hope Bay 2011 Groundwater Quality Report – SRK April 2014

FEIS Vol. 1 Main Volume; Vol. 3, Sect. 4.4.5; Vol. 4, Sect. 4; Vol. 5, Sect. 2; Annex V1-7

Packages P1, P2, P4, P4-6, P4-7, P4-8, P4-9, P4-11, P5-4, and P5-24.

TMAC. 2017. Hope Bay Project: Proponent's Response to Technical Comments on the Draft

Environmental Impact Statement for the Madrid-Boston (Phase 2) Proposal: Toronto, Ontario. Response to comment NRCAN 2.2.3.

Final List of Commitments for the Madrid-Boston Proposal.

41.2.1 Issue

Key predictions from the groundwater models include i) mine inflows, ii) chloride concentrations (as a measure of salinity) and iii) surface water flows to and from lakes. These predictions are used as inputs to the water balance and load model so that it can ultimately influence the assessment of potential and residual effects and the development of water management plans. Groundwater flow and transport modelling of a complex hydrogeological environment in a permafrost setting is a difficult task and requires several simplifying assumptions. The difficulty of obtaining data for model parameters further complicates groundwater modelling. Consequently, uncertainty in the model results is expected and it is difficult to assess this uncertainty. Because of the limited number of hydraulic head measurements and chloride (salinity/density) measurements, it is difficult to calibrate the model or validate the model results.

41.2.2 Proponent's Initial Conclusions

The groundwater modelling report (App. V3-4B) describes the model input, the conceptual model, the implementation of the numerical model, the modelling results as well as a sensitivity analysis to address some of the uncertainty in model parameters. Results of sensitivity analyses suggest groundwater flows typically vary by a factor of about 2-4 and mine inflow chloride concentrations by a factor of about 2.

41.2.3 NRCan's Initial Conclusions

NRCan is generally satisfied with the groundwater modelling provided by the proponent. The conceptual model appears to be reasonable as well the numerical implementation of the model. However, the data support for the model in the form of groundwater level and chloride measurements is weak. Therefore, it is not possible to validate the conceptual and numerical models in terms of flow directions and concentration profiles. Similarly, the model is not truly calibrated as there is no comparison of modelled and measured heads or concentrations. Consequently, there is uncertainty in the model results beyond just the uncertainty inherent in the values of the model parameters (e.g., hydraulic conductivity and storage coefficient) and it is difficult to assess this additional uncertainty.

As noted in the previous comment, NRCan recognizes the significant challenges and costs involved in collecting hydrogeological data from sub-permafrost groundwater environments such as for the Hope Bay Project. Groundwater models sometimes provide the public and users of the results with the impression that the groundwater system is better characterized and understood than it really is. It is NRCan's opinion that although the groundwater modelling appears to be reasonable, the actual mine inflows, water flows to and from lakes and chloride concentrations may still be outside the range of values predicted in the sensitivity models. However, it does appear that the model results are within a range of conditions that can be managed with the proposed mitigation measures.

41.2.4 NRCan's Initial Recommendations

Although it may be possible to improve the model and reduce the uncertainty with additional data, it is nonetheless a complex hydrogeological system in which unexpected groundwater (and permafrost) conditions are possible and mitigation measures may be required at times to reduce the mine inflow of saline groundwater. NRCan recommends that the best way to deal with the 33 uncertainty in the groundwater models is to ensure that groundwater management plans are in place with appropriate mitigation measures to ensure that excessive saline groundwater mine inflows are promptly reduced (further addressed in next comment).

41.2.5 NRCan's Final Conclusions

TMAC's response to NRCan's technical comments 2.2.3 and 2.2.4 refers to the groundwater management and monitoring plans that are in place and will be further refined as the Project moves through the review and licensing process. NRCan supports this approach and believes that the uncertainty inherent in the groundwater modelling is best managed through careful implementation of a groundwater management plan (GWMP). NRCan discussed its comments and conclusions on the GWMP in response to technical comment 2.2.2 above. NRCan notes that there may be practical value in a future update to the groundwater models as data become available with respect to groundwater inflows and groundwater chemistry.

41.2.6 NRCan's Final Recommendations

The Proponent's final commitment for addressing the uncertainties of groundwater model predictions is the implementation of the GWMP. NRCan is of the opinion that the GWMP should provide an effective means to address the consequences related to the uncertainties of groundwater model predictions. NRCan recommends to the NIRB that the Proponent revises and implements the GWMP under the authority of the Nunavut Water Board as discussed in technical comment 2.2.2.

41.3 TMAC RESPONSE FOR NRCAN-2.2.3

The reader is referred to the response to TC-NRCan-2.2.2 for details pertaining to TMACs proposed changes to the GWMP.

42. ID #NRCAN-2.2.4

Groundwater management plans

42.1 SUMMARY OF NRCAN'S REVIEW

42.2 DOCUMENTS REVIEWED

Phase 2 of the Hope Bay Project: Draft Environmental Impact Statement, December 2016, Vol. 1 (sec. 10), Vol.8 (App. 6 and 8). Information Requests for the Madrid-Boston Project: NRCAN-IR14 FEIS Vol. 1 Main Volume; Vol. 3, Sect. 4.4.5; Vol. 4, Sect. 4; Vol. 5, Sect. 2; Annex V1-7 Packages P1, P2, P4, P4-6, P4-7, P4-8, P4-9, P4-11, P5-4, and P5-24. TMAC. 2017. Hope Bay Project: Proponent's Response to Technical Comments on the Draft Environmental Impact Statement for the Madrid-Boston (Phase 2) Proposal: Toronto, Ontario. Response to comment NRCAN 2.2.4.

42.2.1 Issue

As noted above (Issue 2), there is uncertainty in groundwater flow and salinity predictions from groundwater modelling. Consequently, groundwater flow and/or salinity could be higher than expected. Appropriate monitoring, groundwater management plans (with mitigation measures) and follow-up needs to be in place to ensure that potentially problematic groundwater conditions can be avoided, promptly identified and addressed. Groundwater management plans for Doris 34 mine were presented in Appendix 6 of Volume 8. Specific plans for the Madrid North, Madrid South and Boston mines have yet to be developed.

42.2.2 Proponent's Initial Conclusions

In response to NRCAN-IR14, the proponent has indicated that groundwater management plans would be developed for the Madrid North, Madrid South, and Boston mines in the same manner as those proposed for the Doris mine. These plans will be updated for the water licensing process (Table 10.2-1).

42.2.3 NRCAN's Initial Conclusions

NRCAN is satisfied with the proponent's response to NRCAN-IR14. The monitoring and mitigation measures in Appendix 6 of the DEIS would help manage and control the inflow rates. The water quality issues are addressed in Appendix 8 of the DEIS. NRCAN notes the importance of the development and implementation of groundwater management plans as well as monitoring given the uncertainty in the groundwater modelling results.

42.2.4 NRCan's Initial Recommendations

NRCan recommends that groundwater management plans (with well-defined mitigation measures and monitoring) should be developed for the Madrid North, Madrid South, and Boston mines with appropriate thresholds for each mine. If appropriate, groundwater management plans should consider mine water salinity thresholds (as discussed in a previous comment). Implementation and regular updating of these plans for the specific conditions observed in each mine will help ensure workers health, safety, and environmental protection.

42.2.5 NRCan's Final Conclusions

TMAC's response to technical comment 2.2.4 refers to the groundwater management and monitoring plans that are in place and will be further refined as the Project moves through the review and licensing process. The Groundwater Management Plan (GWMP) for the Hope Bay Project has been revised since the DEIS with specific Mine Inflow Management Programs (MIMP) for the Doris, Madrid and Boston mine sites as part of the Water Licence Application. The specific MIMPs for the Madrid and Boston Mines have not yet been subject to peer review as they have recently been added to the Water Licence Applications' GWMP (Annex V1-7, P4- 6). NRCan comment 2.2.2 provides review comments and recommendations for further refinements of the GWMP and the related MIMPs.

42.2.6 NRCan's Final Recommendation

The Proponent is committed to the implementation of the GWMP. NRCan considers the GWMP to provide an effective means to address the considerable uncertainties related to groundwater inflow into the proposed mines. NRCan recommends that the Proponent revises and implements the GWMP under the authority of the Nunavut Water Board as discussed in technical comment 2.2.2.

42.3 TMAC RESPONSE FOR NRCAN-2.2.4

The reader is referred to the response to TC-NRCan-2.2.2 for details pertaining to TMACs proposed changes to the GWMP.

43. ID #DFO-3.1.1

43.1 SUBJECT / TOPIC

Avoidance and Mitigation of Effects to Fish and Fish Habitat

43.2 REFERENCES

- FEIS Volume 5, Section 6.5.4.1 – Loss or Alteration of Fish Habitat, Table 6.5-4.
- FEIS Volume 5, Appendix V5-6Y – Freshwater Fish Community and Habitat Survey Sites, 1993-2017.
- FEIS Volume 3, Section 3.7.4.3 – Stream Crossings, p. 3 – 23.
- HOPE BAY PROJECT: Proponent's Response to Technical Comments on the Draft Environmental Impact Statement for the Madrid-Boston (Phase 2) Proposal, ID#DFO-3.1.2-102.7, p.317.
- DEIS Volume 3, Appendix V3-3I – Madrid-Boston All- Weather Road Preliminary Design, p. 33-34.
- FEIS Volume 5, Section 6.5.4.1 – Loss or Alteration of Fish Habitat, p. 6 – 154
FEIS Volume 5, Section 6.5.3.2 – Best Management Practices, p. 6 - 141-143.

43.3 SUMMARY

A total of 21 water crossings are associated with the proposed all-weather roads as part of the Madrid-Boston Project. Based on the fish and fish habitat surveys conducted from 1993-2017 (FEIS, Vol. 5, Appendix V5-6Y, p. 1-16), the Proponent concluded that four of the streams are non-fish-bearing and the remaining streams are fish-bearing (FEIS Vol. 5, Table 6.5-4, p. 6-149). Four types of crossings are proposed to be used based on the watercourse characteristics: culverts in non-fish bearing water courses, culverts within fish-bearing watercourses, span bridges with pile foundations, and bridges with frozen abutment foundations (FEIS, Vol. 3, Section 3.7.4.3, p. 3-23).

The Proponent provided conceptual water crossing designs (DEIS Volume 3, Appendix V3-3I – Madrid-Boston All-Weather Road Preliminary Design, p. 33-34) and states that: *"Final design plans will be used to refine proposed mitigation measures as required, and the information will be provided to DFO during submission of Request for Review applications for individual crossings as deemed necessary prior to construction"* (HOPE BAY PROJECT: Proponent's Response to Technical Comments on the Draft Environmental Impact Statement for the Madrid-Boston (Phase 2) Proposal, Responses to ID# DFO- 3.1.2-DFO-FPP comments 102.7 , p.317).

DFO notes that the Proponent has also provided a list of general best management practices during the construction phase that include DFO's Measure to Avoid Causing Harm to Fish and Fish Habitat' (FEIS, Vol. 5, Section 6.5.3.2, p. 6-141- 143).

The Proponent identified the potential for water crossing structures to require inspection and maintenance to ensure barriers to water and fish passage do not form over time (Vol. 5, Section 6.5.4.1, p. 6-154). In *(HOPE BAY PROJECT: Proponent's Response to Technical Comments on the Draft Environmental Impact Statement for the Madrid-Boston (Phase*

2) *Proposal*, Responses to ID# DFO-3.1.2-DFO-FPP comments 102.7, p. 317, the proponent agreed to use an appropriate water crossing maintenance and a monitoring plan: "During the authorization process, DFO will outline requirements for monitoring and will be in a position to monitor activities and as built infrastructure as they deem appropriate."

43.3.1 Importance of Issue to Impact Assessment

Watercourse crossings have the potential to impact fish, fish habitat and fish passage if they are not designed, sized, installed and maintained properly.

43.3.2 Detailed Review Comment

DFO-FPP acknowledges that the Proponent highlighted the use of 'DFO Measures to Avoid Causing Harm to Fish and Fish Habitat' design criteria for enabling fish passage and that water crossings require a maintenance and a monitoring program to avoid negative impacts to fish and fish habitat. DFO-FPP also acknowledges that the Proponent has provided general engineering preliminary drawings of 'bridges and culverts designs' in DEIS, Vol. 3, Appendix V3-3I, p.33-34.

DFO-FPP notes that the provided design criteria, watercourse crossing engineer drawings, and the mitigation and monitoring plan that includes mention of 'DFO Measures to Avoid Causing Harm to Fish and Fish Habitat', are conceptual and general in nature. As such, it is unclear at this time, in the absence of detailed engineering designs, what the full suite of measures are that the Proponent intends to implement to avoid, mitigate or offset *serious harm to fish* as defined in the *Fisheries Act* as a result of water crossings proposed for the Hope Bay Phase 2 Project.

Details of a site-specific, best-practices management plan during the construction, including a maintenance plan and monitoring program will be required from the Proponent to DFO-FPP during the regulatory phase.

For fish bearing streams, DFO-FPP will require site-specific detailed design plans during the regulatory phase to determine the full extent of the potential impacts below the high-water mark (HWM).

43.4 RECOMMENDATION/ REQUEST

1. DFO-FPP recommends that the Proponent provide Fisheries and Oceans Canada with detailed watercourse and site specific engineering plans for all water course crossings, supported by measured or modeled stream flow data. This information is to be provided prior to construction, during the regulatory phase, should the project be approved to proceed.
2. DFO-FPP recommends that the Proponent work with Fisheries and Oceans Canada and the affected community members including the Kitikmeot Inuit Association to develop a site-specific construction work plan during the regulatory phase, should the project be approved to proceed. This construction plan should include but not be limited to, the full suite of mitigation measures that will be implemented to reduce the impact on fish and fish habitat during the construction phase.
3. DFO-FPP recommends that an appropriate water crossing maintenance and monitoring plan be developed to ensure that barriers to fish passage do not form over time.

43.5 TMAC RESPONSE FOR DFO-3.1.1

1. TMAC will develop and provide watercourse and site-specific engineering plans to Fisheries and Oceans Canada (DFO), supported by measured or modelled stream flow data prior to construction. The information will be provided prior to construction, during the regulatory phase, once the project is approved to proceed.
2. As part of TMAC's ongoing consultation process, TMAC will work with DFO, the KIA, and the Inuit Environmental Advisory Committee (IEAC) during the regulatory phase to develop a construction plan for watercourse crossings that will include mitigation measures to reduce impacts to fish and fish habitat during construction. TMAC submitted a Request for Review in 2016 associated with the Roberts Bay Discharge Access Road Culvert (02-HCAA-CA7-00117) and therefore intends to take a similar information sharing approach for all future water crossing construction activities.
3. TMAC will work with DFO and abide by any monitoring and reporting requirements of the authorization if and when granted.

44. ID #DFO-3.1.2

44.1 SUBJECT / TOPIC

Potential impacts on Freshwater Fish from Change in Water Flow and Water Volume

44.2 REFERENCE

- DEIS, Volume 1, Annex V1-7, Type A Water Licence Application, Package P5-4 – Madrid-Boston Project water and Load Balance, Hope Bay Project.
- FEIS, Volume 5, Appendix V56AA – Conceptual Fresh Water Fisheries Offsetting Approach, p. 24, 29.
- FEIS, Volume 5, Section 6.5.3.3 – Proposed Monitoring Plans and Adaptive Management, p. 6 – 143-144.
- DEIS, Volume 1, Annex V1-7, Type A Water Licence Application, Package P4-18 – Hope Bay Project Madrid-Boston Aquatic Effect Monitoring Plan, p.3-4.

44.3 SUMMARY

The effects assessment of the Madrid-Boston Project concludes that residual effects will remain after mitigation measures and that fish habitat will be altered through stream flow and lake water level alteration. Those effects have been predicted by the proponent based on simulated results from the water balance model described in DEIS, Vol. 1, Annex V1-7, Package P5-4.

Impacts on fish and fish habitat resulting from the Project and not predicted to be mitigatable are anticipated in the following watercourses (FEIS Vol. 5, Appendix V5-6AA, p.24 &29):

1. Little Roberts Outflow
2. Doris Outflow
3. Ogama Inflow/Outflow
4. P.O. Outflow
5. Patch Outflow
6. Inmiagut Outflow
7. Stickleback Outflow
8. Wolverine Outflow

9. Imniagut Outflow/Lake

In the FEIS Vol. 5, Section 6, p.143-144, the proponent highlighted the use of an Aquatic Effects Monitoring Program (AEMP) that will be carried out during all phases of the Project. The AEMP proposed water level monitoring stations only at locations where water withdrawal will occur or where water surface can be affected by underground mine.

44.3.1 Importance of Issue to Impact Assessment

It is important to monitor water levels and flows in watercourses that will be impacted, to ensure that unauthorized affects to fish and fish habitat are avoided.

44.3.2 Detailed Review Comment

DFO-FPP notes that there exist uncertainty with models based on estimates and estimated data variables. With respect to cumulative surface hydrology impacts and the potential impacts on the fish bearing watercourses, uncertainty with estimated models could result in surface flows that are lower or higher than predicted. As such, DFO-FPP notes that a robust monitoring plan should be implemented. This plan needs to identify variation from the predicted ranges in advance of unauthorized serious harm to fish. It should include low action levels which trigger the need for additional mitigation measures.

DFO-FPP recognizes that the Proponent has proposed a conceptual AEMP that acknowledges the potential for surface water quantities to be affected by the Project. DFO-FPP notes that the AEMP proposes to monitor potential effects of water withdrawal and groundwater removal on the surface water by monitoring water level in Wolverine, Patch, Doris, Windy and Aimaakatalok lakes (DEIS, Vol. 1, Annex V1-7, Package P4-18, p.3-4).

DFO-FPP notes that it is unclear whether the Proponent intends to monitor the water flow and quantities within the fish bearing watercourses where the possible impacts are predicted by the water balance model. Without an appropriate monitoring program in place, it will be difficult to detect the potential variations in the water levels and stream flow prior to an unauthorized impacts to fish and fish habitat occurring.

44.4 RECOMMENDATIONS/REQUESTS

1. DFO-FPP recommends the Proponent include monitoring stations to monitor water levels and stream flows in the AEMP for all fish bearing lakes and streams that are predicted to be potentially impacted by the Project.

44.5 TMAC RESPONSE FOR DFO 3.1.2

1. In order to account for potential variations from predicted water quantity modeling results, TMAC will monitor water levels and flows in fish bearing lakes and streams that are predicted to be potentially impacted by the Project during mining (e.g., P.O., Ogama, Little Roberts, and Glenn lakes in addition to lakes and streams in the AEMP and listed in Section 44.3 above). Hydrometric monitoring will be carried out by standard methods appropriate for assessing changes in lake level/stream flow (e.g., suitable combination of pressure sensors, staff gauges, and/or manual flow measurements in lakes and/or streams). Monitoring requirements will be developed and submitted as part of a fisheries offsetting monitoring plan submitted with a Fisheries Authorization application.

45. ID #DFO-3.1.3

45.1 SUBJECT / TOPIC

Avoidance and Mitigation of Effects to Fish and Fish Habitat resulting from Water Intake and Discharge Pipes

45.2 REFERENCE

- FEIS Volume 5, Section 6.5.4.1 – Loss or Alteration of Fish Habitat, p. 6 - 154-156.
- FEIS Volume 5, Section 6.5.3.2 – Best Management Practices, p. 6 - 141-143.

45.3 SUMMARY

Two water intake pipelines and one discharge pipe are proposed for the Madrid-Boston Project. The intake pipelines will be 0.15 m diameter and will be laid along access roads, transitioning from shoreline to lake bed. Pipelines will extend to 5 m depth in the lake (40 m total length in Windy Lake and 420 m total length in Aimaokatalok Lake). Effluent from the Boston water treatment plant will be discharged into Aimaokatalok Lake through a 0.25 diameter pipeline that will run from the treatment plant to the access roads and from shoreline to lake bed. The discharge pipeline will also extend to 5 m depth in the lake (800 m total length) (FEIS, Vol. 5, Section 6.5.4.1, p. 6-154-156). To reduce impacts to fish and fish habitat during the construction phase, the Proponent refers to the general best management practices list in the FEIS, Vol. 5, Section 6.5.3.2, p. 6-141-143.

45.3.1 Importance of Issue to Impact Assessment

In water Pipeline infrastructure has the potential to impact fish and fish habitat.

45.3.2 Detailed Review Comment

In the FEIS, Vol. 5, Section 6.5.3.2, p. 6-141-143, the Proponent refers to a broad list of best management practices to be implemented during the Madrid-Boston Project that include, but are not limited to *DFO's Measures to Avoid Causing Harm to Fish and Fish habitat* (DFO 2013). DFO-FPP understands that the proposed management practices aim to avoid unnecessary impacts to freshwater fish and fish habitat but are conceptual and not site-specific. Therefore, DFO-FPP requires a detailed site-specific plan of the full suite of mitigation measures that will be implemented during the construction of the pipelines (e.g. site isolation during the construction of the rock berms, design of the fish screens, and a sediment and erosion control plan).

45.4 RECOMMENDATIONS/REQUESTS

1. DFO-FPP recommends that the Proponent work with DFO-FPP and the potentially affected community members including the Kitikmeot Inuit Association, to develop a site-specific construction work plan during the regulatory phase, should the project be approved to proceed. This plan should include but not be limited to, the full suite of mitigation measures that will be implemented to reduce the impacts on fish and fish habitat during construction.

45.5 TMAC RESPONSE FOR DFO-3.1.3

1. As part of TMAC's ongoing consultation processes, TMAC will work with DFO, the KIA and the IEAC during the regulatory phase to gain consensus on acceptable construction monitoring and reporting for freshwater pipeline infrastructure that will include the mitigation measures to be implemented to reduce impacts to fish and fish habitat during construction. TMAC anticipates that these requirements would be included in an authorization from DFO issued prior to construction

46. ID #DFO-3.1.4

46.1 SUBJECT / TOPIC

Potential impacts to Freshwater Fish productivity from changes in water flow and water volume

46.2 REFERENCES

- DEIS Volume 5, Section 1.5.5.3 – Characterization of Residual Effect for Surface Hydrology VEC, Streamflow alteration in Doris Watershed p. 1-69.
- FEIS Volume 5, Section 1.5.5.3 – Characterization of Residual Effect for Surface Hydrology VEC, Streamflow alteration in Doris Watershed p. 1-71
- DEIS Volume 5, Section 6.5.4.2 – Loss or Alteration of Fish Habitat, Water Withdrawal and Use, p. 6-165.
- FEIS Volume 5, Section 6.5.4.2 – Loss or Alteration of Fish Habitat, Water Withdrawal and Use, p. 6-182.

46.3 SUMMARY

In DEIS Vol. 6 Section 6.5.4.2, the Proponent identified that water quantity impacts may have timing issues that require additional assessment. Specifically, the Proponent states in DEIS Vol. 6 Section 6.5.4.2 that:

"Therefore, effects on fish habitat due to a reduction in stream flow are considered negligible based on the application of a 10% variation from baseline threshold. However, effects due to changes in the timing of flows (e.g., later onset of freshet if lake volume is reduced and does not begin flowing in streams) and decrease in the number of days stream habitat is accessible (i.e., later freshet and/or earlier freeze up) are not assessed. The resolution of the simulated monthly data from the water balance report does not allow for detailed assessment for these variables and effects on fish habitat due to a change in the timing of flows may require additional assessment to ensure that effects on access to habitat do not occur. These analyses will be refined prior to submission of the final EIS."

DFO-FPP notes that the corresponding FEIS Vol. 5, Section 6.5.4.2 eliminates all text following the first sentence above. The revised text is as follows:

'Therefore, effects on fish habitat due to a reduction in stream flow are considered negligible based on the application of a 10% variation from baseline threshold. '

46.3.1 Importance of Issue to Impact Assessment

Affecting stream flows at certain times may delay fish in accessing spawning areas and result in fish productivity loss.

46.3.2 Detailed Review Comment

Reduced flow associated with timing may impact fish productivity by impeding fish access to important habitats associated with their biological processes such as spawning, feeding or rearing sites during critical periods of their life cycle.

DFO-FPP is unclear as to whether the predicted changes in timing resulting from a reduction of stream flow as predicted as follows in the DEIS: *"However, effects due to changes in the timing of flows (e.g., later onset of freshet if lake volume is reduced and does not begin flowing in streams) and decrease in the number of days stream habitat is accessible (i.e., later freshet and/or earlier freeze up) are not assessed. The resolution of the simulated monthly data from the water balance report does not allow for detailed assessment for these variables and effects on fish habitat due to a change in the timing of flows may require additional assessment to ensure that effects on access to habitat do not occur. These analyses will be refined prior to submission of the final EIS."* were assessed and accounted for in the FEIS.

It is unclear to DFO-FPP if the FEIS resolved expectations established in the DEIS for analysis of water quantity timing impacts on fish habitat access.

46.4 RECOMMENDATION/ REQUEST-

1. DFO-FPP requests that the Proponent clarify whether water quantity impacts that may have timing issues were accounted for in the impact assessment.
2. DFO-FPP recommends that Proponent conduct an analysis of water quantity timing impacts on fish access to key habitats.

46.5 TMAC RESPONSE FOR DFO-3.1.4

1. Water quantity impacts that may have timing issues were accounted for in Section 6.5.4.2 of the FEIS under the Characterization of Hope Bay Project Potential Effect for Streamflow (pages 6-173 to 6 -188).
2. Section 6.5.4.2 of the FEIS under the Characterization of Hope Bay Project Potential Effect for Streamflow (pages 6-173 to 6 -188) also includes an analysis of the water quantity timing impacts of fish access to key habitats. In this characterization, an initial assessment considered two timing periods (high and low flow) and a follow up assessment in "higher risk" watercourses further determined periods of highest risk for fish and potential effects on habitat use.

In the initial assessment a variation of 10% from baseline conditions (DFO 2013) at high flow (June) and low flow (July, August, and/or September) was used to identify waterbodies that may be affected by reduced streamflows under the two general flow regimes observed in streams in the Project area (Table 3.5-13). Where the maximum simulated reduction in monthly streamflow in either period over the life of the Project was less than 10%, effects on fish habitat were considered negligible and no additional assessment of the quantity or timing of flows was deemed necessary.

For waterbodies with a variation of 10% or greater from baseline conditions at high flow (June) or low flow (July, August, and/or September), a minimum flow threshold of 30% of mean annual discharge (MAD) was used to determine periods of highest risk (DFO 2013). This assessment was carried out on a monthly timescale to contribute to the determination of the life stages of fish and fish habitat requirements that may be affected by reduced flow (Table 6.2-24). The potential effects of reduced streamflow on fish and fish habitat at different times during the open water season for each stream were described based on the % of MAD predicted, fish species known to be present, and their life history characteristics (pages 6-182 to 6-184 of the FEIS). In each case, it was determined that the habitat function, including migratory connectivity and access to habitats, of the streams would be maintained under the reduced flow conditions. The exception was Imniagut Outflow where the reduction in streamflow was predicted to result in a permanent loss of fish habitat requiring offsetting. Although habitat function was determined to be maintained in all other streams, any predicted losses of habitat were nevertheless quantified by calculating the area of potential alteration or disruption using baseline fish habitat data and hydraulic models in order to quantify potential offsetting requirements (Table 6.5-15).

References:

DFO. 2013. Framework for Assessing the Ecological Flow Requirements to Support Fisheries in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2013/017.

47. ID #DFO-3.2.1

47.1 SUBJECT / TOPIC

Potential Impacts to Marine Fish Resulting from Cargo Dock Construction

47.2 REFERENCE

- FEIS, Volume 5, Appendix V5-10G, Pgs. 1 to 29.
- FEIS, Volume 5, Appendix V5-6AB Pgs. 1-5

47.3 SUMMARY

The proponent states the following with respect to their predicted impacts resulting from the construction of the cargo dock: "All potential loss/alteration of habitat and fisheries productivity will result from the construction of a proposed cargo dock on the western shoreline of Roberts Bay. Anticipated losses/alterations may include subtidal habitat underneath the footprint of the cargo dock and rock embankment (i.e. rock armouring, riprap, placed around its perimeter), as well as intertidal habitat underneath the footprint of the causeway" (Vol. 5, Appendix V5-10G, p.1).

The proponent further states: "As a consequence of the cargo dock being constructed below the HVM, fish and fish populations may be adversely impacted in Roberts Bay resulting in the potential for serious harm to fisheries productivity" (FEIS, Vol. 5, Appendix V5-10G, p.1).

In the *Conceptual Marine Fisheries Offsetting Approach for Madrid-Boston*, the proponent provided a conceptual and preliminary assessment of fish habitat to be lost/altered, fish populations, and their abundance in Roberts Bay. This included assigning quantity and quality to fish habitat and identified offsetting options.

DFO-FPP acknowledges that the proponent has committed to work with the Fisheries Protection Program and Inuit communities to finalize an offsetting plan according to DFO's *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* if a final fisheries offsetting plan is deemed necessary (FEIS, Vol. 5, Appendix V5-10G, pgs. 3 & 25).

DFO-FPP notes that the proponent indicates a total of 25 fish species were captured in Roberts Bay from 2002-2017 (FEIS, Vol. 5, Section 10.2.6.3, p.10-46). DFO-FPP also notes that throughout the FEIS (Volume 5, Section 10) and in the *Conceptual Marine Offsetting Approach*, only Arctic Char and Saffron Cod are considered 'valued'.

47.3.1 Importance of Issue to Impact Assessment

Representation of species from all trophic levels that occur in the project area should be considered in the impact assessment and accounted for in the Fisheries Offsetting Plan.

47.3.2 Detailed Review Comments

DFO-FPP finds that the Proponent has limited their assessment of potential impacts regarding the cargo dock to Arctic Char and Saffron Cod, and has only accounted for these two species in their conceptual offsetting plan although 25 fish species were identified by the proponent in Roberts Bay (including Arctic Char and Saffron Cod) in baseline surveys (FEIS, Vol. 5, Appendix V5-10G, p.6).

DFO-FPP acknowledges that the Proponents' rationale for the selection of individual VECs was guided by the EIS guidelines, Traditional Knowledge, and available baseline survey data (FEIS, Vol. 5, Appendix V5-10G, p.7). However, DFO-FPP notes that all 25 fish species identified by the proponent in Roberts Bay (including Arctic Char and Saffron Cod) (FEIS, Vol. 5, Appendix V5-10G, p.6) could be considered part of and/or supporting the productivity of a CRA fishery. The *Fisheries Act* (Section 35(1), prohibition against serious harm to fish applies to fish and fish habitat that are part of or support commercial, recreational or Aboriginal fisheries. The Fisheries Protection Policy Statement (2013) states: "Fish that are part of commercial, recreational or Aboriginal fisheries are interpreted to be those fish that fall within the scope of applicable federal or provincial fisheries regulations as well as those that can be fished by Aboriginal organizations or their members for food, social or ceremonial purposes or for purposes set out in a land claims agreement.

Fish that support these fisheries are those fish that contribute to the productivity of a fishery (often, but not exclusively, as prey species). The "fish that support" may reside in water bodies that contain the commercial, recreational or Aboriginal fisheries or in water bodies that are connected by a watercourse to such water bodies." Therefore, all fishes that are a part of a CRA fishery need to be accounted for in the effects assessment of the Boston-Madrid project.

DFO-FPP reminds the proponent that the 25 species may be a part of a CRA fishery or are fish that support such fisheries and have fisheries value in Nunavut and in Canada.

47.4 RECOMMENDATIONS/REQUESTS

1. DFO requests that the proponent re-evaluate assumptions of valued fishery components to include representation of all the fish species/trophic levels in the proposed marine offsetting plan and make the necessary recalculations to calculate habitat loss.

2. DFO-FPP recommends that the proponent continue to work with the DFO-FPP and the Kitikmeot Inuit Association to develop and finalize a marine Fisheries offsetting plan to ensure that all serious harm to fish and fish habitat as a result of the project are accounted for and adequately offset.

47.5 TMAC RESPONSE FOR DFO-3.2.1

1. The area (0.97 ha) being impacted by the cargo dock's footprint constitutes 0.07% of the total area of Roberts Bay (1,460 ha). If Roberts Bay's area is limited to the shoreline extending up to 100 m seaward from shore (200 ha), the total area lost by the dock still represents only 0.5%. Of this area, the majority of the cargo dock is proposed to lie on non-limiting substrates (i.e., 75% of area below dock's footprint consists of fines/mud at depths between 3 to 25 m).

TMAC acknowledges that up to 25 fish species have been captured throughout Roberts Bay since 2002, though only nine species were captured in 2017 in the vicinity of the cargo dock location. Four species (from highest to lowest catches, Pacific Herring, Fourhorn Sculpin, Saffron Cod, and Arctic Char) dominated captures (78%, Figure 2.2-3 in Chapter 10).

The habitat evaluation procedure (HEP) and the derived HSI and HEU incorporates the species chosen as Valued Ecosystem Components (VECs) in the EIS which were considered representative of all species and include Arctic Char and Saffron Cod. The rationale for the inclusion of these species and not others captured in Roberts Bay are provided in the FEIS (Volume 5, Section 10.1-2, 10.3). As described in Appendix V5-10G, the HEP was developed using Arctic Char and Saffron Cod, consistent with the FEIS.

As part of the HEP, each VEC species/life stage was assigned a habitat suitability index (HSI) ranking for depth and substrate type in relation to its use. The rankings were averaged over life-stage for each species, and further averaged over each depth-substrate combination. To be conservative, the highest HSI values for either species in each habitat were carried over and used in the final calculation of area lost, in Habitat Equivalent Unit (HEU). This approach is consistent with that used in previous projects in Arctic coastal environments (SEM 2011).

Saffron Cod had the highest HSI scores in all habitats, thus the conservative use of these values formed the basis for subsequent calculations. The values were not summed for each species, rather the highest score was utilised and carried over, thereby integrating both species values. This is considered a conservative approach as habitat losses calculated for Saffron Cod also represent habitat losses for Arctic Char. Because Saffron Cod use a greater variety of marine habitats across all seasons, habitat loss calculated for Saffron Cod also accounts for the loss of seasonal use by Arctic Char.

As the number of species included in a HEP increases and their individual habitat requirements are considered, all habitats eventually become important. This would eventually lead to a 1:1 ratio of Habitat Area:HEU as all habitats would have high HSI scores, and HEU would be equal to total habitat lost in m². Including more species in the HEP may change the final HEU calculated, but would depend on whether any of the additional species scored higher than Saffron Cod in any habitat for any specific life stage. Furthermore, it would assume that the value of each species, including their density, is the same which is not the case.

For example, including Fourhorn Sculpin in the HEP (in addition to Arctic Char and Saffron Cod), results in a final HEU lost of 6,340 m² vs 4,766 m² when using Arctic Char and Saffron Cod alone (a 1,574 m² difference – 33% more). This is because Fourhorn Sculpin have higher HSI scores in shallower habitat, and in larger substrates. Therefore, because the maximum value found for any species for any life stage is carried through, the value of shallow habitat with large substrates is over-emphasized. Further, the HSI model developed and used for the ranking numbers presented above for Fourhorn Sculpin is based on very limited data. Thus, scoring becomes very subjective, and is also very conservative. When few data were available, a higher ranking score was assigned to be conservative. This approach likely inflated final numbers. In other words, final numbers can vary greatly depending if a medium or high rank is assigned.

If Pacific Herring are also included in the HEP (i.e., four species total), final HEU is 6,739 m². The HSI scores for Pacific Herring are high in deeper habitat but their presence in Roberts Bay is likely only seasonal. Therefore, the inclusion of Pacific Herring over-emphasizes the value of deep habitats that are only used seasonally. The more species that are added to the model, the greater the likelihood of a particular habitat and life-stage having a high HSI score, eventually resulting in equivalence between the total area of habitat lost and HEU. Therefore, given that there is limited information on the habitat preferences of many of the species present in Roberts Bay (resulting in uncertainty in the calculations) and because the inclusion of too many species over-emphasizes their use of marginal habitats, additional species are not included in the HEP and subsequent calculation of HEU.

2. TMAC will work with the DFO-FPP, KIA and IEAC to develop and finalize a marine Fisheries offsetting plan and refine models for habitat loss/gain predictions to ensure that all serious harm to fish and fish habitat as a result of the project are accounted for and adequately offset.

References:

SEM. 2017. 2016 Milne Ore Dock Fish Offsetting Monitoring. Prepared by Sikumiut Environmental Management Limited for Baffinland Iron Mines Corporation: St. John's Newfoundland.

48. ID #DFO-3.2.2

48.1 SUBJECT / TOPIC

Shipping Impacts – Marine Mammals

48.2 REFERENCE

- FEIS, Volume 5, Marine Wildlife, Pgs. 11-3 to 11-80.

48.3 SUMMARY

DFO-FPP reiterates the comments provided during the DEIS technical submission: DFO Reference 3.2.3 in which DFO-FPP recommended that the proponent provide further information regarding shipping impacts to marine mammals beyond Ring Seal in Roberts Bay and along the shipping route.

1. The proponent has stated the following in terms of the proximity of marine mammals to designated environmental areas: "Most of the marine mammals along the commercial shipping routes likely would not come into close contact with vessels, regardless of the number of vessels, because of their distribution or preferred habitats. The commercial shipping route is located well offshore or in mid-channel, whereas many of the marine mammals are coastal and some are found only in low numbers along the commercial shipping routes" (FEIS, Vol. 5, Section 11.2.2.1, pgs. 11-3 & 11-4).
2. Regarding the potential effects of shipping directly to marine mammals, the Proponent states: "Marine wildlife could interact with the Phase 2 Project and suffer mortality or injury from shipping vessel strikes, entanglement, or other factors. While the rate of wildlife mortality at many projects is very low, the potential effect of direct mortality was evaluated for the Phase 2 Project" (FEIS, Vol. 5, Section 10.3.1, p. 11-63).

Additionally the proponent states: "It is not expected that shipping or the Roberts Bay facility will result in disruption of movement or attraction to the Phase 2 Project site for marine wildlife because shipping will be infrequent and the moving vessels are unlikely to form barrier to movement" (FEIS, Vol.5, Section 10.3.1, p.11- 63).

3. Regarding project related effects to ringed seal, the proponent states: "*Interactions of ringed seals with Project components were evaluated to determine which of the following potential effects may occur...*" (FEIS, Table 11.5-2). Additionally, the proponent states: "*It is not expected that shipping or the Roberts Bay facility will result in disruption of movement for ringed seals because*

shipping will be infrequent and the moving vessels are unlikely to form a barrier to movement" (FEIS, Vol. 5, Section 11.5.2.1, p.11-66).

4. "The following best management practices will be carried out to minimize potential effects on marine wildlife: Aircraft (helicopters) will avoid marine bird colonies by given setback distances" (FEIS, Vol 5. Section 11.5.3, p.11-69). Additionally the proponent states: "Wastes will be managed such that they are not introduced into the marine environment." and "Best management practices will be used to manage fuels, hazardous materials to prevent spills, and to contain and clean up any spills that may occur in the marine environment, including..." (FEIS, Vol 5. Section 11.5.3, p.11-70).
5. In Section 11.5.3 (FEIS, Vol. 5, pgs. 11-68-78), Mitigation for Marine Wildlife VECs – Proposed monitoring Plans and Adaptive Management, the proponent states the following:
 - a) "This is likely because ringed seals prefer to avoid land-based predators such as grizzly bears and wolverine."
 - b) "Ringed seals typically have their breathing holes and maternal lairs in or along pressure ridges and cracks in the sea ice. The sea ice in Roberts Bay is land-fast, and largely devoid of these features."
 - c) "No high-quality habitat will be lost for marine mammals because seals do not use the exposed rock at the cargo dock site as a haul out."
 - d) "The construction location is in Roberts Bay, which will contain noise from pile driving. Baseline studies have indicated that there are no haul-outs for ringed seals or other marine mammals in Roberts Bay and the density or winter breathing holes in the bay are low compared to Melville Sound."
 - e) "Direct Mortality" This is the concern for bowhead whales (i.e., ship strikes).

In section 11.7.1 Impact Statement: Marine Mammals, (FEIS, Vol.5, Section 11.7.1, p. 11-79) the proponent indicates:

- a) Ringed Seal are the most common mammal in Roberts Bay and Melville Sound and that other mammals are not present.
- b) "...and baseline surveys indicated that the density of winter breathing holes is low in Roberts Bay, compared to the higher densities in northern Bathurst Inlet."
- c) "Scientific studies report that seals are not disturbed by shipping, except when vessels are very close by, and seal populations have remained robust in areas with shipping."

- d) *"Scientific studies report that direct mortality of seals due to collisions with vessels is rare, and unlikely to affect local populations of seals."*

48.3.1 Importance of Issue to Impact Assessment

Shipping and cargo dock activities has the potential for significant adverse effects to marine mammals resulting from noise, loss of habitat, and the risk of ship strikes which may cause direct mortality.

48.3.2 Detailed Review Comment

1. The Proponent has not provided sufficient evidence that marine mammals would not likely come into close contact with vessels and that whales are found only in low numbers.

DFO-FPP disagrees with the proponents' statement: *"Most marine mammals along the commercial shipping routes likely would not come in close contact with vessels..."* and note that no references were used to support their statement. DFO-FPP therefore notes the following with respect to the proponent's conclusions:

- a) There is no mention of Ringed Seals on the list of marine mammals that *"could occur near the commercial shipping route during the shipping season"* (FEIS, Vol. 5, Section 11.2.2.1, p.11-4). Ringed seals occur throughout the Arctic, year- round and may use both nearshore and offshore areas (Schimnowski *et al.* 2018).
- b) Peel Sound is the post-calving aggregation of the largest narwhal stock (ca. 50,000) and the largest high-latitude beluga stock (ca. 20,000) (DFO, 2015). This aggregation area is considered key habitat to both whale species as it provides safety within sea ice for newborn calves from killer whales. Therefore, no shipping should occur through this area until mid-August to prevent disturbing whales nursing neonates (Steve Ferguson, Personal Communications, March 2, 2018).
- c) Several primary publications (Smith and Martin 1994; DFO 1995; Barber *et al.* 2001; Richard *et al.* 2001; Koski *et al.* 2002) indicate that Belugas travel to Peel Sound from Lancaster Sound and Bellot Strait (Richard *et al.* 2001). They aggregate around northern Somerset Island for several weeks before moving south to deeper waters off southeastern Prince of Wales Island.
- d) Belugas in Peel Sound move in and out of estuaries, presumably to exploit feeding opportunities offshore (Martin and Smith 1992, Richard *et al.* 2001).
- e) Martin and Smith (1992) observed Belugas performing persistent deep dives

over the Franklin Trench that were consistent with feeding behaviour. Approximately 84% of dives made by tagged Belugas in 1990-1993 in Peel Sound (northern and southern portions) were categorized as deep dives associated with foraging (Martin et al. 1998).

- f) Most beluga remain in estuarine shallow-water bays while nursing neonates in July and early August. Narwhal nursing will occur within the moving sea ice. With the ice melting in Peel Sound area, narwhal will move to areas that retain sea ice further into the Archipelago if necessary. In contrast, in late August to September beluga start using offshore deeper water areas to feed (Steve Ferguson, Personal Communications, March 2, 2018).
 - g) Richard *et al.* (1994) found that the majority of Narwhals in Peel Sound occurred south of Prescott Island in waters greater than 350 m in depth.
2. The proponent has not provided sufficient analysis with respect to accidental injury or mortality from ship strikes beyond the ringed seal species. DFO-FPP disagrees with this assessment and includes rationale for further assessment of potential effects to additional marine mammals below:
 - a) Direct mortality from ship strikes could occur to bowhead whales that are slow and busy feeding. Bowhead are close relatives of Right Whales and have the same sensitivity to ship traffic (Steve Ferguson, Personal Communications, March 2, 2018).
 - b) Although they may not form a physical barrier, a sound barrier may exist as they are known to change their vocal behavior with ship presence (Lesage et al. 1993). Beluga have been seen to avoid approaching ships at ranges of 45-60 km and were aware of an approaching ship at a distance of 85 km. They were observed to move up to 80 km from their original location and remain absent for 1-2 days. It is believed their extreme sensitivity may result from a combination of sound propagation and a scarcity of ships in the area (i.e., if they are not used to ships in an area the initial response may be more severe; Finley et al. 1990).
 3. In Section 11.5.2.1, (FEIS, Vol. 5, p. 65) the proponent outlines the potential effects to ringed seal. DFO-FPP notes that the proponent has not sufficiently assessed the potential impacts of fuel spills on seals from ships. Fuel on the fur of seals could impair their ability to stay warm and float and during summer they are at their thinnest and therefore more susceptible. A fuel spill could result in direct mortality.
 4. The proponent discusses best practices for mitigation of potential impacts to marine wildlife VECs. DFO-FPP notes that important details regarding the safety

of marine mammals such as flying at an altitude > than 100 m has not been included. Additionally when referring to the marine mammal observer program, the proponent suggests that wildlife monitors survey for seals and birds and cease pile driving if wildlife is within a 200 m buffer safety zone (FEIS, Vol. 5, Section 11.5.3, p. 11-70). This is not considered sufficient for Bowhead, Beluga and Narwhal. If these mammals are observed within a 5 km range, DFO-FPP recommends that pile driving should stop.

5. DFO-FPP notes that the proponent has not provided sufficient evidence to support various characterizations of effects to marine mammals:
 - a) There is no citation provided to support the statement: *"This is likely because ringed seals prefer to avoid land-based predators such as grizzly bears and wolverine."*
 - b) Although breathing holes are often found along cracks, stating that they typically occur there may not be accurate. Ringed seals can often be found in high densities in land fast ice areas devoid of cracks and pressure ridges (Young *et al.*, 2015).
 - c) It is incorrect to state that *"No high-quality habitat will be lost for marine mammals because seals do not use the exposed rock at the cargo dock site as a haul out."* Loss of feeding habitat may occur if fish and invertebrates are affected by noise, sedimentation, or fuel.
 - d) DFO-FPP notes that according to Figure 11.2-5, FEIS, Vol. 5, p.11-25, it does not appear that there were any transects flown through the LSA in Roberts Bay. DFO-FPP is unclear what studies or rationale were used to assess seal use of the LSA and make this comparison to Melville Sound
 - e) "Direct Mortality" This is the concern for bowhead whales (i.e., ship strikes).
6. DFO-FPP notes that the proponent has not provided sufficient evidence to support the following potential impacts which could negatively affect marine mammals:
 - a) The proponent has asserted that no marine mammals other than ringed seal are present in the MRSA. This assertion did not consider the impact for Beluga, Narwhal, Polar Bear and Bowhead as they are all known to be present along the proposed shipping route.
 - b) DFO-FPP does not agree that the survey coverage of the Roberts Bay LSA was robust enough to be able to state: *"...and baseline surveys indicated that the density of winter breathing holes is low in Roberts Bay, compared to the higher densities in northern Bathurst Inlet"* (FEIS, Vol.5, Section 11.7.1, p.11-79).

- c) No references were provided to substantiate the following scientific studies reference. *“Scientific studies report that seals are not disturbed by shipping, except when vessels are very close by, and seal populations have remained robust in areas with shipping”* (FEIS, Vol.5, Section 11.7.1, p.11-79).
- d) No citations/evidence provided for the following scientific studies reference: *“Scientific studies report that direct mortality of seals due to collisions with vessels is rare, and unlikely to affect local populations of seals”* (FEIS, Vol. 5, Section 11.7.1, p.11-79).

48.4 RECOMMENDATIONS/REQUESTS

1. DFO-FPP recommends that the Proponent provide evidence or conduct an assessment to support the conclusions that marine mammals will not likely come into close contact with vessels and that whales are found in low numbers, to ensure the potential impacts to all marine mammals are considered and addressed.
2. DFO-FPP recommends that the proponent assess the potential and cumulative effects of shipping on all marine mammals located within the MRSA and along the shipping route.
3. DFO-FPP recommends that the proponent assess the potential impacts of diesel spills on marine mammals, and develop appropriate marine mammal monitoring plans.
4. DFO-FPP recommends that the proponent provide evidence to support characterization of potential effects to marine mammals to ensure all effects are identified and mitigated.

48.5 TMAC RESPONSE FOR DFO-3.2.2

The FEIS evaluated the potential effects of vessels used to re-supply the Project. The spatial boundary for the marine mammal effects assessment includes the marine LSA (Roberts Bay) and the marine RSA (Melville Sound, Elu Inlet and Bathurst Inlet) (Section 11, Volume 5 of the DEIS). The assessment area ends where the Project shipping route joins the common shipping route through the Northwest Passage which is used for community re-supply, commercial and tourism purposes.

The comments from DFO centre around four issues:

- 1) the choice of ringed seal as a Valued Environmental Component (VEC) for the FEIS;
- 2) the potential for interactions between marine mammals and Project vessels in the Northwest Passage,

- 3) the potential for fuel spills to affect marine mammals; and
- 4) additional justification of expected effects on ringed seal.

The following response addresses these comments.

1) Assessment using the VEC Ringed Seal in the Marine Regional Study Area

Within the marine RSA, ringed seals were chosen as the representative species for marine mammals because they are regularly observed and are more abundant relative to the other pinniped species, bearded seal, in the assessment area. Inuit Traditional Knowledge (TK) identified ringed seals as a key component of the environment for Inuit historically, currently, and for the future (KIA 2015).

The summer distribution of marine mammals in the Marine Regional Study Area (MRSA) and the wider geographic area including the shipping route was described in Volume 5, Section 11.2.2.1. The data presented indicated that the probability of encountering marine mammals within the MRSA was highest for ringed seals, followed by bearded seals. This data was derived directly from DFO's published distribution of marine mammals (Stephenson & Hartwig, 2010), which also indicates that the MRSA is outside of the areas of High Biological Importance in the Arctic. Moreover, the common occurrence of ringed seals and less frequent occurrence of bearded seals was supported by baseline studies (Rescan 2011c, 2013a) and TK information (Banci and Spicker, 2016). TK information also points to historically rare sightings of additional marine mammals within the MRSA. These species include beluga, bowhead, narwhal, polar bear and walrus, though determining when these observations occurred was often uncertain (Banci and Spicker, 2016).

The selection of ringed seals as the VEC for marine mammals closely follows NIRB guidelines for inclusion. Ringed seals are:

1. the most commonly encountered marine mammal with which there is potential to interact with the Project within the MLSA and MRSA;
2. Identified through TK as the most important local marine mammal as an indigenous resource; and
3. Is an umbrella species for the only two reliably encountered marine mammals in the MRSA (ringed and bearded seals).

The increase in vessel frequency due to the Project will potentially be six to seven vessels per year for 17 years (Vol 5, Ch 11, Section 11.5.4.1). TMAC has assessed the effects of low frequency shipping on the most commonly encountered member and best representative of the marine mammal community in the MLSA and MRSA: ringed seals.

Following the guidance described above from the NIRB, other less common species are not individually assessed. Most other marine mammals (e.g., cetaceans) are observed sporadically in Melville Sound and Bathurst Inlet (the MRSA), often with decades in between sightings (Banci and Spicker, 2016). Due to their limited presence in the MRSA

or MLSA and TMAC's limited vessel re-supply, cetaceans were excluded as a VEC as described in Section 11.3.3 of the FEIS.

2) Marine Mammals in the Northwest Passage

The DFO comment references the distribution of cetaceans such as narwhal and beluga in Peel Sound, Lancaster Sound and Bellot Strait. These areas are outside the MRSA, located in the Northwest Passage, and are therefore not within the spatial boundary of the assessment.

Section 11.2.2.1 of the FEIS describes the distribution of marine mammals in the Northwest Passage from published DFO sources. Figures and summary tables from the description are attached below to this response. These summary tables and figures agree with the statements made in the DFO comments about the distribution of marine mammals in the Northwest Passage.

The approved High Lake and Back River projects evaluated the potential effects of vessel traffic in the Northwest Passage and concluded that no effects on distribution or abundance of marine mammals are likely (Wolfden 2007, ERM Rescan 2015). These projects have a similar amount of marine vessel traffic as the Proposed Hope Bay Project. Given the similar numbers of vessels expected for the Hope Bay Project, no residual effects on marine mammals are expected in the Northwest Passage.

TMAC considers the Northwest Passage outside of the MRSA assessment area for the FEIS. However, TMAC has planned to conduct mitigation for shipping to reduce potential effects to marine mammals and marine birds in the Northwest Passage. In addition to the site specific mitigation discussed in the EIS for the MRSA, the Wildlife Mitigation and Monitoring Plan (WMMP) includes mitigation intended for the Northwest Passage (pg. 14):

- *Information will be provided to vessel operators regarding 500 m marine set-back from identified habitat sites in Bathurst Inlet/Elu Inlet for marine birds where safe to do so. Ships will avoid the large marine bird colony on Prince Leopold Island by 25 km, except where the safety of the ship dictates otherwise.*

The marine mammal section of the FEIS (Section 11.5.3) describes mitigation to include:

- *Observations by ship's crew of marine mammals and marine birds.*

And when marine mammals or groups of marine birds are observed:

- *Ships will avoid groups of marine mammals and aggregations of marine birds.*
- *Aircraft (helicopters) will avoid marine bird colonies by given setback distances.*

As part of the WMMP, TMAC will be preparing maps and descriptions of key bird habitats such as large marine bird colonies and Prince Leopold Island for supply vessel operators.

TMAC commits to updating the guidance package for vessel operators to include information on sensitive marine mammal habitats in the Northwest Passage, as described in FEIS Figures 11.2.1 and 11.2.2, and Table 11.2.1. This information will be updated to include data published since the FEIS or provided by DFO.

TMAC also commits to discussing mitigation measures for marine mammals in the Northwest Passage that are common to all vessels in Arctic waters, or as provided in a DFO guidance document for Arctic waters. All mitigation is contingent on vessel safety.

With the proposed mitigation, no potential effects on marine mammals in the Northwest Passage are predicted.

3) Assessment of Marine Fuel Spill

TMAC notes that DFO did not provide comments during the DEIS technical comment period or the technical meeting requesting spill modeling or an assessment of potential fuel spill effects on marine mammals. Phase 2 is building upon the already approved and operating Project.

Shipping activities in the Arctic are regulated under the Canada Shipping Act (CSA-2001). Under this Act and regulations, stringent standards are in place that regulate all aspects of shipping activities and shipping operator must abide by these Acts and their regulations. As the regulator, Transport Canada ensures that shipping companies comply with these requirements. With respect to preventing larger spills, all tankers built after July 6, 1993 must be double hulled to operate in Canadian waters, according to regulations on pollution and dangerous chemicals under the Canada Shipping Act, 2001. A double hull has two complete layers of watertight hull surface on the bottom and sides. These regulations have greatly reduced the likelihood of spills at sea.

With respect to fuel spills potentially resulting from fuel transfers, as part of the approved and operating Doris project, TMAC has the following required OPPP/OPEP and vessels are required to have a SOPEP as per IMO regulations.

- Oil Pollution Prevention Plan (OPPP)/Oil Pollution Emergency Plan (OPEP) describes the responses to oil spill scenarios at the Roberts Bay facility and is a requirement of the Canada Shipping Act (2001).
- The Shipboard Oil Pollution Emergency Plan (SOPEP) describes the equipment, training and procedures that the ship must have on board in order to manage and address any fuel spills during shipment or unloading to minimize any effects on the environment and is a requirement of the International Maritime Organization (IMO) for all ships transporting fuel.

TMAC operates the Oil Handling Facility at Roberts Bay. In accordance with Canada's regulatory regime, TMAC has a functional Oil Pollution Emergency Plan (OPEP) in place to deal with potential spills during ship-to-shore transfer of fuel. Under the OPEP, TMAC is

required to train and demonstrate the ability to respond to a spill scenario in Roberts Bay with the necessary means (equipment, material and human resources) to clean up such a spill should it occur. The OPEP is submitted to Transport Canada (the regulator) for review on an annual basis. Spill exercises are conducted annually or as required.

Potential effects resulting from a spill during ship-to-shore transfer is addressed in the TMAC's OPEP.

TMAC will continue to use these existing and operating plans and will update them as required by Transport Canada prior to the transfer of fuel at the proposed cargo dock. The potential for a fuel spill to affect marine mammals was assessed in Volume 7, Chapter 1, Section 1.5.3.1; Fuel Spill During Ship to Shore Transfer. This assessment concluded that potential effects of fuel spills are Not-Significant for marine mammals and marine birds.

4) Assessment of Project Effects on Ringed Seals in Roberts Bay

DFO requested clarification on baseline data and additional justification that vessel traffic for the Project would not result in effects on ringed seals in the MRSA. TMAC provides clarification and additional context in the following section.

DFO Comment:

b)DFO-FPP does not agree that the survey coverage of the Roberts Bay LSA was robust enough to be able to state: "...and baseline surveys indicated that the density of winter breathing holes is low in Roberts Bay, compared to the higher densities in northern Bathurst Inlet" (FEIS, Vol.5, Section 11.7.1, p. 11-79).

TMAC Response:

DFO is correct, there was an error in reporting that baseline surveys indicated that the density of breathing holes in Roberts Bay was lower compared to Bathurst Inlet. This sentence should have indicated that the density of breathing holes within the MRSA (0.22 ind/km²; Melville Sound Transects in Table 11.2-5 and data found in Rescan 2011a) is lower (0.22 ind/km²) than those reported from three separate studies in Bathurst Inlet (0.3, 0.5, 1.2 ind/km²; Table 11.2-4). Thus, it was inferred in the FEIS that the densities of ringed seal breathing holes are expected to be lower in Roberts Bay than in Bathurst Inlet.

Survey results agree with Inuit TK, that identified Elu Inlet and the mouth of Bathurst Inlet as supporting a concentration of ringed seals. Roberts Bay was not identified as a hunting location for ringed seals.

This does not change the results of the assessment. During the winter while sea ice is present, and therefore seal breathing holes exist, there will be no activity in Roberts Bay. The only potential effect to seals during the winter is habitat loss of potentially suitable sea ice habitat where the cargo dock will be constructed. However, this effect is not considered a residual effect in the FEIS (Section 11.5.4.1); the potential effects of habitat loss will go from the current loss of 30 m of shoreline for the existing jetty to a total of 100 m of shoreline for the proposed cargo dock during Madrid-Boston. This total area is small (0.1%) of Roberts Bay.

DFO Comment:

c) No references were provided to substantiate the following scientific studies reference. "Scientific studies report that seals are not disturbed by shipping, except when vessels are very close by, and seal populations have remained robust in areas with shipping" (FEIS, Vol. 5, Section 11.7.1, p. 11-79).

TMAC Response:

Vessel traffic in busy shipping routes has the potential to disturb seals from their haul out sites if vessels are close to haul outs (Jansen et al. 2010, 2015a). However, there is relatively scant information that documents the additional behaviours of seals in relation to vessel activity (Chen et al. 2016) or tying shipping to reduced population viability (Jansen et al. 2015b). Evidence from Alaskan cruise ship studies indicates that seals will continue to use habitat in which ship traffic is common, though will re-enter water from haul outs frequently when ships pass at approximately 100 m distance and approach seals directly (Jansen et al., 2010).

Moreover, the magnitude of shipping effects on marine mammals has been estimated as low when compared to other influences such as climate change, commercial fisheries and industrial development (primarily offshore oil and gas; Huntington 2009). Even within locations in the Arctic where active oil and gas development and infrastructure construction is occurring, seals have remained present and utilize habitat very close to noisy and disturbed sites (e.g., within 11 m; Williams et al, 2006).

DFO Comment:

d) No citations/evidence provided for the following scientific studies reference: "Scientific studies report that direct mortality of seals due to collisions with vessels is rare, and unlikely to affect local populations of seals" (FEIS, Vol. 5, Section 11.7.1, p. 11-79).

TMAC Response:

Although ship strikes with seals have been reported in US waters, the frequency of collisions and the proportion relative to other natural and anthropogenic sources of injury is low. Goldstein reported that out of 5,155 seals injured in California, only 5 (0.01%) of the injuries reported were due to ship strikes (Goldstein et al. 1999). In addition, Swails (2005) reported that only 11 deaths of 622 seals at Cape Cod could be attributed to collisions with boats. These areas have shipping rates much higher than Arctic waters and it is likely that the injuries were related to propeller strikes from fast moving pleasure craft close to shore rather than slower moving sealifts or fuel tankers (Goldstein et al. 1999, Swails 2005). Collisions with larger, slower moving ships is less likely due to the small size, high-speed swimming and maneuverability of seals and other pinnipeds (US Coast Guard 1996). Although the literature does not provide evidence from Arctic waters, mortality resulting from ship collisions likely poses a rare risk that appears lower for pinnipeds than for other marine mammals (Jones et al. 2017).

Because of the rarity of collisions, it would be difficult to establish a relationship between direct mortality due to collisions and changes in population production. For example, even in populations where disturbance from cruise ship activity is well documented, there is no clear evidence that population abundance has been affected by traffic (Jansen et al., 2015). Because of the low frequency of collisions between ships and seals, there

appears to be a low likelihood of adverse long-term effects to seal population abundances and health.

Shipping traffic to Roberts Bay will be minimal and will occur only during the open water seasons. It is expected that ships will transit into the MRSA at speeds of less than 10 knots. Contact with marine mammals is unlikely as such collisions have not been reported elsewhere in the Canadian Arctic. Furthermore, it is TMAC's understanding that the Canadian Coast Guard (CCG), who reports to DFO, and operates a number of vessels in the Arctic, does not track collisions due to their absence of or rare occurrence.

This background information supports the conclusion of the FEIS that there will not be a residual effect of vessel traffic on ringed seals in the MRSA.

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Wolfden 2007, High Lake Final Environmental Impact Statement; Cumulative Effects, Volume 7, Section 1

United States Coast Guard. 1996. Atlantic protected living marine resources (APLMR) initiative: environmental impact statement. Vol 2 Chpt 5.

Summary from Section 11.2.2 of the FEIS; Proximity to Designated Environmental Areas; sub-section 11.2.2.1; Marine Mammals:

Several species of marine mammals likely occur along the shipping routes, including: walrus (*Odobenus rosmarus*), narwhal (*Monodon monoceros*), beluga whale (*Delphinapterus leucas*), bowhead whale (*Balaena mysticetus*), polar bear (*Ursus arctos*) and ringed seals. In addition, several other species may occur along a small proportion of the commercial shipping routes including, bearded seal (*Erignathus barbatus*), harp seal (*Phoca groenlandica*), hooded seal (*Crystophora cristata*), and killer whales (*Orcinus orca*). TK indicates that these species are not commonly observed in the MRSA (Banci and Spicker 2016). Spatial and temporal distributions of these species along the commercial shipping routes are presented in Figures 11.2-1 and 11.2-2 and Table 11.2-1.

The relatively few times and locations when marine mammals could occur near the commercial shipping route during the shipping season are as follows:

- A population of bowhead whales occur in the Peel Sound/Franklin Strait area and in Barrow Strait during August and September. The Eastern Arctic bowhead population is present in Lancaster Sound and Prince Regent Inlet from late June through September as ice conditions allow.

- Beluga whales occur in deep-water areas offshore in Peel Sound called the Franklin Trench from mid-August to early/mid-September. The Western Beaufort Sea beluga population is in the western Mackenzie River estuary and delta from June to late August.
- Narwhals occur in small numbers in Barrow Strait and Peel Sound during August and September. During fall migration back to Baffin Bay via Lancaster Sound, narwhals are dispersed in open-water and remain there as long as open-water permits.
- Very few walrus use the offshore waters and south shores of Barrow Strait, the west shores of Prince Regent Inlet and the Gulf of Boothia, or Peel Sound.

Figure 11.2-1
Migratory Routes and Main Summering Areas of Whales along the Commercial Shipping Route



Figure 11.2-2
Main Summering Areas of Seals, Walrus, and Polar Bears along the Commercial Shipping Route



Table 11.2-1. Spatial and Temporal Distribution of Marine Mammals along the Commercial Shipping Route

Species	Overlap with Proposed Shipping Route in Nunavut	Typical Spatial Distribution ¹	Temporal Distribution	References
Ringed Seal	West and East	Arctic Archipelago	year-round	(McLaren 1958; Heide-Jørgensen, Stewart, and Leatherwood 1992; Harris et al. 1997; Harris et al. 1998; Kapel et al. 1998; Lawson and Moulton 1999; Teilmann, Born, and Acquarone 1999; Moulton and Lawson 2001; Moulton et al. 2002; Kelly et al. 2010)
Walrus	East	Lancaster Sound and Barrow Strait	Spring Migration: June – early-August Summer: August and September Fall Migration: end-September - October	(Davis, Koski, and Finley 1978; Koski and Davis 1979; Koski 1980a, 1980b; Stewart 2008) (Johnson et al. 1976; Koski and Davis 1979) (Koski 1980a)
		Baffin Bay	Wintering: late-October - June	(Riewe 1976; Davis, Koski, and Finley 1978; Kiliaan and Stirling 1978; Sjare and Stirling 1996) (Stewart 2008)
Narwhal	East	Lancaster Sound	Spring Migration: April – July Fall Migration: mid-September – early October	(Finley et al. 1990) (Heide-Jørgensen, Dietz, et al. 2003)
		North of Baffin Island, Prince Regent Inlet, Somerset Island, Gulf of Boothia, Barrow Strait, and Peel Sound	Summer: August and September	(Finley and Johnston 1977; Fallis, Klenner, and Kemper 1983; Smith et al. 1985; Koski and Davis 1994; Richard et al. 1994; Heide-Jørgensen, Dietz, et al. 2003; Heide-Jørgensen, Richard, et al. 2003; Marcoux, Auger-Méthé, and Humphries 2009)
		Davis Strait and Baffin Bay	Winter: October - June	(McLaren and Davis 1982)
Beluga (Eastern High Arctic-Baffin Bay stock)	East	Lancaster Sound (April – July)	Spring Migration: late-April/early May – July Fall Migration: early-September- November	(Davis and Finley 1979; Finley and Renaud 1980; Koski, Davis, and Finley 2002) (Richard et al. 2001; Heide-Jørgensen, Richard, et al. 2003)
		Barrow Strait, Peel Sound, Franklin Strait, Prince Regent Inlet, Somerset Island	Summer: mid-July – mid-August	(Finley 1976; Smith et al. 1985; Richard et al. 2001; Koski, Davis, and Finley 2002)

PROPONENT'S RESPONSE TO TECHNICAL COMMENTS ON THE MADRID-BOSTON FINAL ENVIRONMENTAL IMPACT STATEMENT

Species	Overlap with Proposed Shipping Route in Nunavut	Typical Spatial Distribution ¹	Temporal Distribution	References
		Baffin Bay	Wintering: late-September – early-May	(Davis and Finley 1979; Finley and Renaud 1980; McLaren and Davis 1983; Heide-Jørgensen, Richard, et al. 2003)
Beluga (Eastern Beaufort Sea Stock)	West	Beaufort Sea (western Chukchi Sea may be important fall migration destination)	Spring Migration: April - July	(COSEWIC 2004)
		Mackenzie Delta, Amundsen Gulf, Viscount Melville Sound	Summer: July and August	(Richard, Martin, and Orr 2001; COSEWIC 2004)
		Bering Sea	Winter: November - April	(Tynan, Ainley, and Stirling 2009)
Bowhead Whale (Davis Strait-Baffin Bay stock)	East	Lancaster Sound, Gulf of Boothia, Prince Regent Inlet	Spring Migration: early/mid-May – early-August	(Davis and Koski 1980; Reeves et al. 1983; Moore and Reeves 1993)
			Fall Migration: late-August - October	(Koski and Davis 1980)
		Milne Inlet, and Admiralty Inlet (summer)	Summer: August and September	(Davis and Koski 1980; Koski and Davis 1980; Finley 1990, 2001)
		Hudson Strait, Baffin Bay	Wintering: October – May/June	(Koski, Heide-Jørgensen, and Laidre 2006)
Polar Bear	East	Northern Arctic Archipelago	Summer: August – September	(Amstrup et al. 2000)
		Ice-Covered Waters across Arctic Archipelago as far south as Larsen Sound	Winter: October – June/July	(LGL Limited 2005)
Bearded Seal	West and East	Northern circumpolar	Year-round, moves with ice as ice retreats and reforms	(Fedoseev 1965; Johnson et al. 1966; Burns and Frost 1979; Burns 1981; Kelly 1988)
Harp Seal	East	Lancaster sound, Peel Sound	Spring Migration: July – late-August Fall Migration: late-September-early October	(Finley 1976; Koski and Davis 1980)
		Davis Strait, Baffin Bay, Lancaster Sound, Prince Regent Inlet, Barrow Strait, Peel Sound	Summer: late-August – late-September	(Johnson et al. 1976; Koski and Davis 1979; Fallis, Klenner, and Kemper 1983; Lavigne and Kovacs 1988)
		Labrador coast	Winter: October – mid-June/July	(Koski and Davis 1980)

PROPONENT'S RESPONSE TO TECHNICAL COMMENTS ON THE MADRID-BOSTON FINAL ENVIRONMENTAL IMPACT STATEMENT

Overlap with Proposed Shipping Route in Nunavut		Typical Spatial Distribution ¹		
Species			Temporal Distribution	References
Hooded Seal	East	Lancaster Sound, Baffin Bay, Davis Strait	Summer: August and September	(Sergeant 1976)
		Newfoundland/Labrador/Davis Strait	Winter/Spring: late-September – late-July	(Sergeant 1976)
Killer Whale	East	Lancaster Sound, Prince Regent and Admiralty Inlets	Summer: mid-August – early-October, but rare	(Koski and Davis 1979; Baird 2001; Reeves et al. 2002)
		North Atlantic (open-water)	Winter: early-October through August	(Davis, Finley, and Richardson 1980)

¹ Spatial Distribution only includes distribution of populations and areas with potential for overlap with the proposed shipping route

49. ID #ECCC-4.1.1

49.1 SUBJECT/TOPIC

Incinerator Stack Testing

49.2 REFERENCES

- FEIS, Volume 4, Section 2.6.3.3, Proposed Monitoring Plans and Adaptive Management
- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study
- FEIS, Volume 8, Annex 2 Hope Bay Air quality Management Plan
- FEIS, Type A Water Licenses, Package 4, Annex 16 Hope Bay Incinerator Management Plan
- Madrid Boston Technical Comments Responses IA2E, Section 110,
- #ECCC-4.3
- Phase 2 Technical Comments Commitments Final ECCC #ECCC-4.03
- Canadian Council of Ministers of the Environment (CCME). 2001. Canada-Wide Standards for Dioxins and Furans.
https://www.ccme.ca/files/Resources/air/dioxins_furans/waste_incinerators_coastal_pulp/d_and_f_standard_e.pdf

49.3 ISSUE

Inefficient or improper incineration of waste can result in the release of dioxins, furans and mercury. These contaminants bioaccumulate and may cause adverse effects to human health and the environment.

Appropriate adaptive management is necessary to reduce these emissions should stack emission tests exceed Canada Wide Standards. The response to information request ECCC-4.3 states that “*Adaptive management within the incinerator management plan will be updated in the FEIS*”. However, adaptive management measures to address exceedances specifically related to incineration are not provided in the FEIS, the Incinerator Management Plan, or the Adaptive Management and Continuous Improvement section of the Air Quality Management Plan (Section 5).

The Canada Wide Standards state that facilities burning more than 26 tonnes of waste per year must “*achieve the stack concentration as confirmed by annual testing*” (CCME 2001). Table A-3 of the Air Quality Modelling Study contains the incinerator stack

parameters and emission rates for the five incinerators, three at Roberts Bay and two at the Boston site. This table shows that each of the incinerators at the Roberts Bay site burn 152.08 tonnes of waste per year and each of the two incinerators at the Boston Site burn 91.25 tonnes per year. All incinerators are above the Canada Wide Standard threshold of 26 tonnes per year; therefore, based on the Canada Wide Standard, annual stack testing is required. Section 3.2.1 of the Hope Bay Incinerator Management Plan states that *"The testing will be conducted when the thresholds for monitoring are met"*. Section 3.3 of the Hope Bay Air Quality Management Plan states that *"Incinerator Stack testing occurs annually in years in which quantities of waste incinerated exceed 26 tonnes"*. Commitment ECCC-4.03 states the incinerator will be stack tested within 6 months of commissioning. These statements do not give a clear indication of stack testing frequency.

49.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide adaptive management measures that will be put in place should the results of the stack tests indicate exceedance of the Canada Wide Standards.

ECCC recommends that the Proponent confirm the frequency of stack testing.

49.5 TMAC RESPONSE FOR ECCC-4.1.1

For the purpose of the proposed Boston-Madrid Project, incinerator(s) will be typical modern, controlled-air, batch, dual chamber incinerators that are designed using the principles of pyrolysis (starved-air burning condition) and complete oxidation (high temperature, excess oxygen and sufficient combustion time). Based on implementation of this technology and implementation of the TMAC's waste management program, TMAC has confidence that the requirements of the CWS for Dioxins and Furans and the CWS for Mercury emissions will be met.

TMAC intends to demonstrate compliance with the CWS via stack testing. TMAC clarifies that stack testing will be carried out as required by the regulatory authorities (e.g. federal, territorial). For the purpose of the Madrid-Boston Proposal (Phase 2), TMAC proposes to conduct stack testing of any new incinerator within 6 months of commissioning. Stack testing of existing incinerators is proposed to be performed on an annual basis if there are ongoing significant changes to site activities with the potential to change the composition of the incinerable waste stream (such as during the Construction phase).

In the event that previous stack test results of existing incinerators demonstrate compliance with the CWS for Dioxins and Furans and the CWS for Mercury, as well as activities on site stabilizing so a more consistent incinerable waste stream is achieved, TMAC proposes to perform stack testing at a frequency required by regulators with jurisdictional authority or when there are significant changes to the waste stream. This

approach will be incorporated into the next revision of TMAC's Air Quality Management Plan and Incinerator Management Plan to ensure clarity and address the identified inconsistency.

In the event TMAC has emission exceedances related to incineration, TMAC will investigate to determine the possible source(s) and potential impacts of the exceedances and adaptive management options will be assessed and applied based on the identified contributing factors. Adaptive management options will emphasize identifying and implementing opportunities to prevent the creation of contaminants of concerns (e.g. dioxins, furans and mercury) and include application of available pollution prevention and control techniques economically achievable. These techniques may include:

- Additional waste diversion initiatives to minimize the generation of wastes destined for disposal (waste reduction, material reuse options);
- Waste segregation initiatives aimed at materials with greater potential to generate emissions of dioxins and furans or mercury and aimed at diverting those wastes to recycling or other non-incineration disposal options;
- Combustion control strategies to optimize performance of existing incinerators at destroying pollutants of concern; and
- Use of alternative disposal or treatment technologies such as off-site shipment of waste or procurement of additional technologies that will address the identified contributing factors.

50. ID #ECCC-4.1.2

50.1 SUBJECT/TOPIC

Emissions Inventory Comparison

50.2 REFERENCES

- Phase 2 Technical Comments Commitments Final ECCC #ECCC-4.01
- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study, Section 1.2 Changes from the Draft Air Quality Assessment
- Madrid Boston Technical Comments Responses IA2E, Section 109, #ECCC-4.2

50.3 ISSUE

The NO₂ predictions in the DEIS were in exceedance of the CCME Canadian Ambient Air Quality Standards (CAAQS). The response to information request ECCC-4.2 states that *"The air emissions used for the DEIS air quality modelling study were inherently conservative and model results are also conservative to account for model input assumptions"*. The response also states that *"In preparation of the FEIS, the air quality modelling study will be refined to incorporate revised emissions to better represent the actual emission rates of existing and proposed future equipment to be used"*. At the June 2017 technical meeting the Proponent made the commitment to provide adjusted model input values between the two model runs. Commitment ECCC-4.01 states *"The emissions inventory used for the DEIS will be compared to the FEIS, in order to highlight and summarize the emissions inventory changes. These changes will be discussed with ECCC and documented in the FEIS Air Quality Modelling Study."* Section 1.2 of the Air Quality Modelling Study provides an overview of the changes made between the DEIS and the FEIS, however a clear comparison of those changes is not provided.

50.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide a table that compares emission estimates and modelling inputs between the DEIS and the FEIS along with detailed explanations in order to validate changes resulting from project modifications.

50.5 TMAC RESPONSE FOR ECCC-4.1.2

Emissions estimate summaries for the DEIS and FEIS are presented in Tables 50-1 to 50-3 for construction and Tables 50-4 to 50-6 for operating scenarios. For each scenario, existing conditions, the Madrid-Boston Project (North Domain) and Madrid-Boston Project (South

Domain) are presented. Changes in the assessment between the DEIS and the FEIS are discussed in Section 1.2 of the Air Quality Modelling Study - additional details are provided below.

Differences in emissions between the DEIS and FEIS are mainly attributable to the following:

- In the FEIS a sulphur content of 15 ppm (0.0015%) in diesel was used for off-road mining equipment, and a sulphur content of 1,000 ppm (0.1%) was used for marine shipping vessels. These sulphur contents conform to the Canadian Sulphur in Diesel Fuel Regulations (ECCC 2016b). The DEIS used SO₂ emissions estimates from the US EPA MOVES software which were based on significantly higher sulphur in fuel contents than Canadian regulatory requirements.
- In the FEIS, emissions were estimated based on the requirements that the surface off-road equipment at Doris complies with Tier 3 emission standards for off-road diesel engines (equipment manufactured in or after 2010) and equipment at Madrid and Boston will comply with Tier 4 emission standards (equipment manufactured in or after 2014). In the DEIS, emissions were conservatively estimated assuming that all equipment would comply with Tier 2 standards.
- In the DEIS, equipment emissions were estimated based on conservative assumptions of the horsepower for various categories of equipment. In the FEIS, the makes and models of the existing and proposed equipment were obtained and manufacturer specifications of the equipment horsepower were identified and used in the emission estimation.
- In the DEIS, the Doris Generators were assumed to conform to Tier 1 emissions standards. In the FEIS, manufacturer emissions specifications (also corresponding to Tier 1 levels) were obtained and used. The same manufacturer specifications were conservatively used in the FEIS for the Madrid and Boston generators.
- The Boston mining rate increased from 1 600 TDP in the DEIS to 2400 TPD in the FEIS.
- Boston Power Plant – in the DEIS all 8 units @1.2 MW were assumed operating. For the FEIS, 6 units @1.2 MW will be operating at any given time, with 2 on stand-by.
- Boston Processing Plant – in the DEIS the processing plant included crushing, milling and concentration. For the FEIS, the processing plant was assumed identical in design and capacity to the Doris processing plant and also included flotation, cyanide leach and gold recovery.
- In the DEIS, equipment numbers for the Madrid North, Madrid South and Boston sites were conservatively estimated by scaling the Doris equipment numbers by a factor of 2. For the FEIS, equipment numbers were scaled based on the ratios of

mining production between Doris and the other sites to provide more representative equipment counts. Maintenance equipment counts were scaled based on the camp populations.

- An error in vent shaft emissions was identified in the DEIS – the Doris emissions were applied to the Boston site and vice versa. This was corrected in the FEIS.
- In the DEIS mine emissions were modelled as being emitted from the mine vent shafts. In the FEIS it was confirmed that the mine vents will normally pull air and emissions will be exhausted out the portals.
- Blasting emissions (underground) were not included in the DEIS modelling conducted for operations. These emissions were included in FEIS.
- In the DEIS emission inventory, total vehicle weight was used to calculate fugitive road dust emissions. In the FEIS, the mean vehicle weight was used as per the requirements of AP-42 Section 13.2.2 Unpaved Roads.
- The vehicle kilometers travelled (VKT), used for the calculation of fugitive dust from unpaved roads was updated in the FEIS based on the increased mine production at Boston relative to the DEIS.

Updates and refinements to the dispersion modelling inputs included the following:

- The DEIS used a monthly ozone (O_3) concentration of 40 ppb for the chemistry module in CALPUFF. BC Air Quality Dispersion Modeling Guideline (BC MOE 2015) recommends the use of onsite hourly O_3 concentrations that match with the meteorological data used for the assessment. As no onsite O_3 data were available, data from Fort Smith station in NWT was used as being the most representative of the site. Hourly ozone data from Fort Smith was downloaded for the period January 2015 to June 2017. The maximum hourly measured ozone concentration (71.0 ppb) was used in the OLM conversion.
- In the DEIS, stack heights equal to those of the Doris Power Plant (30-m) were used for the Madrid and Boston Power Plants. The stack heights for these power plants may be lower and were assumed to be 15-m in the FEIS.
- In the DEIS some special receptors fell under area sources for construction and/or Phase 2 operations, leading to overly conservative model predictions reported for these scenarios. These special receptors are required for assessment of current (baseline) conditions only. In the FEIS, these receptors were removed and no predictions were reported for construction and Phase 2 operations.
- The DEIS used small Sigma Z values for both area and road sources, leading to overly conservative model predictions. No rationale for the choice of the values were included in the DEIS. In the FEIS, the Sigma Z values were explicitly calculated

for each source (following US EPA protocols) using the effective height of the individual area or road source.

- The DEIS did not include any buildings to account for building downwash effect for point source emissions. The FEIS included building wake effects in the dispersion model predictions.
- The DEIS conservatively used a release height of 1 m for Bulldozing and Material Transfer drops and modelled them as area sources without providing a basis for this methodology. The FEIS modelled the Bulldozing and Material Transfer sources as volume sources and calculate the release height as per US EPA protocols (US EPA - Haul Road Workgroup Final Report).

In the DEIS the facility "property boundary" was assumed to be the PDA. In the FEIS a refined dispersion modelling "property boundary" was used to better represent the potential for public exposure and compliance with air quality criteria. The hunting exclusion zone around the TMAC facilities was used as a reasonable extent to define the property boundary. The hunting exclusion zone is a requirement of the Consolidation of the Mine Health and Safety Regulations, which prohibits discharge of a firearm within 2-km of any mine infrastructure. Local hunters have informed of the exclusion zone through TMAC's communications as well as communications and help from the KIA - any occurrences of members of the public being located within the hunting exclusion zone are expected to be infrequent and brief in duration.

Table 50-1 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Construction, Northern Domain, Existing Conditions)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Northern Domain	Existing Conditions	Surface mobile equipment	0.821	1.17E-02	0.724	0.058	0.058	0.056	1.499	2.06E-03	0.730	0.108	0.108	0.105	
		Underground mobile equipment and blasting	1.486	1.92E-02	0.585	0.116	0.104	0.099	0.351	3.46E-03	0.272	0.053	0.041	0.038	
		Roads	0.257	4.16E-03	0.111	0.151	0.055	0.019	0.213	2.55E-03	0.081	0.163	0.055	0.016	
		Aircraft	0.004	3.57E-04	0.001	0.0001	0.0001	0.0001	0.004	3.57E-04	0.001	0.0001	0.0001	0.0001	
		Shipping vessels	0.234	1.17E-02	0.024	0.006	0.006	0.005	0.234	1.17E-02	0.024	0.006	0.006	0.005	
		Underground mine heating	0.005	5.24E-05	0.001	0.001	0.001	0.0004	0.005	5.24E-05	0.001	0.001	0.001	0.0004	
		Power generators	2.353	1.19E-03	0.539	0.069	0.066	0.064	1.013	7.52E-04	0.063	0.009	0.009	0.009	
		Processing plant	0.000	8.68E-07	0.000	0.109	0.044	0.044	0.000	8.68E-07	0.000	0.109	0.044	0.044	
		Incinerators	0.002	1.56E-03	0.006	0.004	0.004	0.004	0.002	1.56E-03	0.006	0.004	0.004	0.004	
		Material handling	0	0	0	0.088	0.017	0.009	0	0	0	0.252	0.068	0.012	
		Quarries	0	0	0	0	0	0	0	0	0	0	0	0	
		Wind erosion	0	0	0	7.219	3.610	0.541	0	0	0	3.905	1.952	0.293	
		Total Emissions (t/d)	5.16	0.05	1.99	7.82	3.96	0.84	3.32	0.02	1.18	4.61	2.29	0.53	

Table 50-2 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Construction, Northern Domain, the Madrid-Boston Project)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Construction	Northern Domain	The Madrid-Boston Project	Surface mobile equipment	6.732	0.068	7.319	0.297	0.297	0.288	1.867	0.005	0.861	0.135	0.135	0.131
			Underground mobile equipment and blasting	1.777	0.024	1.125	0.141	0.129	0.123	0.212	0.007	0.302	0.040	0.028	0.025
			Roads	0.720	0.011	0.722	10.123	2.926	0.332	0.775	0.003	0.289	3.102	0.912	0.139
			Aircraft	0	0	0	0	0	0	0	0	0	0	0	0
			Shipping vessels	0.059	0.003	0.006	0.001	0.001	0.001	0.059	0.003	0.006	0.001	0.001	0.001
			Underground mine heating	0.005	5.24E-05	0.001	0.001	0.001	0.000	0.005	5.24E-05	0.001	0.001	0.001	0.000
			Power generators	0.178	8.99E-05	0.041	0.005	0.005	0.005	0.105	1.28E-04	0.061	0.003	0.003	0.003
			Processing plant	0	0	0	0	0	0	0	0	0	0	0	0
			Incinerators	0	0	0	0	0	0	0	0	0	0	0	0
			Material handling	0	0	0	0.043	0.008	0.005	0	0	0	0.252	0.068	0.012
			Quarries	0.016	0.002	0.068	0.209	0.109	0.016	0.549	0.003	0.302	0.346	0.160	0.057
			Wind erosion	0	0	0	0	0	0	0	0	0	0.526	0.263	0.039
			Total Emissions (t/d)	9.49	0.11	9.28	10.82	3.48	0.77	3.57	0.02	1.82	4.41	1.57	0.41

Table 50-3 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Construction, Southern Domain, the Madrid-Boston Project)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Construction	Southern Domain	The Madrid-Boston Project	Surface mobile equipment	2.599	0.033	3.330	0.143	0.143	0.138	0.512	0.001	0.233	0.036	0.036	0.035
			Underground mobile equipment and blasting	1.740	0.020	0.966	0.116	0.116	0.112	0	0	0	0	0	0
			Roads	0.287	0.004	0.329	7.260	2.085	0.224	0.208	6.17E-04	0.077	1.485	0.425	0.064
			Aircraft	0	0	0	0	0	0	0	0	0	0	0	0
			Shipping vessels	0	0	0	0	0	0	0	0	0	0	0	0
			Underground mine heating	0	0	0	0	0	0	0	0	0	0	0	0
			Power generators	0.178	8.99E-05	0.041	0.005	0.005	0.005	0.105	1.28E-04	0.061	0.003	0.003	0.003
			Processing plant	0	0	0	0	0	0	0	0	0	0	0	0
			Incinerators	0.001	6.25E-04	0.003	0.002	0.002	0.002	0.001	6.25E-04	0.003	0.002	0.002	0.002
			Material handling	0	0	0	0.173	0.033	0.018	0	0	0	0.257	0.066	0.015
			Quarries	0.02	0.00	0.068	0.209	0.109	0.016	0.55	0.003	0.302	0.346	0.160	0.057
			Wind erosion	0	0	0	0.016	0.008	0.001	0	0	0	0.023	0.011	0.002
			Total Emissions (t/d)	4.82	0.06	4.74	7.92	2.50	0.52	1.37	0.01	0.68	2.15	0.70	0.18

Table 50-4 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Operation, Northern Domain, Existing Conditions)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Operation	Northern Domain	Existing Conditions	Surface mobile equipment	0.105	0.001	0.047	0.007	0.007	0.007	1.269	0.002	0.625	0.092	0.092	0.089
			Underground mobile equipment and blasting	0	0	0	0	0	0	0	0	0	0	0	0
			Roads	0.060	0.001	0.026	0.098	0.031	0.006	0.116	0.002	0.039	0.135	0.042	0.009
			Aircraft	0.004	0.0004	0.001	0.0001	0.0001	0.0001	0.004	0.0004	0.001	0.0001	0.0001	0.0001
			Shipping vessels	0.234	0.012	0.024	0.006	0.006	0.005	0.234	0.012	0.024	0.006	0.006	0.005
			Underground mine heating	0	0	0	0	0	0	0	0	0	0	0	0
			Power generators	2.353	0.001	0.539	0.069	0.066	0.064	1.013	0.001	0.063	0.009	0.009	0.009
			Processing plant	0.0001	8.68E-07	0.000	0.109	0.044	0.044	0.0001	8.68E-07	0.000	0.109	0.044	0.044
			Incinerators	0.002	0.002	0.006	0.004	0.004	0.004	0.002	0.002	0.006	0.004	0.004	0.004
			Material handling	0	0	0	0.044	0.008	0.005	0	0	0	0.126	0.034	0.006
			Quarries	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
			Wind erosion	0	0	0	0.272	0.136	0.020	0	0	0	0.201	0.101	0.015
			Total Emissions (t/d)	2.76	0.02	0.64	0.61	0.30	0.16	2.64	0.02	0.76	0.68	0.33	0.18

Table 50-5 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Operation, Northern Domain, the Madrid-Boston Project)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Operation	Northern Domain	The Madrid-Boston Project	Surface mobile equipment	3.677	0.051	1.696	0.260	0.260	0.253	1.429	0.003	0.644	0.100	0.100	0.097
			Underground mobile equipment and blasting	3.552	0.048	2.243	0.282	0.258	0.247	0.545	0.011	0.578	0.092	0.069	0.063
			Roads	1.205	0.019	0.932	7.034	2.067	0.273	0.843	0.003	0.315	2.839	0.844	0.127
			Aircraft	0	0	0	0	0	0	0	0	0	0	0	0
			Shipping vessels	0.059	0.003	0.006	0.001	0.001	0.001	0.059	0.003	0.006	0.001	0.001	0.001
			Underground mine heating	0.010	0.0001	0.002	0.002	0.001	0.001	0.010	0.000	0.002	0.002	0.001	0.001
			Power generators	0.049	0.001	0.254	0.002	0.002	0.002	0.780	0.001	0.103	0.010	0.010	0.009
			Processing plant	0	0	0	0.054	0.022	0.022	0	0	0	0.054	0.022	0.022
			Incinerators	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
			Material handling	0	0	0	0.220	0.043	0.023	0	0	0	0.504	0.135	0.025
			Quarries	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
			Wind erosion	0	0	0	37.1	18.6	2.786	0	0	0	20.5	10.3	1.54
			Total Emissions (t/d)	8.55	0.12	5.13	45.00	21.23	3.61	3.67	0.02	1.65	24.13	11.45	1.88

Table 50-6 Comparison of Daily Emission Rates used in the DEIS and the FEIS (Operation, Southern Domain, the Madrid-Boston Project)

Project Phase	Model Domain	Modeling Scenario	Emission Source Group	DEIS						FEIS					
				Daily Average Emission Rate (t/d)						Daily Average Emission Rate (t/d)					
				NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}	NO _x	SO ₂	CO	TSP	PM ₁₀	PM _{2.5}
Operation	Southern Domain	The Madrid-Boston Project	Surface mobile equipment	1.735	0.025	0.811	0.125	0.125	0.121	0.646	0.002	0.292	0.045	0.045	0.044
			Underground mobile equipment and blasting	1.762	0.022	1.060	0.141	0.129	0.123	0.284	0.005	0.293	0.047	0.035	0.033
			Roads	0.327	0.005	0.346	2.430	0.710	0.089	0.314	0.001	0.117	0.953	0.285	0.044
			Aircraft	0.005	0.000	0.002	0.0001	0.0001	0.0001	0.005	0.0005	0.002	0.0001	0.0001	0.0001
			Shipping vessels	0	0	0	0	0	0	0	0	0	0	0	0
			Underground mine heating	0.005	0.0001	0.001	0.001	0.001	0.0004	0.005	0.0001	0.001	0.001	0.001	0.000
			Power generators	0.108	0.001	0.564	0.005	0.005	0.005	1.013	0.001	0.063	0.009	0.009	0.009
			Processing plant	0	0	0	0.108	0.043	0.043	0.0001	8.68E-07	2.04E-05	0.109	0.044	0.044
			Incinerators	0.001	0.001	0.003	0.002	0.002	0.002	0.001	0.001	0.003	0.002	0.002	0.002
			Material handling	0	0	0	0.566	0.181	0.059	0	0	0	0.364	0.106	0.024
			Quarries	0	0	0	0.000	0.000	0.000	0	0	0	0.000	0.000	0.000
			Wind erosion	0	0	0	0.591	0.296	0.044	0	0	0	0.696	0.348	0.052
			Total Emissions (t/d)	3.94	0.05	2.79	3.97	1.49	0.49	2.27	0.01	0.77	2.23	0.88	0.25

51. ID #ECCC-4.1.3

51.1 SUBJECT/TOPIC

Nitrogen Dioxide Monitoring Passive Sampling vs Continuous Monitoring

51.2 REFERENCES

- FEIS, Volume 4, Section 2.6.3.2 Best Management Practices
- FEIS, Volume 8, Annex 2 Hope Bay Air quality Management Plan
- Madrid Boston Technical Comments Responses IA2E, Section 109, #ECCC-4.2
- Phase 2 Technical Comments Commitments Final ECCC #ECCC-4.02

51.3 ISSUE

Section C2.4 of the Air Quality Management Plan states that the *"Use of continuous ambient NO₂ monitors is not recommended due to their sensitivity to environmental conditions, which would make reliable operation and achieving data recovery objectives unlikely."* Given that there are currently several stations continuously monitoring NO₂ in the north, the proponent has not provided adequate justification on why passive monitoring is more reliable than continuous monitoring. Bias is easily induced into passive samplers. For example they can become saturated before the end of the 30 day period when exposed to high concentrations of NO₂ resulting in an under measurement of NO₂ for the duration of that 30 day period.

The most recent version of the Air Quality Management Plan includes adaptive management measures for dust/particulate matter but not for NO₂. The adaptive management plan does not indicate how biases in passive sampling will be avoided. The adaptive management plan does not indicate what operational strategies would be implemented should the NO₂ CAAQS threshold be exceeded.

51.4 RECOMMENDATIONS

ECCC recommends that the Proponent implement continuous NO₂ monitoring in the absence of justification with specific citations to support the conclusion, that continuous NO₂ monitoring is not as reliable as passive sampling.

ECCC recommends that the Proponent provide specific measures and strategies in an adaptive management plan for NO₂ should the NO₂ be exceeded.

51.5 TMAC RESPONSE FOR ECCC-4.1.3

The comment in the ambient monitoring plan regarding the sensitivity of continuous monitors to environmental conditions and the resulting recommendation to use passive samplers is primarily based on expected issues with finding locations meeting the applicable ambient monitoring siting requirements and also with access to a reliable power supply in remote areas. In locations with extreme temperature levels, an environmentally controlled enclosure is required with considerable heating/cooling power requirements in order to maintain the instrumentation within the required temperature range. This typically requires connection to a nearby hydro line, which is unlikely to be available at locations where the monitors would ideally need to be sited in the vicinity of the Project. Portable power supplies such as mobile generators have been found to be unreliable in these applications (due to power fluctuations and difficulties in maintaining their un-interrupted operation), resulting in significant data losses.

Passive sampling is a viable option for locations where power is not available and has previously been conducted in the vicinity of the existing Doris Project as part of that project's compliance monitoring program. The uptake rate of passive samplers can be varied through changes in geometry and sorbent material to ensure that sampler saturation will not occur for the maximum expected ambient concentrations.

How the NO₂ CAAQS is applied by the Government of Nunavut will affect the need for ambient NO₂ monitoring (see response to IR HC 4.1.4). If the CAAQS is adopted by the Government of Nunavut as a means of assessing regulatory compliance at an industrial facility, then continuous NO₂ monitoring may be considered at a location with available power (although it may not be ideally sited with respect to monitoring siting criteria) as a means to validate and quantify potential NO₂ exceedances. Should it not be adopted, then passive sampling is expected to provide sufficient characterization of ambient NO₂ levels.

Section 5 of the Air Quality Management Plan focuses on dustfall, however it is noted in this section that "If monitoring data for other parameters are found to be in exceedance of applicable standards, objectives, or predictions, or are showing an increasing trend in contaminant concentrations, adaptive management options will also be assessed and applied." Should exceedance of an NO₂ standard, objective or prediction be measured, the Hope Bay Air Quality Management Plan will be updated to include specific adaptive management plans for NO₂.

52. ID #ECCC-4.1.4

52.1 SUBJECT/TOPIC

Dust Suppression

52.2 REFERENCES

- FEIS, Volume 4, Section 2.6.3.2 Best Management Practices
- FEIS, Volume 8, Annex 2 Hope Bay Air quality Management Plan
- FEIS, Volume 3, Section 4.5.1 Road Network and Maintenance
- Madrid Boston Technical Comments Responses IA2E, Section 109, #ECCC-4.4
- Phase 2 Technical Comments Commitments Final ECCC #ECCC-4.02

52.3 ISSUE

The response to IR ECCC-4.4 states, *"TMAC acknowledges that achieving a 75% reduction of dust emissions with the use of road watering is not a valid assumption. Road watering is only used when conditions are above freezing. The use of coarse material for road surfaces and speed control for vehicles has proven as the most effective dust mitigation practice. The air quality model will be updated for the FEIS. Input will consider site dust fall monitoring information obtained during 2016 and 2017."*

Commitment ECCC-4.04 states, *"The methods used for road dust suppression (e.g., suppression type and application frequency) will also be refined and reflected in the model. The revised FEIS Air Quality Modelling Study will include detailed justification of the methods used to determine the resulting expected road dust control efficiency"*.

As indicated by the response to IR ECCC-4.4 and Commitment ECCC-4.04 the FEIS should contain detailed justification of the methods used to determine the appropriate road dust control efficiency. Section 4.1 of the FEIS Air Quality Modelling Study states *"Dust control efficiency of 75% was assumed on haul roads and the AWR [all weather road] during summer, corresponding to application of water twice daily (US EPA 2006). Summer is assumed to be 4 months – June to September"*. No other justification is provided for the use of 75% road dust efficiency, which the proponent has previously stated as *"not a valid assumption"*. If this assumption is now valid then documentation supporting the validity of the assumption would be required.

52.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide a rationale and supporting documentation for the use of 75% dust control efficiency.

52.5 TMAC RESPONSE FOR ECCC-4.1.4

The discussion in the response to IR ECCC-4.4 in the DEIS was meant to acknowledge that achieving a 75% control efficiency by watering alone may not be achievable all the time, not that a 75% control level is not achievable nor valid. During the summertime, a control efficiency of 75% is achievable through watering alone, as demonstrated by US EPA - *Emissions Factors & AP 42 (Fifth Edition), Volume 1: Stationary Point and Area Sources, Chapter 13.2.2: Unpaved Roads*. In this document, the results of extensive testing of the control efficiency resulting from watering unpaved roads at different application rates and frequencies is presented. Figure 13.2.2-2 in the EPA document (presented below) demonstrates that a 75% control efficiency or greater is achievable provided sufficient water is applied at regular intervals.

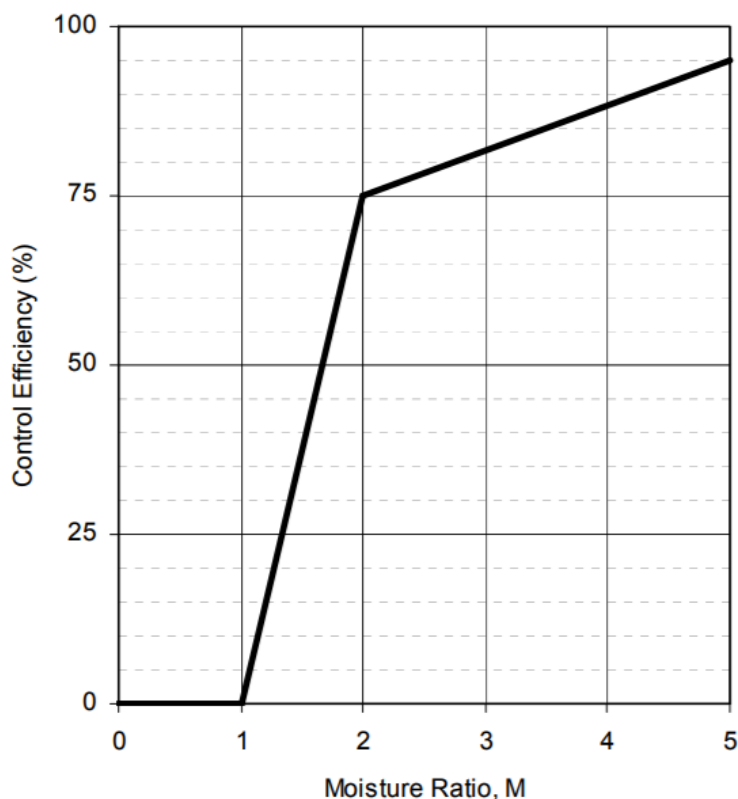


Figure 13.2.2-2. Watering control effectiveness for unpaved travel surfaces

Additionally, a recent study by Golder Associates - *Determination of Natural Winter Mitigation of Road Dust Emissions from Mining Operations in Northern Canada*, which studied monitoring data at two mines located in Northern Canada suggests that up to a 90% control efficiency is achievable on non-precipitation days during the summertime.

During spring/fall periods when water cannot be applied to the haul roads due to temperatures falling below freezing, alternative methods will be utilized to achieve this control efficiency. Application of coarse stone and speed controls are both demonstrated methods for reducing dust emissions from unpaved roads – applying coarse materials on an unpaved road reduces the amount of silt on the road surface available to be emitted. Road dust emissions have been found to be speed dependent – controlling/reducing vehicle speeds will result in reductions in road dust emissions. Chemical dust suppressants may also be utilized during these periods.

Section B.2.2 of the *Hope Bay Project Air Quality Management Plan (Volume 8, Annex V8-2)* presented in the FEIS includes dustfall monitoring locations intended to quantify dustfall levels with distance from the Doris-Windy All Weather Road. The results of this study will be used to confirm/refine the adequacy of the road dust control measures through the adaptive management methodology described in the Air Quality Management Plan.

References:

U.S. EPA. 2006. Emissions Factors & AP 42 (Fifth Edition), Volume 1: Stationary Point and Area Sources, Chapter 13.2.2: Unpaved Roads.
<https://www3.epa.gov/ttnchie1/ap42/ch13/final/c13s0202.pdf>

Golder Associates. 2012. *Determination of Natural Winter Mitigation of Road Dust Emissions from Mining Operations in Northern Canada*.

53. ID #ECCC-4.1.5

53.1 SUBJECT/TOPIC

VOC Emissions

53.2 REFERENCES

- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study, Section 1.5 Substances of Concern
- FEIS, Volume 3 Project Description

53.3 ISSUE

Section 1.5 of the Air Quality Modelling Study (AQMS) states “*Volatile organic compounds (VOC) and ground level ozone (O₃) were not included in the AQMS as Madrid-Boston Project VOC and O₃ emissions were determined to be negligible based on the Project Description (as of July 31, 2017)*”. The Project Description does not explain why VOC emissions can be considered negligible.

Based on the Project Description and the AQMS the majority of diesel emissions are from electricity generation and mobile equipment. Fuel storage for station and mobile equipment is also required. VOCs can be emitted from the combustion and storage of diesel fuel. Currently the FEIS does not quantify these VOC emissions or demonstrate that they are negligible. In order to determine the total emissions from the project VOC emission estimates are needed or adequate rationale as to why VOC emissions are negligible should be provided.

53.4 RECOMMENDATIONS

ECCC recommends that the Proponent quantify (instead of only stating that the ambient emissions are negligible) the VOC emission estimates from all sources during all phases of the project. Alternatively, ECCC recommends that the Proponent provide supporting evidence demonstrating that the VOC emissions from the project would be negligible.

53.5 TMAC RESPONSE FOR ECCC-4.1.5

A summary of estimated daily average total VOC emission rates is presented in Table 53-1 for the construction and operating scenarios. For each scenario, existing conditions, the Madrid-Boston Project (North Domain) and Madrid-Boston Project (South Domain) are presented, along with the total estimated VOC emission rate for the Project as a whole. These estimates included emissions from:

- Surface mobile equipment
- Underground mobile equipment
- Diesel trucks on roads
- Aircraft
- Underground mine heating
- Diesel power generators

Total VOC emissions were estimated using the same emissions estimations methods as for other contaminants and were predicted to be about 0.52 tonne/day during construction and 0.48 tonne/day during operation. The current VOC emission rate from the existing Doris site activities (operations) is estimated to be 0.16 tonne/day. Inclusion of the Madrid-Boston Project is predicted to increase total VOC emissions by about 0.36 - 0.38 tonne/day. Relative to NO_x, total VOC emissions are about 5.6 – 8.5 % of the NO_x emission levels.

The above estimates are for total VOCs – individual speciated VOCs would have much lower emission levels. Only a few speciated VOCs have ambient air quality objectives and experience with other mine sites has shown the predicted levels to be well below ambient objectives.

Table 53-1 VOC Emission Rates for the Madrid-Boston Project

Project Phase	Model Domain	Modeling Scenario	Daily Average VOC Emission Rate (t/d)
Construction	Northern Domain	Existing Conditions	0.16
		The Madrid-Boston Project Only	0.26
	Southern Domain	The Madrid-Boston Project	0.10
		Total Emissions during Construction (t/d):	0.52
Operation	Northern Domain	Existing Conditions	0.10
		The Madrid-Boston Project Only	0.25
	Southern Domain	The Madrid-Boston Project	0.13
		Total Emissions during Operation (t/d):	0.48

54. ID #ECCC-4.1.6

54.1 SUBJECT/TOPIC

Wind Turbines

54.2 REFERENCES

- FEIS, Volume 4, Section 2.1, Changes from the Draft EIS
- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study

54.3 ISSUE

In the DEIS, the Proponent indicated that they would undertake a feasibility study to determine if wind turbines could be implemented. In the FEIS it is stated that there will be the *"inclusion of two wind turbines near the Doris site, two wind turbines near the Madrid North site and two wind turbines near the Boston site. These turbines will supply the power necessary to operate the Doris mill and camp, Madrid concentrator, and, Boston mill and camp, and will be located approximately 2.5 km and 3.0 km south of the sites. The power plants were conservatively assumed to operate at maximum capacity without any reduction in capacity due to the wind energy generation."*

If turbines are to be used then the air pollutant emissions for the project will be reduced. This will depend on when the wind turbines are installed during the life of the project and their cumulative magnitude. Although ECCC is not in a position to review the technical aspects of the Feasibility Study it would be helpful to know when the wind power will be implemented. If it is implemented later in the project, it will have less of an effect on the emission reductions.

54.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide the timelines for integrating the wind turbines into the power distribution grid.

54.5 TMAC RESPONSE FOR ECCC-4.1.6

Should TMAC proceed with the installation of wind turbines, the expected timeframe for construction of the wind turbines would be from 2021 to 2022. The wind turbines would be expected to be operational by 2023.

55. ID #ECCC-4.1.7

55.1 SUBJECT/TOPIC

Stationary Diesel Engines

55.2 REFERENCES

- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study, Section 4.3.1.1 Genset Stacks
- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study, Table A-1 Generator Stack Parameters and Emission Rates

55.3 ISSUE

ECCC has signaled its intent to regulate air pollutant emissions from stationary diesel engines. The proposed regulation would affect manufacturers and importers and would introduce Canadian emission standards for new engines in alignment with U.S. federal emission standards for air pollutant emissions from these sources. Proposed regulations are planned for publication in 2018, meaning that final regulations would not be published until approximately one year later. (For questions: please refer to ec.combustion.ec@canada.ca).

Table A-1 of the AQMS shows there are three 750 kW gensets that will only meet Tier 2 emission standards. Two of those gensets are operational during construction and one is operational at Madrid South during operations. This table shows that all other gensets (1600 kW) are to meet Tier 4 standards. A rationale for not meeting Tier 4 during construction at Quarry D Construction camp and Boston Construction camp and during operations at Madrid South is not provided.

55.4 RECOMMENDATIONS

ECCC recommends that the Proponent consider using engines that meet Tier 4 emission standards for all construction and operation phases.

55.5 TMAC RESPONSE FOR ECCC-4.1.7

Power supply at Madrid South, the Quarry D construction camp, and the Boston construction camp may utilize existing generators rather than acquiring new equipment, as the gensets at these locations account for only 8.2% of the total generation capacity of the Project. The air quality assessment conservatively assumed these gensets would meet Tier 2 emission standards.

56. ID #ECCC-4.1.8

56.1 SUBJECT/TOPIC

Emission Standards

56.2 REFERENCES

- Phase 2 Technical Comments Commitments Final ECCC #ECCC-4.01
- Madrid Boston Technical Comments Responses IA2E, Section 108, #ECCC-4.1
- FEIS, Volume 4, Section 2.6.3.2 Best Management Practices
- FEIS, Volume 4, Appendix V4-2I Air Quality Modelling Study, Section 4.3.4 Road Sources

56.3 ISSUE

Commitment ECCC-4.01 and the response for IR ECCC-4.1 state that *“New equipment purchased for Phase 2 will comply with Canadian regulations for emission standards during the procurement period”*.

The emissions section of the AQMS states that *“Year 2010 was modeled in MOVES2014a to represent Tier 3 emission standards for haul trucks at the existing Doris mine site, and year 2016 was modelled to represent Tier 4 emission standards for haul trucks at Madrid North, Madrid South and Boston sites and trucks travelling along the AWR [all weather road]”*. The relevant emissions also reflect Tier 3 for the Doris mine site and Tier 4 for the new sites, which satisfy the commitment. Clarity on where the Tier 3 fleet will be used after they are no longer used at Doris is required.

56.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide confirmation that the equipment (both operations and construction) used at Doris North (i.e., Tier 3) is going to be used at the Madrid and Boston sites and if so that the equipment will be retrofitted to meet Tier 4 standards (since the air quality modeling used to predict environmental effects assumes that all equipment will meet Tier 4).

ECCC recommends that the Proponent confirm that any new equipment purchased for use on the project will meet Tier 4 standards.

ECCC recommends that the Proponent not remove emission control technologies from off-road equipment, implement an emission control technology maintenance program, and provide employee training on minimizing off-road equipment idling.

56.5 TMAC RESPONSE FOR ECCC-4.1.8

The air quality modelling study in the FEIS assumed that existing non-road equipment at the Doris site meets Tier 3 emissions standards (as this is expected to be representative of the existing equipment). It is anticipated that much of the equipment required for Phase 2 will be new equipment. In those cases, TMAC confirms that new equipment will meet current regulatory standards for new equipment, which would be Tier 4 levels for surface non-road equipment. For cases when the equipment purchased for Phase 2 is reconditioned or re-purposed from existing operations, the equipment would meet the emission guidelines applicable at the time of manufacture. Based on this approach, it is assumed that not all equipment required for Phase 2 may meet the Tier 4 emission standard for surface non-road equipment. This assumption is mitigated in the air quality modelling study by using a conservative equipment utilization factor and conservative assumption that emissions from the Madrid North and Boston generators had the same emissions as the Doris generators.

Using a conservative equipment utilization factor is expected to result in emissions from surface non-road equipment being over-estimated. In addition, based on fuel consumption data for the Doris site, which is expected to be representative of the Madrid North and Boston sites, approximately 70% of all fuel is consumed for power generation and the power plants are expected to be the dominant NO_x emissions sources. The generators at the Madrid North and Boston power plants will be new units that will meet the regulatory standards in place at the time of their purchase, which would be Tier 4, while the air quality assessment conservatively assumed these gensets would meet lower (Tier 1) emission standards. Based on these two key conservatisms (equipment utilization and generator vintage), the air quality modelling study over-estimates NO_x emissions and ambient air quality from the Boston-Madrid Project. As noted in the response to GN-9, TMAC is currently updating the air quality modelling to address emission estimate conservatisms with respect to NO_x, with results of that additional modelling expected by April 27.

Section 2.2 of the *Hope Bay Project Air Quality Management Plan (Volume 8, Annex V8-2)* presented in the FEIS includes additional mitigation measures to be implemented for the Project such as those recommended by ECCC, including:

- Vehicle and equipment idling is minimized when not in use and able to do so
- All mobile and stationary engines are regularly serviced to maintain efficiency
- A preventive maintenance program is in place for all machinery and equipment

- On-site staff at all levels are provided training and instruction in their duties relating to process control and air emissions (e.g., the required measures to be implemented during start-up, shut down and abnormal conditions)

TMAC does not anticipate any need to remove emission control technologies from off-road equipment except in the event of extreme conditions for which the equipment could not be operated with the control in place.

It is noted that emissions from engines used exclusively in underground mining equipment are exempted from ECCC emissions regulations and fall under provincial/territorial jurisdiction. TMAC confirms this equipment will meet the applicable Nunavut regulations.

57. ID #ECCC-4.2.1

57.1 SUBJECT/TOPIC

Species at Risk

57.2 REFERENCES

- Wildlife Mitigation and Management Plan (WMMP)

57.3 ISSUE

The Proponent identified potential species at risk occurring in the project area and interactions with project activities in Volumes 4 and 5 of the FEIS. Mitigation measures and monitoring are found in the FEIS Volumes and the WMMP. The WMMP is described as “a *living document that can evolve over time*” in response to “*changing conditions*” and will be “*reviewed annually and updated as needed*” (section 1.4).

ECCC is satisfied with the mitigation and monitoring measures proposed to minimize project impacts on species at risk for which ECCC has primary management responsibility. However, ECCC notes that species at risk information is not clearly presented or consolidated in the WMMP. There should be a specific “Species at Risk” section in the WMMP with a table that clearly identifies the species potentially interacting with the project and how the proposed mitigation and monitoring are addressing the potential pathways of effects. This Species at Risk section should be kept current during all phases of the project. This is particularly important as new species are assessed by COSEWIC or added to Schedule 1 of SARA on a regular basis. For example, COSEWIC has revised their assessments of Dolphin Union Caribou to Endangered and Peregrine Falcon *anatum/tundrius* to Not at Risk in November 2017 which is not reflected in the WMMP. Although these changes may not have immediate implications for the impact assessment of the Project, there may be future implications during the construction or operations. This would apply to all new Endangered or Threatened listings or for species which have their risk status changed on Schedule 1. This section of the WMMP will also be important to ensure that proposed mitigation and monitoring measures for the Project are consistent with future applicable species at risk recovery strategies and action/management plans.

57.4 RECOMMENDATIONS

ECCC recommends that the WMMP be revised to include a section consolidating species at risk information.

ECCC recommends that the Proponent consult the Species at Risk registry (<https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&%20n=24F7211B-1>) to maintain the most current information in the WMMP and the annual WMMP reports, as new species are assessed by COSEWIC or added to Schedule 1 of SARA on a regular basis.

57.5 TMAC RESPONSE FOR ECCC-4.2.1

TMAC agrees to include a section in the 2018 WMMP listing the species at risk, and relevant mitigation

58. ID #ECCC-4.2.2

58.1 SUBJECT/TOPIC

Wind Turbines – Potential Impacts to Migratory Birds

58.2 REFERENCES

- Volume 4 – 9D. Hope Bay Phase 2 Migratory Standwatch Surveys 2017
- Volume 4 – Terrestrial Environment
- Wildlife Mitigation and Management Plan (WMMP)
- Environment Canada, 2007a. Wind Turbines and Birds: A guidance document for Environmental Assessment.
- Environment Canada, 2007b. Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds.

58.3 ISSUE

The proponent conducted bird passage migration counts to support the impact assessment of the proposed wind turbines. Although fewer surveys were conducted than recommended due to weather constraints, surveys followed ECCC monitoring protocols (2007b). Surveys were conducted between May 31- June 5 2017, and September 2-7 2017.

Geese were reported as the most abundant bird group observed, accounting for 90-93% of all observations in both seasons. Migration was described as broad- fronted with no obvious migratory corridor on the landscape. There was a single observation of a species at risk, Short-eared Owl. The likelihood of potential collisions was determined to be low, however residual impacts were predicted for all bird Valued Ecological Components (VECs) (i.e. Upland Breeding Birds, Waterbirds and Raptors). The Proponent is proposing to conduct 2 years of post- construction mortality monitoring following ECCC monitoring protocols (2007b).

ECCC met with the Proponent in March 2017 to discuss initial plans related to the installation of wind turbines on site. During these discussions, ECCC noted fog as a potential hazard to consider in their impact assessment. Fog was recognized as a collision hazard for the wind turbines in sections 9.18.3.5 and 9.20.3.4 of Volume 4 (Direct Mortalities for Waterbird and Upland Breeding Bird VECs). However, the Proponent reports that there were only two days in each of the months of August to October of 2017 where the ceiling was low (i.e. fog) and concluded it would only marginally increase potential risks of collisions. This description of number of days of fog on site seems inconsistent with the description of weather conditions in Section 2 of the Migratory Stand Watch Surveys

2017 report, where monitoring was shortened both in spring and fall due to weather constraints (i.e. fog).

The proponent identified Buff-breasted Sandpiper, SARA listed as Special Concern, as a potentially vulnerable species to collisions with wind turbines. However, the Proponent confirmed that Buff-breasted Sandpiper had not been detected in the Hope Bay Belt during any of their bird monitoring programs to date. ECCC reviewed records of Buff-breasted Sandpiper spring and fall migration movements in the Kitikmeot Region from two unpublished studies. Of six Buff-breasted Sandpipers tagged in Texas in 2017, three of them travelled northward between Bathurst Inlet and the eastern end of the Kent Peninsula during spring migration from June 1 – 5. These individuals nested on Victoria Island and eastern Kent Peninsula. Although one individual appears to have traveled through the Hope Bay Belt and the project, there is no strong evidence of a migratory corridor as all six birds crossed Coronation Gulf and Dease Strait at different locations along the Kitikmeot Region coastline. Southbound movements of 8 Buff-breasted Sandpipers tagged in Alaska in 2017 were located between Queen Maud Gulf Migratory Bird Sanctuary (MBS) and Kugaaruk during the period of June 23 – July 31. The early southbound movement dates are suggestive of non-breeders or failed attempts.

No critical habitat of species at risk exists at or near the proposed wind turbine locations. Proposed sites are not adjacent to any known colonies. The Proponent noted “*several tundra swans... gathering at the lake northwest of the Boston site during the fall migration surveys*” (Migratory Standwatch Surveys 2017). However, it is difficult to determine how significant of a bird concentration this represents without an actual count. Table 9.18-2 of Volume 4 also identifies high use areas for Waterbirds near Project infrastructure, but it is unclear where these areas are located in relation to proposed wind turbine locations. The nearest areas recognized as nationally significant for birds are Bathurst and Elu Inlets Key Habitat Sites (KHS) and Queen Maud Gulf MBS. Bathurst and Elu Inlets KHS contains greater than 10% of the national populations of Common Eider and Iceland Gull. Both of these species are at-sea or coastal migrants and not expected to interact with the proposed land-based wind turbines. Queen Maud Gulf MBS is approximately 50 km east of the Project and not likely to influence site sensitivity.

Mitigation is expected to lower but not completely eliminate the effect of direct mortality to migratory bird VECs due to potential collisions with wind turbines. Thus, a residual effect of direct mortality is predicted for migratory bird VECs due to Phase 2 and the Hope Bay Project (Section 9.18.3.5).

The Proponent considered design features to mitigate impacts and proposes monitoring to determine if adaptive management is required (i.e. if a mortality reaches a threshold of 14 birds/turbine/year). Two years of post-construction monitoring is proposed to address concerns of residual impacts to Migratory Bird VECs. However, the WMMP does not include the proposed monitoring in the Upland Breeding Bird and Waterbird VEC sections (3.1.9 and 3.1.10). In addition, no details are discussed in the FEIS documents

about the proposed monitoring, such as which type of survey or level of effort is planned, other than they will follow ECCC guidance.

ECCC advises that a significant effort is required for the results of post- construction monitoring to be scientifically valid and comparable to other projects (see ECCC 2007b). Monitoring would require scavenger trials and searcher efficiency trials to address sampling biases. ECCC notes that mitigation measures during wind turbine operations have not been considered to address potential residual impacts and could potentially be more cost-effective than the level of monitoring to inform adaptive management.

ECCC advises that a significant effort is required for the results of post- construction monitoring to be scientifically valid and comparable to other projects (see ECCC 2007b). Monitoring would require scavenger trials and searcher efficiency trials to address sampling biases. ECCC notes that mitigation measures during wind turbine operations have not been considered to address potential residual impacts and could potentially be more cost-effective than the level of monitoring to inform adaptive management.

The proponent described waterbird migration through the area as broad-fronted with no obvious migratory corridor. This is not unexpected and consistent with ECCC's observations elsewhere in the Arctic. Although relatively large numbers of geese, cranes and swans were observed, particularly during fall counts, none of these species are a conservation concern at the moment. As the alignment of the turbines will be perpendicular to the coastline, ECCC suspects there would be little barrier to large waterbird movements. As such, ECCC supports the probability of a residual effect for direct mortality as moderate (i.e. increased localized risks under poor visibility during the migratory periods) and suspects the effects would be non-significant based on the conservation status of the most abundantly observed migratory birds during baseline.

58.4 RECOMMENDATIONS

1. ECCC recommends that the Proponent investigate and consider implementing preventative operational mitigation measures that could minimize risks to birds during periods of poor visibility at peak bird migration periods.
2. ECCC recommends that the proposed wind turbine monitoring be added to existing discussions between the Proponent and interested parties on site-wide bird monitoring objectives and priorities.
3. ECCC recommends that the Proponent submit all data sets to the centralized bird/bat monitoring database known as the "*Wind Energy, Bird and Bat Monitoring Database*" <https://www.bsc-eoc.org/birdmon/wind/main.jsp>.

58.5 TMAC RESPONSE FOR ECCC-4.2.2

In response to Environment and Climate Change Canada (ECCC)'s comments and questions related to birds and wind turbines, TMAC provides the following commitments and explanations:

1. Commitment: TMAC agrees to add the monitoring for the proposed wind turbine to the existing discussions with ECCC and interested parties on site-wide bird monitoring.
2. Commitment: TMAC agrees to discuss preventative operational mitigation measures for wind turbines during periods of poor visibility at peak bird migration periods.

Note that TMAC may choose to operate the wind turbines during foggy periods and conduct the monitoring as planned, or apply mitigation measures so as to avoid monitoring requirements. Key determinants will include the number of foggy days on site during migration and the extent of monitoring required to meet ECCC guidance.

3. TMAC supports regional initiatives that are aimed at improving understanding of wildlife in the Hope Bay Belt area. Administered by a joint partnership between the government (Canadian Wildlife Service/Environment Canada and Ontario Ministry of Natural Resources) and other stakeholders (Canadian Wind Energy Association, Bird Studies Canada), the "Wind Energy Bird & Bat Monitoring Database" is an initiative to further understanding of the impacts of wind turbines on birds and bats and lead to future improvements in the Environmental Assessment and approval processes.

Commitment: TMAC agrees to submit data sets to the centralized bird/bat monitoring database known as the "Wind Energy, Bird and Bat Monitoring Database".

References:

<https://www.bsc-eoc.org/birdmon/wind/main.jsp>.

OMNR. 2011. *Birds and Bat Habitats: Guidelines for Wind Power Projects. First Edition*. Prepared by the Ontario Ministry of Natural Resource (OMNR). Queen's Printer for Ontario, Canada. <https://www.ontario.ca/document/bats-and-bat-habitats-guidelines-wind-power-projects> (accessed 2018).

EDI. 2017. *Hope Bay Project Phase 2: Migratory Standwatch Surveys Report, 2017*. Prepared for TMAC Resources Inc.

59. ID #ECCC-4.2.3

59.1 SUBJECT/TOPIC

Wildlife Use of Tailings Impoundment Area and Water Storage

59.2 REFERENCES

- Volume 4 – Terrestrial Environment
- Volume 6 Section 5 - Human Health and Environmental Risk Assessment (HHERA)
- Wildlife Mitigation and Management Plan (WMMP), Sections 3.1.9 and 3.1.10

59.3 ISSUE

The proponent conducted an environmental risk assessment to evaluate exposure pathways of the Project for different contaminants of potential concern on a number of wildlife receptors (Sections 5.5 and 5.6 of the HHERA). Bird receptors selected for the freshwater environment include Canada Goose, Least Sandpiper, Red-breasted Merganser and Long-tailed Duck as representative species for the Waterbird and Upland Breeding Bird VECs. Results of the HHERA informed the effects assessment for changes in environmental quality for these Migratory Bird VECs. The Proponent concluded that project effects on environmental media quality were negligible and could not lead to increased risks. No residual effects of attraction to infrastructure were predicted with the proposed monitoring and management.

Monitoring data from other operating mines in the North suggests that waterbirds can make extensive use of water management ponds, especially if these areas are subject to earlier thaw than the natural water bodies. If these ponds are not designed and managed to deter use by migratory birds there may be increased exposure times leading to increased risks.

Although the HHERA included conservative assumptions, it reports that during the Construction and Operational phase, copper and methylmercury may affect the health of fish-eating and aquatic invertebrate-eating birds, due to Hazard Quotients (HQ) greater than 1.0. However, the Proponent also concludes that as HQs are already elevated under existing conditions, and increases in HQs during Construction and Operational phases would be small and unlikely to be measurable.

The HHERA makes the assumption that most wildlife would be deterred from using the TIA due to mining activities that would be ongoing during the Operational phase. This is not consistent with monitoring results from similar projects and should be supported by available monitoring data on site. The Proponent considers it unlikely that wildlife would

spend appreciable amounts of time within the TIA and exposures to TIA water is expected to be minimal. In section 9.2.11 of Volume 4, the proponent also states that there have been no incidents of waterbirds being attracted to artificial waterbodies at the Doris Project. It is unclear if “incidents” refers to observations of waterbird usage of the TIA and other areas used as water storage or something different.

The HHERA and Volume 4 propose mitigation and monitoring measures to minimize the potential for terrestrial wildlife (including migratory birds) to be exposed to the water contained within the TIA during the Operational phase. These include monitoring of TIA water quality as part of the Aquatic Effects Monitoring Program, monitoring of the TIA for wildlife usage, deterring wildlife use if water quality does not meet acceptable standards, or the use of water cannons or other types of deterrents to exclude wildlife from the TIA.

However, a description of the design features of the TIA and other areas used as water storage and monitoring of migratory bird use of these areas are lacking in the WMMP. It is also unclear if monitoring for usage by birds is in place for existing operations as there is no mention in the WMMP and whether and when active deterrence of bird usage is conducted on site.

ECCC did not find a description of the design features of the TIA and other areas used as water storage in place to minimize attraction to and deter birds from using them. ECCC's recommendations would also address some of the concerns the Proponent received related to “*effects due to wildlife interactions with tailings*” during community consultations (section 9.3.1.3 Volume 4).

59.4 RECOMMENDATIONS

1. ECCC recommends that the Proponent revise the WMMP to include monitoring of waterbird and shorebird usage of the TIA and other areas used as water storage and ensure that it is reported in the annual WMMP reports.
2. ECCC recommends that the Proponent clarify whether measures to deter migratory birds from using the TIA and other areas used as water storage would only occur if water quality does not meet acceptable standards or if it would be a standard practice.
3. ECCC recommends that the Proponent assess existing design features in place at the TIA and other areas used as water storage and determine whether additional design mitigations are feasible to limit exposure times for migratory birds in these areas.

59.5 TMAC RESPONSE FOR ECCC-4.2.3

The Tailings Impoundment Area (TIA) is an already-permitted structure under the existing Doris Project and associated water licence.

This response clarifies the monitoring and mitigation for waterbirds in the TIA and other Project ponds. The Hope Bay Project will have 2 types of ponds: the Tailings Impoundment Area (TIA) and contact water ponds at Doris, Madrid North and South, and at Boston.

1. Monitoring Migratory Birds in the TIA and Deterrence Measures

The TIA is used for the deposition of tailings. The FEIS assessed the potential for waterbirds to use the TIA and be exposed to water there and proposed mitigation to exclude waterbirds if Project ponds do not meet wildlife guidelines for water quality (Section 9.18.3.4):

If water quality in Phase 2 ponds does not meet water quality guidelines for wildlife, appropriate management will be conducted to exclude birds from these areas (e.g., air cannons). The effectiveness of deterrent systems will be monitored and adaptively managed if they are not successful.

TMAC commits to updating the WMMP Plan to include more detail on the existing monitoring and mitigation for waterbirds in the TIA.

Monitoring and management steps updated in the WMMP will include:

- 1) TMAC will monitor water quality in the TIA on a regular basis during operations of the Project as per our existing water licence requirements;
- 2) If the water in the TIA does not meet wildlife guidelines for waterbirds, then monitor the TIA for waterbirds during spring and fall migration will be done; and
- 3) If ponds contain water that does not meet wildlife guidelines and waterbirds are actively using these ponds, the IEAC will be engaged as to methods for deterrence of waterbirds.

Water quality is managed through the Water Management Plan; Hope Bay Project (Package P4-7 and P4-8) and monitored through the Hope Bay Project Phase 2 Aquatic Effects Monitoring Plan (Package P4-18) for the life of the Project. Water quality predictions for the TIA reclaim water pond have indicated that this water will not exceed guidelines for the protection of wildlife (Volume 6, Chapter 5, Section 5.6.1.3). As such, impacts on wildlife health are not anticipated by wildlife use of the TIA.

The existing camera monitoring program includes timed photos every 30 minutes of the shoreline and TIA surface at the north and south ends of the TIA and can detect waterbirds. This monitoring method has detected some use of the TIA by waterbirds in 2017. As more tailings are deposited, the area of open water will shrink reducing the probability that waterbirds will use the TIA.

2. Assessing Mitigation and Management of the TIA

TMAC has assessed the existing design features in place at the TIA to determine whether additional design mitigations are feasible to limit exposure times for migratory birds in these areas.

Existing design features and mitigation for the TIA include:

- Monitor water quality in the TIA on a regular basis during construction and operations of the Project;
- At closure, the Doris TIA will be capped surface to minimize direct contact by terrestrial animals; once the Reclaim Pond has reached the required discharge criteria, the North Dam will be breached and the flow returned to Doris Creek.
- The FEIS and WMMP stated that waterbirds would be deterred from the TIA if water did not meet wildlife guidelines. The commitment above clarifies the types of surveys and triggers for deterring waterbirds from the TIA.

With these monitoring and mitigation measures in place, along with the clarification over triggers for deterring waterfowl from the TIA, no additional monitoring or mitigation is required.

3. Assessing Mitigation and management of Water Ponds

Existing design features and mitigation for contact water ponds include:

- As indicated in the Project Description, infrastructure design included environmental sensitivity mapping and avoidance of areas identified as sensitive landscape features, such as wetlands, residences (carnivore dens and raptor cliff nests, migratory staging areas for birds, etc.).
- Contact water ponds at Doris, Madrid North, Madrid South and Boston are meant to collect water during rain events or due to snow melt. These ponds will largely be kept in a dry state, thereby reducing residence time of water to minimize any attraction of migratory birds, especially considering the amount of naturally occurring water bodies in the region that are available to birds.
- There will be no sewage ponds generated for the Project; instead sewage will be treated and discharged.
- A closure, a low permeability cover, including a geomembrane, will be placed over the Boston TMA. The contact water containment berms will be breached and the liner will be cut to prevent any water collecting.

Given that the contact ponds will be kept in a dry state and there are no sewage ponds, no additional design mitigation is proposed for Project ponds.

60. ID #ECCC-4.2.4

60.1 SUBJECT/TOPIC

Cumulative Impacts of shipping in Bathurst/Elu Inlet Key Habitat Site on Migratory Birds

60.2 REFERENCES

- Volume 5 – Marine Environment
- Wildlife Mitigation and Management Plan (WMMP)
- TMAC Hope Bay Phase - ECCC DEIS Technical Comments
- TMAC Doris North Addendum - ECCC Technical Comments
- Sabina Back River – ECCC FEIS Technical Comments
- Dickson, D.L. 2012. Seasonal movement of Pacific Common Eiders breeding in arctic Canada. Canadian Wildlife Service Technical Report Series No. 521
- Hoover, A.K. and D.L. Dickson. 2007. Nesting Ecology and Survival of the Pacific Common Eider (*Somateria mollissima v-nigra*) in Central Arctic Canada. Technical Report Series 471, Canadian Wildlife Service, Edmonton, Alberta.

60.3 ISSUE

The proponent concluded that no residual effects for marine birds are anticipated as a result of Project-related activities. Consequently, no potential residual effects were evaluated for significance or carried forward to a cumulative effects assessment. As a result, in their response to ECCC DEIS comments, the Proponent stated that monitoring for marine birds in Regional Study Area is not justified.

The Project's marine wildlife regional study area overlaps the Bathurst and Elu Inlets Key Habitat Sites for Migratory Birds (KHS). ECCC has indicated in previous submissions to the NIRB (ECCC Technical Comments: DEIS TMAC Phase 2, TMAC Doris North Addendum, FEIS Sabina Back River) that there is uncertainty related to the magnitude of direct and cumulative effects of shipping through the Bathurst and Elu Inlets KHS on marine birds. ECCC's concerns relate to potential disturbance and pollution events impacting Common Eiders from shipping activities. The only information available on distribution of Common Eiders during the shipping season, August-September, is based on individuals from a colony at Nauyak Lake (Dickson 2012). The colony only represents a portion of Common Eiders known to use the KHSs. There is insufficient data to conclude with

certainty that all Common Eiders in the KHS follow the movements and distribution reported in Dickson (2012).

Hoover and Dickson (2007) suggested that the undisturbed nature of Bathurst Inlet area within the Kitikmeot Region contributes to Common Eider populations. Similar numbers of eider attempted to nest each year of their study and a relatively high percentage of nests also hatched each year compared to other breeding areas for Common Eiders.

The Bathurst/Elu Inlet KHS contains more than 10% of the national population of Common Eider Direct and cumulative impacts resulting from shipping in this KHS could lead to population level impacts. Although the probability of a major pollution event within this KHS and the marine Regional Study Area (RSA) is low, the magnitude of potential impacts could be high. It is important to understand the abundance and distribution of Common Eiders (and other Marine Birds) during the shipping period to reduce disturbance through avoidance, where possible, and to be able to prioritize the wildlife response in the event of spill.

ECCC acknowledges that it is not the Proponent's sole responsibility to determine the direct and cumulative effects of shipping on Common Eiders within the KHS (and marine RSA). However, ECCC notes that the project will result in increased shipping traffic in the region will directly contribute to possible increased negative effects and would like a commitment from the Proponent to contribute to a study with ECCC and others to better understand the distribution and abundance of Common Eider during the proposed shipping period in the KHS. ECCC's recommendation would also address some of the concerns received related to impacts of shipping on marine wildlife during community consultations (section 9.3.1.3 Volume 4).

60.4 RECOMMENDATIONS

ECCC recommends that the Proponent commit to work or consult with ECCC on any monitoring study of Common Eiders and to share any associated data.

60.5 TMAC RESPONSE FOR ECCC-4.2.4

TMAC is committed to mitigating and minimizing disturbance to marine birds in marine Key Habitat Sites (KHSs) and along the shipping route. Vessel transits through some KHSs cannot be avoided, including the Bathurst Inlet/Elu Inlet. Although the shipping routes do not overlap with eider areas during the proposed open-water shipping season (Dickson 2012), the current scientific knowledge of common eiders post-breeding distribution in these key habitat sites results from a single capture site (Nauyak Lake, located just off of Parry Bay on Kent Peninsula), and it is possible that their post-breeding distribution may differ from the areas outlined in the Dickson (2012) report.

The WMMP details mitigation and management activities planned to reduce or eliminate potential effects on marine birds, including Pacific common eider (Annex V8-3, Section 2.9 and Volume 5, Chapter 11, Section 11.5.3). Proposed shipping management activities include having shipping contractors adhere to the marine setback distance of 500 m from identified habitat sites in Bathurst Inlet/Elu Inlet for marine birds, except where the safety of the ship is in concern, as per the "Marine Setbacks" for "Coastal Waterfowl and Seaducks" outlined in the 2016 Nunavut Planning Commission (2016). Ships will also avoid the known marine bird colony on Prince Leopold Island by 25 km, and any large aggregations of marine birds, except where the safety of the ship dictates otherwise. With mitigation and monitoring measures no residual effects were predicted for marine birds due to shipping.

TMAC is open to having dialog with ECCC on collaboration on other Project monitoring activities, however notes that marine re-supply associated with our project is a negligible increase to the region and the FEIS has indicated with good confidence that no residual effects are predicted. Community and Project re-supply often share vessels destined for communities and therefore are not dedicated vessels for TMAC, making TMAC's predictions of resupply conservative.

CWS. 2012. *Birds and Oil - CWS Response Plan Guidance*. Canadian Wildlife Service. <http://www.cnlopb.ca/pdfs/arkexlsggs/responseplan.pdf> (accessed March 2016).

Dickson, D.L. 2012. Seasonal movement of Pacific Common Eiders breeding in arctic Canada. Canadian Wildlife Service Technical Report Series No. 521 Available online at: <http://ec.gc.ca/Publications/default.asp?lang=En&xml=65AD25CF-A8D8-4407-9B5C-7BAB469B3403>

Nunavut Planning Commission. 2016. *Draft Nunavut Land Use Plan*.

61. ID #ECCC-4.3.1

61.1 SUBJECT/TOPIC

Closure Tailings Thickness

61.2 REFERENCES

- Volume 1 Annex V1-7 Type A Water Licence Applications
- Source: Package P4-9: Hope Bay Project, Phase 2, Doris-Madrid Tailings Impoundment Area Operations, Maintenance, and Surveillance Manual
- Section: 4.9 Concurrent Closure

61.3 ISSUE

The Proponent states that the tailings surface will be covered with a nominal waste rock cover of 0.3 m thickness. The function of the cover is to prevent dust and to minimize direct contact by terrestrial wildlife. Once the water quality in the Reclaim Pond has reached the required discharge criteria, the North Dam will be breached as originally intended for Phase 1. The TIA, once breached will discharge into Doris Lake which in turn discharges into Doris Creek. The minimum thickness of cover that can practically be placed over the tailings surface would be about 0.3 m thick, and therefore the cover design has been set at 0.3 m thick Run of Quarry material.

ECCC notes that the thickness of the cover is exactly the minimum thickness (0.3m) that can be practically placed over the tailings surface.

61.4 RECOMMENDATIONS

ECCC recommends that the Proponent demonstrate that the 0.3m will provide adequate protective cover long term (post closure) to ensure that there are no negative impacts on downstream water quality.

61.5 TMAC RESPONSE FOR ECCC-4.3.1

Detailed water and load balance modeling (P5-4 Madrid-Boston Project Water and Load Balance, Hope Bay Project) has confirmed that long term water quality from the Doris TIA has no negative impacts on the downstream environment. As a result, there is no requirement for an infiltration or oxygen reducing cover over the tailings surface. Therefore, the 0.3 m Run of Quarry (ROQ) rock cover, as proposed, is designed to specifically prevent dust and minimize direct contact by terrestrial life.

62. ID #ECCC-4.3.2

62.1 SUBJECT/TOPIC

Seepage Collection

62.2 REFERENCES

- Volume 1 Annex V1-7 Type A Water Licence Applications
- Source: Package P4-10: Hope Bay Project Boston Tailings Impoundment Area Operations, Maintenance, and Surveillance Manual
- Section: 3.4.3 Seepage Collection

62.3 ISSUE

The Proponent states that post-closure seepage through the active layer will be limited to what may infiltrate through the low permeability cover. This volume of flow is considered negligible, and water quality modeling has confirmed there will be no environmental impact. As a result, no post-closure seepage collection is planned or required (SRK 2017b.)

ECCC is of the view that the impact of climate change on structures like dry stack tailings is unknown. As such it is prudent to have a contingency plan for the potential increase in seepage as a result of changes to permafrost distribution as a result of climate change.

62.4 RECOMMENDATIONS

ECCC recommends that the proponent develop a contingency plan to account for the potential impacts of climate change on structures like dry stack tailings post closure, and the increase to seepage that may occur should permafrost distribution change in the long-term.

62.5 TMAC RESPONSE FOR ECCC-4.3.2

TMAC recognizes that climate change could impact the performance of long-term structures such as the Boston tailings management area (TMA). As a result, the Boston TMA has been designed taking climate change into account (Package P5-1 Climate Change Analysis Approach Report, Hope Bay Project). For example, the thermal analysis undertaken on the Boston TMA (Package P5-26 Boston Tailings Management Area Preliminary Design Hope Bay Project, Appendix D) to estimate active layer thickness in the dry stack tailings in support of the long-term geochemical load balance which considers climate change. Based on that analysis, as well as the water and load balance

modeling (Package P5-4 Madrid-Boston Project Water and Load Balance, Hope Bay Project) it was concluded that a High Density Polyethylene (HDPE) liner would be a suitable method to limit infiltration, and subsequently an infiltration analysis was completed (Package P5-26 Boston Tailings Management Area Preliminary Design Hope Bay Project, Appendix E), which confirmed that long-term post-closure seepage is not expected to be a concern. This infiltration rate is a function of imperfections in the liner and is not affected by changes to permafrost distribution as a result of climate change. Furthermore, deformation modeling for the TMA (Package P5-26 Boston Tailings Management Area Preliminary Design, Appendix F) considers climate change and confirms that expected deformation is sufficiently small so as not to affect the performance of the liner.

TMAC considers that the design and supporting analyses have conservatively and sufficiently accounted for the potential impacts of climate change on structures like dry stack tailings post closure and no additional contingency measures are required

63. ID #ECCC-4.3.3

63.1 SUBJECT/TOPIC

Waste Rock Seepage

63.2 REFERENCES

- Volume 1 Annex V1-7 Type A Water Licence Applications
- Package P4-12: Hope Bay Project Water and Ore/Waste Rock Management Plan for Boston Site
- Executive Summary: Current Site Conditions

63.3 ISSUE

The proponent states that the main geochemical issue associated with the ore and waste rock is the potential for leaching of metals under neutral pH conditions. Monitoring has demonstrated that seepage immediately down- gradient of the camp pad and ore stockpiles has elevated concentrations of sulphate, chloride, arsenic, nickel and selenium. However, prior to reaching the shoreline of the lake, concentrations of these metals are substantially lower and stable, indicating that there is considerable attenuation as these flows pass over the tundra.

ECCC notes that the above statement could be interpreted to mean that the elevated metal concentration of these contaminants (Sulphate, chloride, arsenic, nickel, and selenium) will be deposited in the terrestrial environment, where they may make their way into the aquatic environment. Subsection 36(3) of the federal *Fisheries Act*, administered by ECCC prohibits the discharge of deleterious substances to waters frequented by fish, or to a place where those substances might enter such waters. Therefore, the proponent must ensure that, at all times during the Project, deleterious substances are prevented from entering into fish-bearing waters or any tributaries.

63.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide information on how this seepage would impact the aquatic environment.

63.5 TMAC RESPONSE FOR ECCC-4.3.3

When the Boston closure plan was developed in 2009, an aquatic specialist from Rescan (now ERM) was asked to visit Boston and to provide a preliminary assessment of the ephemeral streams flowing downstream of the Boston camp pad. The ephemeral

streams were no longer flowing, and they were characterized as having no stream channelization, no substrate/stream bed, and no aquatic vegetation. Therefore, they were not considered to be fish habitat. However, the margins of Aimaokatalok Lake, including the mouths of the ephemeral streams were considered to be important fish habitat for ninespine stickleback and other small or juvenile fish. On this basis, the aquatic environment downstream of the Boston camp pad was determined to be the confluence of the ephemeral streams and the lake, and not within the ephemeral stream channels.

The objective of the water and load balance was to assess the potential impacts of seepage from ore and waste rock at key locations downstream of the site, including ephemeral streams of the stockpile area and specific areas of Aimaokatalok Lake (Appendix B of SRK 2009). The water and load balance concluded that seepage that reports to the lake is effectively diluted and predicted concentrations are close to background levels.

Ephemeral streams monitoring was initiated in 2009 and is conducted annually. Results are compared to the water and load balance predictions to assess for changing trends in the context of adaptive management. To date, monitoring indicates that water quality monitoring data are consistent with the ephemeral streams predictions from the water and load balance predictions and that there are therefore no projected impacts to the receiving environment.

References:

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

64. ID #ECCC-4.3.4

64.1 SUBJECT/TOPIC

Monitoring Intervals

64.2 REFERENCES

- Volume 1 Annex V1-7 Type A Water Licence Applications
- Package P4-12: Hope Bay Project Water and Ore/Waste Rock Management Plan for Boston Site
- Executive Summary - Monitoring and Verification Plans and
- 5 Verification and Monitoring Plans

64.3 ISSUE

The proponent states that the geochemical characterization of waste rock and ore materials has indicated that all waste rock and most of the ore is non-acid generating (SRK 2009b - Supporting Document A). Some of the ore was classified as having an uncertain potential for Acid Rock Drainage (ARD). To monitor the oxidation of the ore, a survey of rinse pH and conductivity will be completed every ten years as well as seepage monitoring, discharge monitoring, and ephemeral stream monitoring.

ECCC is of the view that a 10 year interval to conduct monitoring is not adequate since any environmental impact that would occur would not be easily detected in time for any effective mitigation.

ECCC recommends that a shorter monitoring interval be implemented as a more effective way to detect any environmental issues that could occur and to allow for more timely adaptive management responses.

64.4 RECOMMENDATIONS

ECCC recommends that a shorter monitoring interval be implemented as a more effective way to detect any environmental issues that could occur and to allow for more timely adaptive management responses.

64.5 TMAC RESPONSE FOR ECCC-4.3.4

The objective of the rinse test survey is to determine the development of locally acidic conditions within the stockpiles. In 2008, all ore stockpiles (including those classified as

uncertain) were non-acidic, owing to the high levels of buffering capacity in the Boston stockpiles. Minimum values of total inorganic carbon (or carbonate) and modified neutralization potential are 186 and 135 kgCaCO₃/t, respectively. The frequency of monitoring is suitable given the appreciable availability of buffering capacity within the overall stockpiles and slower rates of mineral weathering in arctic climates.

Annual monitoring conducted as part of the Boston closure plan includes the seepage and ephemeral streams monitoring. Seepage samples are collected at the toe of the camp pad and provide data for source concentrations from the waste rock and ore. The annual seepage monitoring data therefore provides a direct measurement of the water quality from the camp pad and ore stockpiles. Also, as discussed as part of the response to ECCC-4.3.3, ephemeral streams monitoring data are compared to the results of the water and load balance in the context of adaptive management. The annual seepage and ephemeral stream monitoring programs are of sufficient frequency to effectively detect any environmental issues that could occur and allow for adaptive management responses.

65. ID #ECCC-4.3.5

65.1 SUBJECT/TOPIC

Effects Assessment – Freshwater Water Quality

65.2 REFERENCES

- Volume 5, Section 4: Freshwater Water Quality
- Table 4.5-7 – Summary of Effects Screening Results for the Aimaokatalok Watershed
- Appendix V5-4D: Summary of Observed, Predicted Baseline, and Predicted Base Case Water Quality Results for Madrid-Boston Project

65.3 ISSUE

In order to characterize potential effects to freshwater quality from the Madrid-Boston Project, the Proponent completed the following effects assessment screening:

- Predicted concentration is more than 10% greater than the predicted baseline during one or more of the Project phases.
- Predicted concentration is more than 10% greater than the predicted baseline and greater than applicable threshold for one or more of the time- step months.
- Predicted concentration is more than 10% greater than the predicted baseline and greater than applicable threshold for one or more of the time- step months, and is higher than the 95th percentile of observed baseline concentrations.

ECCC disagrees with the order of analysis for the effects determination, specifically, the first step being a comparison of modelled water quality concentrations with the project to modelled baseline concentrations. Modelling carries a high degree of uncertainty which can only be reduced by observed data and completion of a post-audit. By comparing modelled base case project concentrations to modelled concentrations without the project, the associated uncertainty may be quite high. Given that observed data is available for all modelled waterbodies, a more appropriate approach would be to compare modelling to observed baseline data which provide an accurate description of the existing baseline concentrations.

In addition, when observed baseline concentrations are compared to the modelled baseline concentrations the modelled baseline is often higher than the observed baseline, at times by an order of magnitude. While ECCC acknowledges that the modelled baseline is a prediction of the state of the water bodies into the future without

the project and accounts for natural variability and climate change, the differences in certain parameters between observed and predicted baseline may indicate that the model is not a good fit.

For example, as per Appendix V5-4D2, mercury in the Eastern Arm of Aimaokatalok Lake has a median observed baseline concentration of 0.0000008 mg/L and a 95th percentile concentration of 0.000005 mg/L, both well below the CCME water quality objective of 0.000026 mg/L. The predicted modelled baseline has a median mercury concentration of 0.000027 mg/L and a maximum of 0.00004 mg/L, exceeding the CCME water quality objective of 0.000026 mg/L. This is a considerable difference in mercury concentration to be attributed to climate change and natural variability alone. When mercury in the Eastern Arm of Aimaokatalok Lake is assessed through the effects assessment since the predicted concentrations with the project (median – 0.000026 mg/L, maximum – 0.00004 mg/L) are not 10% greater than the predicted baseline, the parameter has not been carried through the effects assessment, even though the predicted concentration with the project is >10% higher than observed baseline. If the predicted concentration was first compared to the observed baseline, it would become apparent that a 32x increase was predicted to occur compared to observed baseline that the CCME water quality guideline was predicted to be exceeded, and that mitigation and/or management may be required.

65.4 RECOMMENDATIONS

ECCC recommends the freshwater water quality effects assessment be re-run in such a way that compares predicted concentrations to observed baseline first, and then proceeds with the effects assessment in order to ensure that parameters with the potential to increase due to the Project are not overlooked as an artifact of the model.

65.5 TMAC RESPONSE FOR ECCC-4.3.5

TMAC stands behind the approach to first compare predicted base case water quality modelling results to predicted baseline since the effects of the Project are built off of the predicted baseline values and it is a standard first approach for water quality effects assessments. A key flaw comparing base case predictions to observed data is it has the potential to identify parameters of concern that are solely due to model artifacts, such as conservative climate change assumptions that are accounted for by comparing base case to predicted baseline results. This is particularly important for this FEIS assessment since the predicted baseline and base case water quality modelling results were strongly influenced by climate change inputs (Package 5-4).

For the specific example of mercury, the only predicted increases are during the post-closure period and are five percent or less. The magnitude of predicted increase from the modelled post-closure baseline (i.e., 0.000001 mg/L), if applied to observed baseline, is insufficient to exceed the CCME water quality objective of 0.000026 mg/L, even if the

magnitude of change is increased by an order of magnitude (i.e., 0.00001 mg/L) to account for the difference between modelled and observed baseline concentrations.

66. ID #ECCC-4.3.6

66.1 SUBJECT/TOPIC

Necessity of the Site Specific Water Quality Objective for Copper

66.2 REFERENCES

- Volume 5, Section 4 – Freshwater Water Quality
- Section 4.5.1.3 – Site Specific water quality objective for Copper
- Table 4.5-6 – Predicted Water Quality Concentrations in the immediate Aimaokatalok Lake receiving environment related to the Boston Combine WTP-STP Discharge
- Appendix V5-4C – Hope Bay Copper Site Specific water quality objective
- Appendix V5-4D1 – Summary of screening effects to water quality in Stickleback Lake
- Appendix V5-4D4 - Summary of screening effects to water quality in Windy Lake

66.3 ISSUE

The Proponent has indicated they would prefer to apply a site specific water quality objective (SSWQO) for copper of 0.009 mg/L, rather than apply the CCME guideline of 0.002 mg/L. This request is based on the following rationale:

1. Copper is naturally elevated above CCME water quality guidelines in certain waterbodies within the Madrid-Boston project area.
2. The Water and Load Balance predicts that copper concentrations will become elevated above baseline concentrations in Doris Creek, Wolverine Lake, and Stickleback Lake.

The Proponent chose to use a Water Effect Ratio (WER) procedure to develop a site specific guideline to account for the increases in the impacted creeks, rather than a Background Procedure to account for naturally elevated copper concentrations. The Proponent derived the SSWQO of 0.009 mg/L and used it for characterization of effects for all water bodies in the Madrid-Boston Project.

As stated by the Proponent, “for the characterization of potential effects to freshwater quality, the base case predictions of the Water and Load Balance model were screened against the predicted baseline concentrations, the assessment thresholds, and the range of observed baseline conditions. The assessment against predicted baseline was included because of the inclusion of climate change and lake evaporation into the

model, as well as to provide an efficient conceptual screen between the effects of the Project Activities and the environment without the Project (predicted baseline)."

When the observed baseline versus predicted baseline is analyzed, it appears that the model is a good fit for Doris Creek (concentrations of observed and predicted baseline are comparable). However, ECCC notes significant differences between the observed and predicted baseline copper concentrations in Stickleback Lake and Wolverine Lake.

For example, the copper concentrations listed below (taken from Appendix V5- 4D) show the range of median copper concentrations that would be expected over life of mine (construction through post-closure).

Water Body	Observed (median values)	Predicted Baseline(Median values)	Predicted Base Case (Median values)
Stickleback Lake	0.00041 mg/L (open water) – 0.00057 mg/L(ice)	0.00127 mg/L (open water) – 0.00286 mg/L (ice)	0.00134 mg/L (open water) – 0.00477 mg/L (ice)
Wolverine Lake	0.0007 mg/L (open water) – 0.0008 mg/L (ice)	0.0017 mg/L (open water) – 0.0038 mg/L (ice)	0.0017 mg/L (open water) – 0.0044 mg/L (ice)
Doris Creek	0.0015 mg/L (open water)	0.00149 mg/L – 0.00155 mg/L (open water)	0.00153 mg/L – 0.00181 mg/L (open water)

In Stickleback Lake and Wolverine Lake the observed median baseline concentrations are below the CCME water quality objective, however, the predicted baseline (median) concentrations approach and even exceed the CCME water quality objective (an order of magnitude difference). These differences between observed and modelled baseline concentrations potentially indicate that the model is not a good fit, as it would be expected that the predicted baseline copper concentrations would be comparable to the observed baseline concentrations.

In addition, while the copper concentrations in Stickleback and Wolverine Lakes are quite different between the observed baseline and the predicted baseline, the concentrations are quite similar between the predicted baseline and the predicted base case.

ECCC questions the necessity for a copper SSWQO given that it appears that the modelling may be artificially inflating the predicted baseline copper concentrations and

potentially the predicted base case predictions. Several lakes in the Madrid-Boston project area do have naturally elevated copper concentrations and a Background Procedure approach may be appropriate for those lakes; however, given the abnormally high predicted baseline concentrations in relation to copper in the observed baseline, additional justification for a SSWQO in these two impacted lakes is required.

66.4 RECOMMENDATIONS

ECCC recommends that the Proponent quantify and discuss the drivers behind the differences between observed baseline and predicted baseline in Stickleback Lake and Windy Lake.

ECCC recommends that the Proponent provide rationale and discussion on the certainty associated with the predicted base case copper concentrations.

ECCC recommends that the Proponent provide rationale for the necessity of a SSWQO given the additional details provided in the first two points.

66.5 TMAC RESPONSE FOR ECCC-4.3.6

A SSWQO for copper was used as an assessment threshold for the FEIS freshwater water quality assessment largely because the water quality modelling showed the predicted base case copper concentrations in Wolverine and Stickleback lakes were above the CCME minimum guideline of 0.002 mg/L for most of the project's life and the predicted base case concentrations were greater than 10% of the predicted baseline concentration in each lake (>20% for Wolverine Lake; >80% for Stickleback Lake). However, TMAC acknowledges that the modelled baseline copper concentrations were several fold greater than observed concentrations in Wolverine and Stickleback lakes, and that likely lead to inflated predicted base case concentrations. Thus, TMAC has re-considered its position of adopting a copper SSWQO for the Madrid-Boston Project, and will instead monitor potential changes to copper in the Project lakes through the AEMP. If copper levels increase significantly over time in a Project lake relative to the reference condition, and increase to 75% of the hardness-dependent CCME water guideline, the development of an SSWQO could be considered as a medium or high action level response through the Aquatic Response Framework within the AEMP (currently being revised).

67. ID #ECCC-4.3.7

67.1 SUBJECT/TOPIC

Arsenic Site Specific Water Quality Objective

67.2 REFERENCES

- Volume 5, Section 4 – Freshwater Water Quality
- Section 4.5.1.2 – Site Specific Water Quality Objective for Arsenic
- Table 4.5-6
- Package 5-4: Hope Bay Water and Load Balance Report

67.3 ISSUE

The modelling provided by the Proponent suggests that arsenic concentrations in Doris Creek during post-closure are expected to rise above baseline concentrations (0.00029 mg/L) and the CCME water quality guideline (0.005 mg/L). The increase is identified as an effect of restoring the natural Tail Lake Catchment through the TIA.

Total arsenic concentrations in Doris Creek in the base case modelling scenario are predicted to be an average concentration of 0.0042 mg/L (open water) and a maximum of 0.01 mg/L (under ice). The upper case modelling scenario predicts concentrations to be an average of 0.0052 mg/L (open water) and a maximum of 0.012 mg/L (under ice). Based on these results, the Proponent has indicated that they would use a site specific water quality objective of 0.028 mg/L that was developed for a site with similar Arctic habitat for the characterization of effects of the Madrid-Boston Project.

ECCC has several comments regarding the application of the SSWQO of 0.028 mg/L to Doris Creek during post closure and its use as a site-wide SSWQO.

1. The arsenic SSWQO of 0.028 mg/L that is referenced was developed for the Back River Project. However, the Proponent has referenced the February 2017 version of that document, which established an arsenic water quality guideline of 0.028 mg/L. This value underwent further scrutiny and was amended to exclude an ecologically irrelevant amphibian species and to ensure protectiveness of zooplankton. After this review a concentration of 0.025 mg/L was agreed upon by the parties as being more appropriate to that particular site.
2. The proposed objective is over 2 times higher than the maximum modelled concentrations of the post-closure upper case in Doris Creek and 77 times higher than the baseline upper case. While a similar SSWQO may have been deemed

appropriate for a similar Arctic site, given the predicted concentrations, the SSWQO could be reduced to reflect reasonably achievable levels.

3. ECCC questions the necessity of a site specific water quality objective given that exceedances of CCME are only anticipated in maximum under ice, and upper case predictions. The highest predictions for total arsenic in Doris creek are still half of the threshold that is being proposed.
4. Given that the exceedances of the water quality objective are only anticipated to occur during the post-closure period the Proponent should investigate additional measures which could be used to reduce releases of arsenic prior to closure, to meet closure objectives and reduce environmental impacts during the post-closure period.

67.4 RECOMMENDATIONS

ECCC recommends that the SSWQO of 0.028 mg/L be reconsidered as ECCC notes that it is higher than accepted values at comparable projects.

ECCC recommends that the Proponent discuss a reasonably achievable SSWQO compared to predicted concentrations given that the proposed SSWQO is over 2x higher than the maximum predicted arsenic concentration.

ECCC recommends that the Proponent discuss how closure objectives will be achieved given the exceedances that are predicted during the post-closure period as well as discuss potential mitigation measures that could reduce the arsenic concentrations prior to closure and during the post-closure phase.

67.5 TMAC RESPONSE FOR ECCC-4.3.7

TMAC has re-considered applying an SSWQO for arsenic at this early juncture of the Madrid-Boston Project. Instead, it will monitor potential changes to arsenic in the Project lakes through the AEMP. If arsenic levels increase significantly over time in a Project lake relative to the reference condition, or increase to 75% (0.00375 mg/L) of the CCME water guideline (0.005 mg/L), the development of an SSWQO could be considered as a medium or high action level response through the Aquatic Response Framework within the AEMP (currently being revised). TMAC re-considered this position because increases in arsenic above the CCME guideline are only predicted for Doris Creek for approximately one month per year during post closure and the maximum predicted concentrations for the rest of the Project lakes are less than 50% the CCME guideline during all Project phases (Appendix V5-4D) and are therefore safe for aquatic life. It is also likely the maximum arsenic concentrations in Doris Creek during post closure are overestimated. This is because during the water quality modelling exercise (Package P5-4) the TIA overflow was conservatively routed directly to Doris Creek instead of to northern Doris Lake (which is the actual pathway) where arsenic would be reduced before flowing into Doris Creek.

Nonetheless, from a water quality effects standpoint, the maximum arsenic concentration modelled in Doris Creek during post-closure (0.00999 mg/L) is far below the 0.019 mg/L arsenic SSWQO recommended by the KIA (see KIA-FEIS-17) and the 0.025 mg/L agreed to for the Back River Project, both of which implicitly consider toxicological information to create thresholds safe for aquatic life. Given the uncertainty of the modelling results in Doris Creek and these previously developed SSWQOs, this would be considered an infrequent, low to moderate magnitude residual effect using the assessment criteria outlined in Table 4.5-12 of the FEIS water quality assessment (Volume 5, Chapter 4), and would not result in significant effects in Doris Creek, and more broadly, in other lakes in the Madrid-Boston Project area.

Although TMAC will investigate additional measures that could be implemented to reduce arsenic releases, TMAC anticipates that closure objectives can be met based on FEIS predictions, which are well below the aquatic health chronic effects threshold developed for the Back River Project. Project-specific information will continued to be collected by TMAC during operations that will confirm if closure objectives are on target, and can be used to refine future predictions for post-closure and future mitigation, if necessary.

68. ID #ECCC-4.3.8

68.1 SUBJECT/TOPIC

Fish Sampling

68.2 REFERENCES

- Package 4-18: Hope Bay Project Aquatic Effects Monitoring Plan
- Package 5-4: Hope Bay Water and Load Balance Report

68.3 ISSUE

Fish tissue testing is required under the *Metal Mining Effluent Regulations* (MMER) if any effluent sample contains greater than 0.0001 mg/L of total mercury. In the Water and Load Balance (Appendix C-1) the maximum mercury concentration is 0.0002 mg/L, and if reached would require fish tissue testing. In addition, if the concentration of effluent in Aimaokatalok Lake is greater than 1% in the area located within 250 meters of the final discharge point, a fish population study will also be required. However, no details on potential fish sampling are provided in the Aquatic Effects Monitoring Program (AEMP.)

Based on the effluent modelling results for Boston Mine it is likely that fish tissue testing will be required within Aimaokatalok Lake. The required fish tissue testing can be completed using non-lethal methods via a dermal punch or a biopsy needle. ECCC notes that the current AEMP provides no details on the potential requirement for fish tissue testing or fish sampling locations or species.

68.4 RECOMMENDATIONS

ECCC recommends that the Proponent complete fish tissue sampling prior to mine development. This information would then be used in future determination of effects to fish and in development of a study design. Consideration should also be made for the selection of sampling locations and a sample species. Key considerations in selection of fish species are the mobility and residence time of that species, as this determines effluent exposure.

68.5 TMAC RESPONSE FOR ECCC-4.3.8

Fish tissue sampling was conducted in Aimaokatalok Lake and reference lakes as part of freshwater fish and fish habitat baseline studies in 2009 and 2010; fish community and biology data were collected as part of these surveys (Rescan 2010 and 2011). Table 1 summarizes baseline sampling conducted in 2009 and 2010. This information may be used

in development of a study design should one be triggered under the MMER and may also be useful for the future determination of effects to fish.

Under the MMER, the first study design for biological monitoring studies, including fish population and tissue studies, is not required to be submitted until 12 months after the mine becomes subject to Environmental Effects Monitoring (Schedule 5 of MMER). Because discharge is not expected to occur for at least another two years, TMAC has sufficient time to develop a study design that incorporates fish sampling, as deemed necessary.

Table ECCC-4.3.8 – Baseline Fish Sampling in Aimaokatalok and Reference Lakes, 2009 and 2010

Sampling Year	Lake	Fish Community		Fish Biology	Lake Trout Tissue*
		Gillnet	Hydroacoustic		
2009	Reference Lake A	X	-	X	N = 10
2009	Reference Lake B	X	-	X	N = 10
2010	Reference Lake B	X	-	X	-
2010	Reference Lake D	X	-	X	N = 11
2010	Aimaokatalok Lake	X	X	X	N = 13

Dashes = sampling not conducted

*Tissue = analysis of 25 metals including mercury on muscle and liver tissues

References:

Rescan. 2010. *2009 Freshwater Fish and Fish Habitat Baseline Report, Hope Bay Belt Project*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.; Vancouver, BC.

Rescan. 2011. *Hope Bay Belt Project: 2010 Freshwater Fish and Fish Habitat Baseline Report*. Prepared for Hope Bay Mining Limited by Rescan Environmental Services Ltd.; Vancouver, BC.

69. ID #ECCC-4.3.9

69.1 SUBJECT/TOPIC

Sediment Sampling

69.2 REFERENCES

- P4-18: Hope Bay Project Aquatic Effects Monitoring Plan

69.3 ISSUE

The parameters listed for sediment quality analysis of effects include % moisture, pH, particle size, total nitrogen, total organic carbon, total arsenic, total cadmium, total chromium, total copper, total lead, total mercury, and total zinc.

Sediment phosphorus release (internal loadings) can be an important source of phosphorus and can maintain phosphorus concentrations in the water column even in the absence of further external loads. Exchange of phosphorus across the sediment-water interface is regulated by redox interactions which are dependent on oxygen supply and various other factors. Under aerobic conditions (open water) the exchange is largely from the water to the sediments, while under anaerobic (typically under ice) conditions, total phosphorus can be released from the sediments to the overlying waters potentially causing adverse effects to the aquatic ecosystem such as alteration of trophic status.

69.4 RECOMMENDATIONS

ECCC recommends that total phosphorus in sediments be analyzed to evaluate changes in total phosphorus that may be released to the overlying waters during periods of low dissolved oxygen. This parameter should be included in any additional baseline collected prior to mine development as well as be included in the monitoring suite during operations.

69.5 TMAC RESPONSE FOR ECCC-4.3.9

TMAC does not feel measuring total phosphorus in the lake sediments is necessary for the AEMP for a few reasons. First, if low under-ice oxygen concentration resulted in an efflux of phosphate from the sediments to the overlying water column, this effect would be captured in the deep water total phosphorus measurements during the annual under-ice, April sampling period. This would then be subjected to a statistical evaluation to determine if TP concentrations were increasing over time relative to a reference lake.

Second, measuring sediment phosphate levels in summer (when the sediments samples are collected) does not necessarily provide a direct link to under-ice TP water concentrations, as the sediment flux is influenced by oxygen availability and the natural variation of biophysical and biogeochemical processes. Third, the analytical laboratory ALS Environmental that has been historically used for the Hope Bay Belt sediment analyses does not have specific test for sediment total phosphorus (Amber Springer, ALS, personal communication). Rather, ALS measures sediment phosphorus using a strong acid digestion followed by ICPMS (EPA method 200.2) which measures all sediment phosphorus including the mineral fraction that is not bioavailable. ALS is also capable of measuring 'plant available' sediment phosphate (primarily ortho reactive phosphorus) which is a procedure for soil analysis and is fraught with poor and variable detection limits that are not suitable for a long-term effects analysis.

It is understood that monitoring for parameters that are indicators of potential increases in lake productivity are a critical part of the Madrid-Boston AEMP. There are several parameters beyond sediment total phosphorus that will evaluate potential changes to lake trophic status including total organic carbon (TOC), total nitrogen, and benthic invertebrate descriptors in the sediments as well as TP, nitrogenous compounds, TOC, and chlorophyll a concentrations in the water column.

70. ID #ECCC-4.3.10

70.1 SUBJECT/TOPIC

Aquatic Effects Monitoring Plan Development

70.2 REFERENCES

- Package P4-18 Hope Bay Project Aquatic Effects Monitoring Plan

70.3 ISSUE

Monitoring of the aquatic effects of the Madrid-Boston Project must be sufficiently robust to detect changes before they become impacts, to verify FEIS predictions, and to inform adaptive management.

ECCC has reviewed the proposed Madrid-Boston Aquatic Effects Monitoring Plan (AEMP) and has identified a number of aspects which require clarification.

1. The study design descriptions make reference to MMER-EEM monitoring and non-MMER-EEM monitoring. It is not clear why the programs are not fully integrated and described in this document for clarity and completeness.
2. Non-MMER-EEM monitoring will use a Before-After-Control-Impact (BACI) study design and proposes to monitor and evaluate only parameters which have CCME guidelines for potential effects. The full suite of parameters sampled should be evaluated for water and sediments, with focus subsequently shifting to parameters of potential concern if warranted based on monitoring data.
3. The MMER-EEM sites in Aimaokatalok Lake are set up as a multiple gradient study design, but for water quality it is not clear how the statistical analysis will be done. It appears to be set up as a Before-After comparison, but the gradient design would be suited to regression or ANCOVA analysis. Sampling stations for 1a and 1b are 50 m from the discharge, and the next sample stations are 250m then 750 m and 1500m from the diffuser in two directions. Plume delineation modeling should be referenced to support that spacing. A continuum of sampling stations is needed along the exposure gradient, and it is not clear that sampling will be done sufficiently close to the discharge to characterize effects in the near field. In addition, the sediment and benthic samples to be collected from these sites are proposed to consist of a single grab sample (Section

3.2.4 Benthos) which will be used to evaluate potential changes in benthos. This sampling effort would not meet the guidance provided by the MMER-EEM

program, nor would it be comparable to data collected previously or at other sites.

4. There are other details on monitoring and sampling methodology that raise questions. For example, ECCC has concerns with collection of three versus the recommended five sediment samples per station. Fish monitoring has been omitted from the AEMP and deferred to the MMER- EEM; this should be integrated and presented in both programs.
5. Monitoring results should be linked to a response framework which sets thresholds for change to trigger mitigation actions.

70.4 RECOMMENDATIONS

ECCC recommends that:

- The Proponent further develop the details of the AEMP
- Both the AEMP and MMER-EEM monitoring programs should be harmonized to the extent possible, and details provided on the MMER- EEM program. Where there is overlap between the two programs, data should be combined for presentation (e.g. water sample data for two seasons under the AEMP with the additional two sampling times under the EEM) and evaluation. This will improve the characterization of variability and increase the dataset used for statistical analysis.
- For non-MMER-EEM monitoring, a full suite of parameters sampled be evaluated for water and sediments, with the focus shifting to parameters of potential concern if warranted based on monitoring data.
- For MMER-EEM Sites in Aimaokatalok Lake clarity around how statistical analysis will be undertaken should be included. It is recommended that a continuum of sampling stations is needed along the exposure gradient, and that sampling will be done sufficiently close to the discharge to characterize effects in the near field
- Monitoring results be linked to a response framework which sets thresholds for change to trigger mitigation action.

70.5 TMAC RESPONSE FOR ECCC-4.3.10

- Acknowledged. TMAC will update the Madrid-Boston AEMP with an Aquatic Response Framework similar to the approach taken for the Doris AEMP. The updated AEMP will be provided to the interested parties prior to the May Final Hearing in Cambridge Bay.
- Acknowledged. TMAC will improve the harmonization between the AEMP and MMER programs in the updated Madrid-Boston AEMP.

- For non-MMER water and sediment quality parameters, the Madrid-Boston AEMP will take the approach as the approved Doris AEMP where CCME parameters and accompanying toxicity modifying factors are statistically evaluated for potential project effects. Several other non-CCME parameters (e.g., calcium, sodium, conductivity, total dissolved solids, sulphate, and other metals) will also be analyzed and will be reported in the appendices of the annual AEMP report. These parameters could be evaluated under the Aquatic Response Framework if deemed necessary.
- The updated Madrid-Boston AEMP will improve the clarity of the statistical approach regarding the MMER design in Aimaokatalok Lake and will revisit the sample sites within gradient design as informed by the hydrodynamic modelling carried out for the FEIS.
- Acknowledged. TMAC will update the Madrid-Boston AEMP with an Aquatic Response Framework with environmental thresholds that trigger further mitigation/information collecting similar to the approach taken for the Doris AEMP. The updated AEMP will be provided to the interested parties prior to the May Final Hearing in Cambridge Bay.

71. ID #ECCC-4.3.11

71.1 SUBJECT/TOPIC

In-Water Works – Cargo Dock Construction

71.2 REFERENCES

- Volume 5, Section 8: Marine Water Quality
- Section 8.5.4.2 – Site Preparation, Construction, and Decommissioning
- Package 5-10: Hope Bay Cargo Dock Preliminary Design

71.3 ISSUE

The proposed construction of the cargo dock in Roberts Bay will include disturbance to the marine environment due to the in-water works. This disturbance has the potential to suspend sediments causing increases in concentrations of total suspended solids (TSS) and metals in the water column of Roberts Bay. The Proponent states that disturbance will likely be limited to the dock footprint and that monitoring and adaptive management of in-water construction through the *Fisheries Act* Authorization will limit turbidity levels during construction.

The preliminary design for the cargo dock references the use of a silt curtain around the cargo dock, which will remain in place throughout construction. However, neither the preliminary design nor the FEIS indicate how monitoring will occur such that any potential impacts to Roberts Bay will be detected and mitigated nor does it explain how any mitigation may be put in place while considering the effects of tidal action. Details on these potential impacts, monitoring, and mitigation measures should be provided in the environmental assessment stage such that all potential impacts to Roberts Bay are identified.

In addition, while the preliminary cargo dock design indicates that cargo dock construction will be completed in the open water period, there is no detail regarding the construction timeline and the length of time required for in-water construction.

71.4 RECOMMENDATIONS

ECCC recommends that the Proponent provide details on proposed monitoring locations and proposed methods for monitoring TSS and turbidity during construction to ensure that the marine environment is protected. This should include any expected impacts on construction and monitoring due to tides.

ECCC recommends that the Proponent provide details on the construction timeline including length of time for in-water construction.

71.5 TMAC RESPONSE FOR ECCC-4.3.11

TMAC will develop a monitoring program for TSS to the satisfaction of DFO, should DFO require the program as part of any DFO authorization that may be issued post project approval.

TMAC expects the in-water construction of the cargo dock to take approximately 2 months such that construction will be completed in the open water period.

72. ID #ECCC-4.3.12

72.1 SUBJECT/TOPIC

Post-Audit of Water Quality Modelling

72.2 REFERENCES

- P4-19: Hope Bay Project Boston Conceptual Closure and Reclamation Plan
- P4-21: Hope Bay Project Doris-Madrid Interim Closure and Reclamation Plan

72.3 ISSUE

Section 7 of the Conceptual/Interim Closure and Reclamation Plans discusses the data that will be gathered and the potential research that will be undertaken to gain a better understanding of the specific site conditions at the Boston site. The Proponent lists the types of data that will be collected through their various monitoring programs and indicates that if any of the data is found to be indicative of a problematic trend of unforeseen processes that a more detailed evaluation be undertaken. The Proponent identifies the updating of predictive models to be used as adaptive management to refine closure requirements.

As the majority of the water management on site relies on modelling data, the verification of the accuracy of this modelling data is an important step to reduce uncertainty during the life of the project. Ongoing audits of modelling predictions should be completed for effluent discharges at the Marine Mixing Box and Boston Mine, and water quality in Roberts Bay and Aimaokatalok Lake at specific points within mine life relating to key mine events. Auditing will provide valuable information to verify the accuracy of predictions, identify and explain differences, improve future models, reduce uncertainties, and adaptively manage issues. This information is useful not only to refine closure requirements but can inform ongoing operations by identifying potential future environmental issues.

72.4 RECOMMENDATIONS

ECCC recommends that effluent and water quality audits be completed for Roberts Bay and Aimaokatalok Lake at specific time intervals relating to major milestones in the Madrid-Boston Project. ECCC recommends that modelling audits be completed at a minimum every 3-5 years.

72.5 TMAC RESPONSE FOR ECCC-4.3.12

TMAC maintains that the updating of predictive models will be used as adaptive management to refine closure requirements. This will include the updating of predictive models for Roberts Bay and Aimaokatalok Lake. Specific details for the predictive model re-calibration frequency and scope will be determined in the water licensing stage.

73. ID #GN-01

73.1 DEPARTMENT

Department of Culture and Heritage

73.2 ORGANIZATION

Government of Nunavut

73.3 SUBJECT/TOPIC

Discovery of Human Remains

73.4 REFERENCES

- FEIS, Annex Vol.8-6, s. 3.4, p.14 - Guidelines for Effects Management
- GN Department of Culture and Heritage - Human Remains Policy

73.5 SUMMARY OF PROPONENT'S CONCLUSIONS

In s.3.4 of Annex Vol.8-6, the Proponent provided that if human remains are encountered, the Proponent will contact/consult the RCMP, coroner, physical anthropologist, Inuit Heritage Trust, and representatives of local communities.

73.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

In accordance with the Department of Culture and Heritage's Human Remains Policy, where human remains are encountered during the course of a land use operation, the Proponent is also requested to contact the Territorial Archaeology office to seek appropriate assistance and advice in order to determine the correct course of action.

73.7 REVIEWER'S RECOMMENDATIONS

If human remains are encountered during any land use operations, the Proponent shall immediately contact the Territorial Archaeology office and the RCMP for guidance.

73.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Condition:

The Proponent shall immediately contact the Government of Nunavut's Territorial Archaeology Office and the RCMP following the discovery of any human remains.

73.9 TMAC RESPONSE FOR GN-01

The reviewer has identified an error. That paragraph should have stated:

"The following procedures will be implemented by TMAC personnel if any cultural or human remains are observed during any ground disturbing actions:..."

The first step listed in those procedures is that the Territorial Archaeologist will be contacted. The RCMP was meant to be a second, additional contact for human remains only.

Further evidence that this was an isolated editorial error can be seen in the following statements later in this same document.

In the last paragraph of 5. Procedures Summarized on page 39 it is stated:

"In the unlikely event of an accidental negative effect to either a known or unrecorded archaeological, burial or heritage site, all work in the vicinity of the find will cease and the Operational Procedures outlined above and presented in Appendix A will be followed. The Territorial Archaeologist of the Government of Nunavut will be notified and a qualified archaeologist will assess the incident."

This is the procedure further stated in Appendix A1 Construction Operational Procedures.

The intent always was to direct that the Territorial Archaeologist must be contacted for any cultural or human remains issues that may arise during construction or operations.

74. ID #GN-02

74.1 DEPARTMENT

Department of Culture and Heritage

74.2 ORGANIZATION

Government of Nunavut

74.3 SUBJECT/TOPIC

Site Typology

74.4 REFERENCES

- FEIS, Main Report, Vol.6, s.2, Table 2.2-1 - Archaeology
- FEIS, Annex Vol.8-6, Table 4.1 - Archaeology
- FEIS, Annex Vol.8-6, Hope Bay Project Heritage Resources Protection Plan

74.5 SUMMARY OF PROPONENT'S CONCLUSIONS

With regard to site type classification (typology), the Proponent has agreed to revise the FEIS to include information that was provided in the site forms submitted to the GN for all sites recorded on the Hope Bay Project.

The relevant sections of the FEIS are Vol.6, s.2, Table 2.2-1 and Annex Vol.8-6, Table 4.1.

74.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

While the Proponent revised Table 4.1 of Annex Vol.8-6 of the FEIS, the Proponent has not revised Table 2.2-1 of Vol.6, s.2 of the FEIS.

74.7 REVIEWER'S RECOMMENDATIONS

The GN recommends that typology in Table 2.2-1 of Vol.6, s.2 of the FEIS be revised to conform with Table 4.1 of Annex Vol.8-6 of the FEIS.

74.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following commitment be formally recognized by the Proponent

before the close of the Final Hearing:

The Proponent shall update Table 2.2-1 of Vol.6, s.2 of the FEIS to align with the data listed in Table 4.1 of Annex Vol.8-6 of the FEIS.

74.9 TMAC RESPONSE FOR GN-02

This comment is editorial in nature and is focused on semantics. Table 2.2-1 is simply a convenient summary of the contents of the recorded sites. Since this document is a final environmental impact statement, revising this table will not change the results impact assessment. Regardless of what terms we apply to the recorded cultural features, they will be treated in the same manner. Sites would be mitigated (if required and only after regulatory approvals) based on the site content and physical evidence present, not based on the typology. We will provide more functional identifications where possible in our future references to the sites.

75. ID #GN-03

75.1 DEPARTMENT

Health

75.2 ORGANIZATION

Government of Nunavut

75.3 SUBJECT/TOPIC

Sexual Health and Sexual Health Education

75.4 REFERENCES

- FEIS, Main Report, Vol.6, s.3 – Human Environment, Socio- economics
- TC-GN-03 Technical Comment Response
- Proponent's TC-GN-03 Technical Comment Response
- Pre-Hearing Conference Decision Report, Annex D: List of Commitments Generated during the Technical Meeting and Pre- hearing Conference for the Phase 2 Hope Bay Belt Project Proposal and the Water Licence Application, p.3

75.5 SUMMARY OF PROPONENT'S CONCLUSIONS

While a specific analysis of sexual health trends in the Kitikmeot region was not included in the Proponent's FEIS, the Proponent did note that the health status of Kitikmeot residents requires further improvement to be on par with that of the general Canadian population (FEIS, Main Report, Vol.6, s.3, pp. 3-86).

In the FEIS, the Proponent has committed to “engage with the GN on the topic of sexual health, and will include sexual health awareness as part of worker orientation for employees and contractors, and will provide on-site access to contraceptives” (FEIS, Main Report, Vol.6, s.3, pp. 3-120).

During the DEIS review period, the Proponent committed to “have dialogue with the Government of Nunavut on the topic of sexual health, including education and awareness materials, sexual health data to consider in the FEIS, and sexually transmitted infections (STIs) testing” (TC-GN-03 Technical Comment Response).

75.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Anecdotes regarding similar mining projects in the territory indicate that a variety of sexual interactions likely occur between employees at the project sites.

75.7 REVIEWER'S RECOMMENDATIONS

The Proponent has committed to engage with the GN on the topic on sexual health and sexual health awareness in its FEIS. The GN requests the Proponent fulfill this commitment.

75.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following commitments be formally recognized by the Proponent before the close of the Final Hearing:

- i) The Proponent shall update their Occupational Health and Safety Plan to include sexual and well-being information in its employee orientation programming.
- ii) The Proponent shall make screening for sexually transmitted infections readily available at the Project site.
- iii) The Proponent shall undertake an education program to inform workers of the range of health services available on-site.
- iv) The Proponent shall, on a regular and on-going basis, participate in discussions and dialogue with the GN Department of Health in connection with Project activities, policies or Project-induced public health issues which may have effects on health and social services facilities, programs and services.

75.9 TMAC RESPONSE FOR GN-03

- i) TMAC has adopted several policies and implemented practices concerning health, safety, and the overall welfare of people and the environment. TMAC has a Health and Safety Policy which underlines a commitment to the health, safety and well-being of all employees, contractors, visitors and local communities. TMAC has a Fit for Work Program that applies to all employees, contractors and visitors to Hope Bay. The Fit for Work combines testing with education, supervisor training and support for employees. The Fit for Work Program, combined with TMAC's Drug and Alcohol Policy are fundamental to promoting and enhancing workplace safety and protecting the working environment. TMAC fosters a culture of safety by providing

our employees with safety training, appropriate protective equipment and infrastructure, and a system of employee safety monitoring and accountability.

As stated in the FEIS, TMAC remains committed to engage with the GN on the topic on sexual health and sexual health awareness. TMAC will support sexual health awareness and education by providing access to information through the site medics, and will provide on-site access to contraceptives. Access to this information through the site medics will be communicated to workers as part of worker orientation.

In response to the GN Department of Health request for TMAC to update the Occupational Health and Safety Plan, TMAC notes that the current Hope Bay Human Resources Plan describes the orientation for new personnel. This orientation includes topics related to health and wellness in relation to TMAC's Respectful Workplace Policy, health and safety requirements and policies. No further updates are required at this time to the Human Resources Plan or the Health and Safety Management Plan with respect to the topic of sexual health and sexual health awareness. As previously stated, TMAC will support sexual health awareness and education by providing workers access to information. In support of this, TMAC would welcome receiving from the GN Department of Health information and/or materials appropriate to provide orientation-level sexual health and well-being information to workers.

- ii) Recognizing that STIs are a health concern of focus in Nunavut, TMAC is not in agreement with the GN's request that screening for sexually transmitted infections (STIs) be readily available at the Project site (proposed commitment ii). This is not a service in which TMAC needs to be or should be involved. The Canadian Guidelines on Sexually Transmitted Infections (Government of Canada, 2018) defines an approach for the prevention, diagnosis, treatment and management of STIs. This guideline includes recommendations for the assessment, counselling, screening, diagnosis and management of STIs, including partner notification and public health reporting. It outlines the required steps for managing the STI assessment process, which include:
- Assessing the reason for a consultation by a patient;
 - Knowing STI risk factors and epidemiology;
 - Conducting patient history and STI risk assessment;
 - Providing patient-centred education and counselling;
 - Performing a physical examination;

- Selecting appropriate screening/testing;
- Diagnosing by syndrome or by organism and post-test counselling;
- Treating;
- Reporting to public health and partner notification;
- Managing co-morbidity and associated risks; and
- Following up.

The guide indicates that selecting the appropriate tests for patients is a crucial step in the diagnosis and management of STIs. Approaches to screen STIs include urine tests, swabs, physical exams and blood tests. The selection and implementation of appropriate tests should be based on patient history, risk factors and findings on physical examination undertaken by a qualified health practitioner.

In line with guidance outlined in the World Health Organization's (WHO) Sexual health, human rights and the law (World Health Organization, 2015) in the field of sexual health, specific training is needed, especially in the area of counselling related to sexuality, and dealing with patients with a non-judgemental and respectful attitude, with sensitivity to gender and human rights dimensions. WHO guidance on core competencies for sexual health emphasizes that all workers at the primary health care level dealing with sexual health must be adequately trained, prepared and supported in their work, and this must be accompanied by a supportive infrastructure and supervision system to ensure that these health workers maintain an adequate level of competence.

As previously noted in this response, and as described in TMAC's Health and Safety Management Plan, TMAC provides on-site first aid facilities and a trained first aid attendant or advanced medical care personnel. The focus of the resources on-site are occupational health and safety. Site-level first aid attendants are not qualified nor do they have the capacity to implement STI screening in a manner that aligns with best practices outlined by Canadian and international standards.

Community research undertaken in 2017 (FEIS Volume 6, Appendix V6-3B) concluded that the local health centres include programs related to sexual health, such as sexual health services and communicable disease services. The community health centers indicated that they typically had sufficient staff to meet the demand, and if more help was needed in specific cases, support would be provided. As such, and in consideration of both the local health centre expertise and resources, as well as in consideration of the privacy of TMAC employees, TMAC considers that STI

screening is more appropriately addressed by community health centres by trained health service providers.

In developing the FEIS, TMAC acknowledges sexual health impact prediction has been hampered by the lack of Government of Nunavut, Department of Health statistics relevant to this subject for the Kitikmeot region. TMAC has made several reasonable attempts to gain this information during the course of this environmental assessment.

As the only public health agency capable of gathering accurate sexual health statistics in the Kitikmeot region, we do not believe it is appropriate for the Government of Nunavut to fault this FEIS for any lack of information or analysis related to this subject. However at the same time, TMAC believes it is not necessary to revert to a reliance on anecdotal and not scientifically-based evidence on sexual health from similar mining projects in the territory in order to predict these types of project impacts at Hope Bay.

The Hope Bay Project has experienced a protracted period of advanced exploration and mine construction over the previous decade. During the past 10 years, and as diligently reported annually as part of the Hope Bay Socio Economic Monitoring Program (SEMP), the Project has engaged a large number of workers including Kitikmeot Inuit. This period provides a wealth of firsthand, baseline information on the actual social contact and interactions between southern and Nunavut workers at Hope Bay over the course of hundreds of person-years of employment. During that period, no specific systemic issues related to sexual health were reported at Hope Bay. Also during this period, health officials, police, community representatives or other participants of the Kitikmeot Socio-Economic Monitoring Committee reported no specific comments or concerns regarding sexual health at Hope Bay.

In the absence of objective data on this subject, these two points provide reasonable subjective assessments of the significance of sexual health to work at Hope Bay, and would provide notice of specific sexual health issues at Hope Bay. As the conditions of work will be the same between the existing Doris Mine and planned Madrid and Boston sites, TMAC asserts there is no reason to believe that sexual health issues would emerge at our operating sites when they have not done so in the past.

Acting cautiously, TMAC is prepared to engage the GN on this subject to ensure that past Hope Bay conditions persist to the future. We are particularly interested in engaging GN on this topic if any information on sexual health trends in the Kitikmeot region could be gathered and shared. However, TMAC is not prepared to institute public health programming at our Sites in response to sexual health at this time.

- iii) The GN has proposed that TMAC develop an education program to inform workers of the range of health services available on-site. TMAC notes that health services available on-site are as described in TMAC's Health and Safety Management Plan, include first aid facilities and a trained first aid attendant or advanced medical care personnel. In order to inform workers of health and safety services on-site, TMAC currently does and will continue to incorporate this information into personnel orientation. Workers are also free to seek out and obtain this information from management and health service personnel on-site. No additional programming is required to inform workers of health services available on-site.
- iv) TMAC reconfirms its commitment to engage with the GN on the topic of sexual health and sexual health awareness . This includes the implementation of a regular and on-going dialogue with the GN Department of Health, which may include topics such as Project activities, policies or Project-induced health issues with may have an effect on health and social services facilities, programs and services.

TMAC notes that In February 2018, TMAC was approached by the GN Department of Economic Development and Transportation to enter into a Memorandum of Understanding (MOU) with the Government of Nunavut in order to promote cooperation, coordination and implementation of joint activities. This MOU, as drafted, would include the formalization of a TMAC-GN committee including representatives from a number of relevant GN departments that would regularly meet and discuss matters of mutual importance. TMAC is willing to consider entering into this MOU and is conducting consultations with the Kitikmeot Inuit Association to discuss how such an MOU could be structured to support the efforts of the Hope Bay IIBA Implementation Committee. If an MOU can be concluded to the mutual satisfaction of TMAC, KIA and the GN, this engagement tool will be included in the Community Involvement Plan.

References:

Government of Canada. 2018. Canadian Guidelines on Sexually Transmitted Infections. Accessible online at: <https://www.canada.ca/en/public-health/services/infectious-diseases/sexual-health-sexually-transmitted-infections/canadian-guidelines/sexually-transmitted-infections.html#toc>

World Health Organization. 2015. Sexual health, human rights and the law. Geneva: Switzerland. Accessed online at: http://apps.who.int/iris/bitstream/handle/10665/175556/9789241564984_eng.pdf;jsessionid=177AF7E54B2A41169B7744F583596481?sequence=1

76. ID #GN-04

76.1 DEPARTMENT

Finance

76.2 ORGANIZATION

Government of Nunavut

76.3 SUBJECT/TOPIC

Economic Impact Model Report Summary

76.4 REFERENCES

- TC-GN-06
- FEIS, Main Report, Vol.6, s.3 – Human Environment, Socio- economics

76.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent acknowledged during the DEIS review that its estimates of territorial tax (namely petroleum tax and payroll tax) for the construction and operation phases of the Project were low. In the FEIS, the Proponent has reassessed the estimates and has also provided tax revenues to be generated on a phase-by-phase basis. Updated estimated tax revenues can be found at Vol.6, s.3, p.121-123 of the FEIS.

76.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The GN conducted comparative analysis of the Proponent's payroll and fuel tax estimates with its own. The GN concluded that estimates in the FEIS are reasonable.

76.7 REVIEWER'S RECOMMENDATIONS

The GN would like for the Proponent to communicate changes regarding territorial tax estimates generated by the Project.

76.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following commitment be formally recognized by the Proponent before the close of the Final Hearing:

The Proponent will communicate to the GN available information on major changes to project- related tax and estimates on an ongoing basis. This communication will not preclude either party from contacting the other to request an updated estimate of territorial taxes.

76.9 TMAC RESPONSE FOR GN-04

TMAC will communicate to the Government of Nunavut (GN) available information on major changes to project- related tax and estimates in the case that any major change occurs, or as needed. TMAC agrees that this communication will not preclude either party from contacting the other to request an updated estimate of territorial taxes.

TMAC notes that In February 2018, TMAC was approached by the GN Department of Economic Development and Transportation to enter into a Memorandum of Understanding (MOU) with the GN in order to promote cooperation, coordination and implementation of joint activities. This MOU, as drafted, would include the formalization of a TMAC-GN committee including representatives from a number of relevant GN departments that would regularly meet and discuss matters of mutual importance. TMAC is willing to consider entering into this MOU and is conducting consultations with the Kitikmeot Inuit Association to discuss how such an MOU could be structured to support the efforts of the Hope Bay Inuit Impact and Benefit Agreement (IIBA) Implementation Committee.

If an MOU can be concluded to the mutual satisfaction of TMAC, KIA and the GN, this engagement tool will be included in the Community Involvement Plan.

77. ID #GN-05

77.1 DEPARTMENT

Economic Development & Transportation

77.2 ORGANIZATION

Government of Nunavut

77.3 SUBJECT/TOPIC

Community Involvement Plan

77.4 REFERENCES

- Pre-Hearing Conference Decision Report, Appendix D: List of Commitments Generated during the Technical Meeting and Pre-hearing Conference for the Phase 2 Hope Bay Belt Project Proposal and Water Licence Application, pp.4-7
- DEIS, Vol.8, Annex 24, Hope Bay Project Community Involvement Plan
- Kent Gustavson, Consultant [TMAC], Personal Communication, January 31, 2018

77.5 SUMMARY OF PROPONENT'S CONCLUSIONS

During the DEIS review period, the Proponent committed to update its Community Involvement Plan (CIP) in the FEIS in response to TC-GN-05, 08, 29, 32.

The Proponent opted to not update the CIP in the FEIS and communicated by electronic communication its reason, stating:

The decision was made that an update to the TMAC Hope Bay Project CIP was not required. The document included in the FEIS is the current version. It is believed that the information currently provided in the CIP and detailed in the FEIS is sufficient to satisfy the spirit and intent of the GN technical comments. The Stakeholder Identification section of the CIP provides a description of how TMAC defines its stakeholders, which includes the GN, and the Stakeholder Engagement section defines the various approaches to engagement.

Specific communication processes, methods and schedule, as well as stakeholder contacts, will be determined as needed and appropriate, based on the issue or initiative in question. The CIP is a 'living document', and revisions may be made at a

later date to ensure that the CIP works as intended and is continually improved. However, it is felt that detailing stakeholder issues/initiatives, schedule of communications, and list of key contacts in the CIP would be soon outdated and not improve the efficacy of engagement. [Personal Communication from Ken Gustavson, Consultant [TMAC], dated January 31, 2018.]

77.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The overarching goal of the CIP is to identify stakeholders that may be impacted by the Project and the means by which the Proponent plans to communicate with them if granted Project Approval.

The GN agrees that the current draft of the CIP satisfies most of the relevant GN technical comments made during the DEIS review phase. The GN recognizes that the Proponent intends for the CIP to be a 'living document'. The GN would like to see the Proponent commit to updating the CIP on an ongoing basis if granted Project Approval.

77.7 REVIEWER'S RECOMMENDATIONS

If granted project approval, the GN would like for the Proponent to update the CIP on an ongoing basis so that the CIP reflects current and relevant stakeholders throughout the life of the Project and outlines updated means of communication to ensure effective communication and continued engagement with all stakeholders throughout the Project lifecycle.

77.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following commitment be formally recognized by the Proponent before the close of the Final Hearing:

The Proponent shall update the Community Involvement Plan on an ongoing basis to ensure the CIP reflects current and relevant stakeholders as well as effective communication and engagement with stakeholders throughout the lifecycle of the Project.

77.9 TMAC RESPONSE FOR GN-05

TMAC will periodically review the Community Involvement Plan (CIP) and, as required, shall update the CIP to ensure that it reflects current and relevant stakeholders, as well as effective communication and engagement methods.

TMAC notes that In February 2018, TMAC was approached by the Government of Nunavut (GN) Department of Economic Development and Transportation to enter into a Memorandum of Understanding (MOU) with the Government of Nunavut in order to promote cooperation, coordination and implementation of joint activities. This MOU, as drafted, would include the formalization of a TMAC-GN committee including representatives from a number of relevant GN departments that would regularly meet and discuss matters of mutual importance. TMAC is willing to consider entering into this MOU and is conducting consultations with the Kitikmeot Inuit Association to discuss how such an MOU could be structured to support the efforts of the Hope Bay IIBA Implementation Committee. If an MOU can be concluded to the mutual satisfaction of TMAC, KIA and the GN, this engagement tool will be included in the CIP.

78. ID #GN-06

78.1 DEPARTMENT

Economic Development and Transportation

78.2 ORGANIZATION

Government of Nunavut

78.3 SUBJECT/TOPIC

Socio-Economic Monitoring

78.4 REFERENCES

- TC-GN-04
- Proponent's TC-GN-04 Technical Comment Response
- FEIS, Main Report, Vol. 6, s.3, pp. 3-112 – Human Environment, Socio-economics
- Doris North Project Certificate [No. 003] Amendment, TC No. 28
- Doris North Project Certificate [No. 003] Amendment, TC No. 40

78.5 SUMMARY OF PROPONENT'S CONCLUSIONS

New Term and Condition No. 40 of the amended Project Certificate [No. 003] for the Doris North Gold Project states that the Proponent will submit an updated Doris North Socio-Economic Monitoring Plan (SEMP) for Hope Bay Socio-Economic Working Group review and comment. Any changes as agreed to by the Hope Bay Socio-Economic Working Group shall be submitted to the NIRB. Furthermore, the updated SEMP is to comply with New Term and Condition No. 40 of the amended Project Certificate [No. 003] for the Doris Project and is expected to apply to the proposed Phase 2 Project.

As stated in the Proponent's TC-GN-04 Technical Comment Response, the Proponent was to modify the SEMP to monitor predicted socio-economic impacts characterized in the DEIS, as well as regional concerns identified by the Kitikmeot SEMC. The Proponent has included an updated SEMP in the FEIS.

The Proponent stated in its Technical Comment Response that all recommended items listed in the GN's TC-GN-04 are consistent with the current practices and commitments

of the Proponent with respect to the Doris Project and the socio-economic monitoring plan for the Phase 2 Project.

78.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

As specified in the GN's TC-GN-04 during the DEIS review phase, the Proponent and its commitment and approach to socio-economic monitoring throughout the life of the Project is consistent with GN expectations for project-specific socio-economic monitoring.

78.7 REVIEWER'S RECOMMENDATIONS

If the Proponent is granted Project Approval, the GN recommends the existing Hope Bay Socio-Economic Working Group monitor project-specific socio-economic indicators in order to assess Project impacts and benefits. The working group shall oversee the Project SEMP.

Term and Condition wording for the Phase 2 Hope Bay Belt Project on this issue should align with that of the Doris North Project Certificate [No. 003], namely Term and Condition No. 28.

78.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Condition, consistent with revised term and condition No. 28 of NIRB Project Certificate [NO.: 003]:

The Proponent continues to be an active member in the Hope Bay Socio-Economic Working Group. Invited members of this Working Group shall include the Proponent, the Government of Nunavut, Indigenous and Northern affairs Canada, and the Kitikmeot Inuit Association. Working Group members may invite new participants to participate, on an as-needed basis.

The central focus of the Hope Bay Socio-Economic Working Group shall be on collaborating to ensure that the Hope Bay Socio-Economic Monitoring Plan provides for appropriate project-specific socio-economic effects monitoring as required throughout the life of the Project. The Hope Bay Socio-Economic Monitoring Plan shall apply to the Project as described in the FEIS.

The Proponent, reflecting the input of the Hope Bay Socio-Economic Working Group, shall produce an annual Hope Bay Socio-Economic Monitoring Plan report.

The GN also proposes the following Terms and Condition, consistent with new term and condition No. 40 of NIRB Project Certificate [NO.: 003]:

Within one (1) year of the issuance of a Project Certificate, the Proponent shall submit an updated Hope Bay Socio-Economic Monitoring Plan (SEMP) to the Hope Bay Socio- Economic Working Group for review. The SEMP shall identify updates, changes, and any amendments made to Terms of Reference for the Hope Bay Socio-Economic Working Group. Updates to the SEMP shall reflect the changing circumstances as outlined in the Hope Bay Final Environmental Impact Statement and Final Hearing Report. Any changes as agreed to by the Hope Bay Socio-Economic Working Group shall be submitted to the Nunavut Impact Review Board.

78.9 TMAC RESPONSE FOR GN-06

TMAC remains committed to the Hope Bay Socio-economic Monitoring Program (SEMP) and will continue to engage with the Hope Bay Socio-economic Monitoring Working Group (SEMWG) as defined under the Hope Bay SEMP and the SEMWG Terms of Reference.

TMAC is currently working with the Hope Bay SEMWG to update the SEMP. A draft SEMP update has been prepared (March 2018) that takes into account the Doris Project amendment and the Madrid-Boston (Phase 2) FEIS results, and has been provided to the Hope Bay SEMWG for review and input. Additional revisions will be considered based on the Final Hearing Report prior to the SEMP update being finalized.

79. ID #GN-07

79.1 DEPARTMENT

Family Services

79.2 ORGANIZATION

Government of Nunavut

79.3 SUBJECT/TOPIC

Financial Literacy

79.4 REFERENCES

- FEIS, Annex Vol.8-7, p. 14 – Hope Bay Human Resources Plan
- TC-GN-02
- Pre-Hearing Conference Decision Report, Annex D: List of Commitments Generated during the Technical Meeting and Pre- hearing Conference for the Phase 2 Hope Bay Belt Project Proposal and the Water Licence Application, p.3

79.5 SUMMARY OF PROPONENT'S CONCLUSIONS

As specified in TC-GN-02 during the DEIS review phase, the Proponent has acknowledged the need for financial literacy skills in the Kitikmeot Region.

During the DEIS review phase, TMAC made the following commitments:

- TMAC will reach out to third parties to deliver financial management programs such as financial literacy, financial planning and personal budgeting (FEIS, Annex V8-7, p. 14 and Pre-Hearing Conference Decision Report).
- TMAC will approach GN Family Services (or other GN departments as appropriate) to solicit input and/or participate in the delivery of programming to Project workers. TMAC will also track statistics regarding the delivery of the programming. This may include the number and percentage of workers that have completed the training. TMAC will also provide updates on program participation to the Kitikmeot Socio-Economic Monitoring Committee during its annual meeting (Pre-Hearing Conference Decision Report).

79.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

As specified in TC-GN-02 on this subject matter during the DEIS review, an individuals' income has a strong correlation with their level of health and quality of life; income is a social determinant of health. The manner in which ones' income is used and spent can increase or decrease these positive effects on health. Consequently, to secure the best health outcomes, financial literacy is needed.

79.7 REVIEWER'S RECOMMENDATIONS

The GN recommends that the Proponent:

- Deliver or work with external partners to deliver financial literacy programming to Project employees;
- Track knowledge-levels in the Project workforce; and
- Report on employee program participation to the Kitikmeot Socio-Economic Monitoring Committee during its annual meeting.

79.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Conditions:

- i) The Proponent shall reach out to third parties to deliver financial management programs such as financial literacy, financial planning and personal budgeting. TMAC will approach GN Family Services (or other GN department as appropriate) to solicit input and/or participate in the delivery of programming to Project workers.
- ii) TMAC will track statistics regarding the delivery of the programming. This may include the number and percentage of workers that have completed the training. TMAC will provide updates on program participation to the Kitikmeot Socio- economic Monitoring Committee during its annual meeting.

79.9 TMAC RESPONSE FOR GN-07

- i) As described in TMAC's Hope Bay Human Resources Plan, TMAC will reach out to third parties such as financial institutions to deliver financial management programs such as financial literacy, financial planning and personal budgeting.
- ii) TMAC has indicated that, to the extent that such communications are consistent with and not limited by obligations under the Hope Bay Inuit Impact and Benefit Agreement (IIBA), TMAC will share relevant quantitative and qualitative data

concerning the implementation and success of training and education programs, with other socio-economic monitoring initiatives. This could include, for example, providing updates on program participation to the Kitikmeot Socio-economic Monitoring Committee (Kit-SEMC).

TMAC maintains that the Hope Bay Socio-economic Monitoring Program (SEMP) should be the primary mechanism through which Project-specific socio-economic performance information is shared and discussed with stakeholders. The SEMP is designed in collaboration with the Hope Bay Socio-economic Monitoring Working Group (SEMWG), including representation from the Government of Nunavut, Indigenous and Northern Affairs Canada, and the Kitikmeot Inuit Association, and is to reflect the priorities and interests expressed by the Kit-SEMC, which has a larger community-based representation. The specific socio-economic indicators that are to be monitored and reported on will be defined under the SEMP and its processes. Specific monitoring indicators should not be defined by Project Certificate Terms and Conditions.

80. ID #GN-08

80.1 DEPARTMENT

Family Services

80.2 ORGANIZATION

Government of Nunavut

80.3 SUBJECT/TOPIC

Labour Force Analysis

80.4 REFERENCES

- FEIS, Main Report, Vol.6, s.3, pp. 3-129-131, Human Environment, Socio-economics
- FEIS, Main Report, Vol.6, Table 3.5-7
- Pre-Hearing Conference Decision Report, Appendix D: List of Commitments
Generated during the Technical Meeting and Pre-hearing Conference for the Phase 2 Hope Bay Belt Project Proposal and the Water Licence Application, p.7

80.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent has forecasted Project employment (by location) during the construction and operations phases of the proposed Project:

Table 3.5-7. Total Employment (person-years) and Personal Income Impacts during the Construction Phase

	Direct Employment	Indirect Employment	Induced Employment	Total
Employment:				
Canada	2,281	3,003	1,734	7,018
Nunavut	321	150	96	567
Qikiqtaaluk	32	97	34	163
Kivalliq	0	5	9	14
Kitikmeot	289	48	52	389

- FEIS, Main Report, Vol.6, Table 3.5-7, p.3-130

Table 3.5-9. Total Employment (person-years) and Personal Income Impacts during the Operation Phase

	Direct Employment	Indirect Employment	Induced Employment	Total
Employment:				
Canada	9,484	10,380	6,649	26,514
Nunavut	1,100	510	362	1,973
Qikiqtaaluk	0	177	183	360
Kivalliq	0	28	68	96
Kitikmeot	1,100	306	111	1,517

- FEIS, Main Report, Vol.6, Table 3.5-9, p.3-132

The Proponent has committed to maximizing employment benefits in the Local Study Area and Regional Study Area (FEIS, Vol.6, s.3, p. 3-129). The Proponent has also stated that it will work to identify recruitment strategies that will maximize Inuit employment at the Project (FEIS, Vol.6, s.3, p. 3-129).

During the DEIS review phase, the Proponent has committed to:

- Provide the GN and the NIRB information regarding the labour force needs of the Project, should the Project receive regulatory approval and the decision is made by TMAC to proceed with the construction of the Project (PHC Decision Report, Appendix D, p. 7); and

To have continued dialogue with the GN regarding anticipated labour force needs, employment schedules, and education and training requirements related to specific positions" (PHC Decision Report, Appendix D, p. 7).

80.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

In order to maximize local employment throughout the life of the Project, the local labour force must be able to respond to the requirements of the mining industry. Proponent forecasts suggest that most of the local labour force will be in entry-level and semi-skilled positions. The GN would like the Proponent to make efforts towards maximizing the local labour forces' ability to align with necessary skill-sets needed to work at the mine.

80.7 REVIEWER'S RECOMMENDATIONS

To produce accurate labour-market information and reliable economic and employment forecasting for the current and future labour force, the GN requires the most up-to-date estimates of what types of employment will be available through the Project and what skills are required for these jobs.

The GN recommends that the Proponent provide a detailed staff schedule that accounts for each of the Project phases. Positions should be presented by department and division, and each position should be listed with its associated National Occupational Classification (NOC) code.

80.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Conditions:

1. Proponent is strongly encouraged to submit staff schedule forecasts to the Nunavut Impact Review Board and to the Government of Nunavut six (6) months prior to each phase of the Project (construction, operations, closure). Staff schedule forecasts should be inclusive of:
 - Title and number of positions required by department or work area;
 - Potential start dates;
 - Transferable skills, both certified and uncertified which may be required for, or gained during, employment within each job category and trade; and
 - The NOC code for each individual position.
2. The Proponent is encouraged to consult the Government of Nunavut's Career Development division during development of the schedule. A new schedule shall be submitted following any significant deviation from original predictions.
3. The Proponent's Human Resources shall make best efforts to collaborate with the Government of Nunavut's Career Development Officer, Regional Manager of Career Development, and Director of Career Development. Semi-annual calls, at minimum, should be initiated by the Proponent with these Government of Nunavut representatives regarding:
 - Hiring procedures and policies;
 - Issues regarding employee recruitment and retention; TMAC policies regarding career pathways and opportunities for advancement;
 - Internal and/or partnered training and development of employees; and
 - Long-term labour market plans to facilitate training in communities.

80.9 TMAC RESPONSE FOR GN-08

As noted in the comment, TMAC has provided an updated estimate of labour force needs and workforce schedule for each phase of the Project in the FEIS.

To the extent that such communications are consistent with and not limited by TMAC's obligations under the 2015 Hope Bay IIBA, six (6) months prior to each phase of the Project (construction, operations, closure), TMAC can provide the GN and the NIRB information regarding the labour force needs of the Phase 2 Project, should the Project receive regulatory approval and the decision is made by TMAC to proceed with the construction of the Project. A new schedule can be submitted following any significant deviation from original predictions. Where information is available, the staff schedule forecasts can be inclusive of:

- 1) the title and number of positions required by department or work area;
- 2) the potential start dates;
- 3) the level of education required (with reference to the specific positions); and
- 4) whether on-the-job or other forms of training and certification will be required (with reference to specific positions).

TMAC will consult the Government of Nunavut's Career Development division to understand any education, training or work experience programs that support local labour forces' ability to align with necessary skill-sets needed to work at the Project. It is anticipated that information will be provided by the GN regarding programs funded by, managed by or developed in collaboration with the GN's Career Development Division.

TMAC will engage the Government of Nunavut's Career Development Officer, Regional Manager of Career Development, and Director of Career Development to provide information, updates and respond to comments, as needed, in relation to:

- Issues regarding employee recruitment and retention;
- Internal and/or partnered training and development of employees; and
- Long-term labour market plans to facilitate training in communities.

With respect to the GN's request for collaboration regarding hiring and recruitment, TMAC will be transparent about procedures and policies; however, TMAC is not in agreement with the request for collaboration on policies or procedures. The discussion will be focused around identifying opportunities to support local labour force to obtain necessary skill-sets needed to work at the Project.

TMAC notes that In February 2018, TMAC was approached by the GN Department of

Economic Development and Transportation to enter into a Memorandum of Understanding (MOU) with the Government of Nunavut in order to promote cooperation, coordination and implementation of joint activities. This MOU, as drafted, would include the formalization of a TMAC-GN committee including representatives from a number of GN departments that would regularly meet and discuss matters of mutual importance. TMAC is willing to consider entering into this MOU and is conducting consultations with the Kitikmeot Inuit Association to discuss how such an MOU could be structured to support the efforts of the Hope Bay IIBA Implementation Committee. If an MOU can be concluded to the mutual satisfaction of TMAC, KIA and the GN, this engagement tool will be included in the Community Involvement Plan.

81. ID #GN-09

81.1 DEPARTMENT

Family Services

81.2 ORGANIZATION

Government of Nunavut

81.3 SUBJECT/TOPIC

Accredited Project-Related Training for Employees

81.4 REFERENCES

- FEIS, Main Report, Vol.6, s.3 – Human Environment, Socio-economics
- FEIS, Main Report, Vol.6, s.3, Table 3.5-11
- TC-GN-29
- Pre-Hearing Conference Decision Report, Appendix D: List of Commitments
Generated during the Technical Meeting and Pre-hearing Conference for the Phase 2 Hope Bay Belt Project Proposal and the water Licence Application, p.7

81.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The total Project-demand for workers cannot be met by the population of the Kitikmeot Region alone. An approximate 12% to 35% of workers will be comprised of Nunavummiut from the Kitikmeot region:

- FEIS, Main Report, Vol,6, s,3, Table 3.5-11, p.3-137

Table 3.5-11. High and Low Hiring Scenarios for Kitikmeot Workers

Category	Inuit		Total		Total Project Demand
	Low	High	Low	High	
Skill Level A (university education)	5	10	6	11	110
Skill Level B (college education or apprenticeship training)	45	134	50	149	495
Skill Level C (secondary school and/or occupation-specific training)	35	104	39	116	385
Skill Level D (on-the-job training is usually provided)	30	99	33	110	110
Total	115	347	128	386	1,100

During the DEIS review phase, the Proponent committed to the following:

- The Community Involvement Plan will be update for the FEIS to provide additional detail regarding the communication protocols to support these discussions on an ongoing basis; and
- TMAC will participate in further discussion with the Department of Family Services and the Nunavut Arctic College regarding its participation and support for the provision of training.

81.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Training local residents would alleviate the local labour shortage by creating a more skilled local workforce. As specified in TC GN-29, the Proponent has recognized the value of accredited or recognized training and post-secondary education.

In order for the local workforce to better meet human resource demands of the Project, the Proponent should commit to apprenticeships from the construction phase onward and to accredited Project-related training for employees. The GN's Department of Family Services is willing to educate the Proponent on apprenticeship and trades-related programs.

81.7 REVIEWER'S RECOMMENDATIONS

The GN recommends that the Proponent consult with the GN regarding accredited Project-related training that future Project employees may potentially access. The GN also recommends that the Proponent develop a communication strategy regarding such training opportunities for employees.

81.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Term and Condition:

The Proponent shall establish a working group comprised of the Proponent, the GN Department of Family Services (and other necessary GN departments), to discuss and address training required to fill the skills-gap of the Kitikmeot workforce on an ongoing basis.

81.9 TMAC RESPONSE FOR GN-09

As communicated in the annual Hope Bay Socio-economic Monitoring Program (SEMP) reports, which are presented to and discussed with the Hope Bay Socio-economic Working Group and the Kitikmeot Socio-economic Monitoring Committee (which includes representation from the Government of Nunavut Department of Family Services), the

Project is predicted to result in the creation of substantial work experience and training for Canadian and Inuit workers.

As part of the 2015 Hope Bay Inuit Impact and Benefit Agreement (IIBA) and managed by the IIBA Implementation Committee, TMAC established an Education and Training Fund. TMAC committed to an initial contribution of \$15,000 to the fund upon the achievement of commercial production, following with yearly contributions of up to \$100,000. Contributions to this fund are provided to support education and training opportunities for Inuit to develop and provide training, including trades, within the Kitikmeot high school system and off-site education and training programs aimed at preparing Inuit for employment in mining and related fields.

TMAC is supportive of ongoing communication and discussions with the GN Department of Family Services and other stakeholders, such as Nunavut Arctic College, regarding training opportunities and requirements to fill the skill-gaps of the Kitikmeot workforce. In addition, the Hope Bay SEMP is an important mechanism through which Project-specific socio-economic performance information is shared and discussed with stakeholders.

TMAC notes that In February 2018, TMAC was approached by the GN Department of Economic Development and Transportation to enter into a Memorandum of Understanding (MOU) with the Government of Nunavut in order to promote cooperation, coordination and implementation of joint activities. This MOU, as drafted, would include the formalization of a TMAC-GN committee including representatives from a number of GN departments that would regularly meet and discuss matters of mutual importance. TMAC is willing to consider entering into this MOU and is conducting consultations with the Kitikmeot Inuit Association to discuss how such an MOU could be structured to support the efforts of the Hope Bay IIBA Implementation Committee. If an MOU can be concluded to the mutual satisfaction of TMAC, KIA and the GN, this engagement tool will be included in the Community Involvement Plan.

82. ID #GN-10

82.1 DEPARTMENT

Nunavut Housing Commission

82.2 ORGANIZATION

Government of Nunavut

82.3 SUBJECT/TOPIC

Reporting Mechanisms (Housing)

82.4 REFERENCES

- TC-GN-31
- TC-GN-32
- Kent Gustavson, Consultant [TMAC], Personal Communication, January 31, 2018
- FEIS, Annex Vol.8-5 - Hope Bay Project Community Involvement Plan
- FEIS, Main Report, Vol.6, s.35.5.4, p. 153 – Human Environment, Socio-economics
- Nunavut Housing Corporation Annual Report. 2012/2013
- Nunavut Housing Needs Survey. 2010.
<http://www.eia.gov.nu.ca/stats/housing.html>

82.5 SUMMARY OF PROPONENT'S CONCLUSIONS

Impacts related to the change in demand for housing are expected to be minimal, and may result in a relatively small and gradual but positive shift in housing tenure. Should the level of impact change over time, it will be collaboratively addressed through measures outlined in the Proponent's Community Involvement Plan (CIP).

During the DEIS review phase, the Proponent committed to updating the CIP to clarify communication with the NHC and other stakeholders regarding housing-related matters. As per electronic communication from the Proponent on January 31, 2018, the Proponent decided to not update the Project CIP. As a result, the Proponent does not provide for a means to communicate and/or to monitor housing changes.

82.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

In DEIS TC-GN-32, NHC stated that the CIP does not contain adequate mechanisms to address housing-related issues (e.g. overcrowding and migration). The NHC holds that the Project will increase demand on the region's social housing stock as a result of direct-project employment, project-induced in-migration, and population increase within the Project Local Study Area (LSA). Consequently, the Proponent's CIP and FEIS are inadequate to deal with the issues that could arise from the Project increase pressures on a territory with a shortage of adequate housing.

82.7 REVIEWER'S RECOMMENDATIONS

In order to better provide for the expected increase in housing demands in the Kitikmeot region, the NHC recommends that the Proponent establish a monitoring and reporting mechanism to identify migration trends and effects as a result of the Project, and that the Proponent work with the NHC to mitigate possible Project-related housing demands. This would allow the Proponent to collaborate with the GN, NHC, and other agencies and interested groups to identify measures for managing and mitigating adverse impacts on employee well-being and communities included in the LSA.

The NHC recommends a voluntary employee survey to evaluating the housing situation of mining employees. Given that housing is a key determinant of health, and overcrowded living conditions are directly associated with adverse health outcomes, it is important the Proponent take the opportunity to capture this information.

82.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following commitment:

The Proponent shall work with the Kitikmeot Socio-Economic Monitoring Committee to design and implement a voluntary survey to be offered to its Nunavummiut employees on an annual basis in order to identify levels of overcrowding, changes of address, housing status (e.g., public/social, privately-owned/rented, government, etc.), housing occupancy and migration intentions, while respecting confidentiality of all persons involved. The survey should be designed in collaboration with the Government of Nunavut, the Nunavut Housing Corporation and other relevant stakeholders.

82.9 TMAC RESPONSE FOR GN-10

As per the Doris Project Certificate [NO.:003] Term and Condition No. 49, if the Government of Nunavut and the Nunavut Housing Corporation develop an anonymous voluntary housing survey, TMAC will make the survey available to Nunavummiut site personnel and TMAC will return any completed surveys to the Government of Nunavut. As noted in the

condition, interpretation of the results, modifications to the surveys and any reporting of the results remain the responsibility of the authors of the survey, the Government of Nunavut and Nunavut Housing Corporation.

The Hope Bay Socio-economic Monitoring Program (SEMP) monitors the accuracy of socio-economic impact predictions, determines the effectiveness of planned mitigation measures, and identifies any unanticipated effects. The SEMP report is prepared annually, reviewed with the Hope Bay Socio-economic Monitoring Working Group (SEMWG) and the Kitikmeot Socio-economic Monitoring Committee (Kit-SEMC), which includes representation from Nunavut Housing Corporation. The SEMP currently includes an indicator to monitor the number of Project employees who relocate within or out of the Kitikmeot region. The SEMP is being updated to take into account the results of the FEIS for the Madrid-Boston (Phase 2) Project. TMAC will continue to rely on the SEMWG and Kit-SEMC as an important mechanism to identify and discuss any Project-related housing issues, should they arise.

83. ID #GN-11

83.1 DEPARTMENT

Nunavut Housing Corporation

83.2 ORGANIZATION

Government of Nunavut

83.3 SUBJECT/TOPIC

Employment-Induced Migration and Relocation

83.4 REFERENCES

- FEIS, Main Report, Vol.6, s.3.5.5, pp. 118 and 147 – Human Environment, Socio-economics
- TC-GN-31

83.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent expects a negligible increase to in-migration to the Kitikmeot region or between communities within the Kitikmeot because of the Project (FEIS, Main Report, Vol. 6, s. 3.5.4). Consequently, the Project does not require specific mitigation measures regarding housing and migration issues.

83.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The NHC notes that improved economic security and increased income due to employment may result in workers seeking to leave potentially overcrowded living situations in pursuit of their own homes. Additionally, the GN and NHC anticipate the positive economic benefits will extend to the whole Kitikmeot region, most notably LSA communities (Cambridge Bay and Kugluktuk).

For the purposes of optimizing operations, it is in the best interest of the Proponent to promote employee well-being and advancement within the company. Investment in enhancing employee access to a range of housing options for themselves and their families can have long-term positive outcomes for the Project, the community, and the territory as a whole.

83.7 REVIEWER'S RECOMMENDATIONS

The Proponent should pursue collaboration with the GN, NHC, and other agencies and interested groups to identify measures to enhance employee access to a range of housing options, such as homeownership programs, in order to mitigate adverse impacts to the region's housing situation.

The GN recommends that the Proponent work with interested groups to improve employee access to a range of housing options, including private homeownership.

The GN recommends that the Proponents expand the voluntary employee survey to determine interest in financial literacy programming and to NHC homeownership programs.

83.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Term and Condition:

1. The Proponent shall provide financial literacy, financial planning, and personal budgeting training with a view to enhancing employee access to a range of housing options, including homeownership, in collaboration with the Government of Nunavut and the Nunavut Housing Corporation as part of the regular Life Skills Training and/or Career Path Program.
2. The Proponent shall work with the Government of Nunavut and the Nunavut Housing Corporation to explore options for a Proponent-driven employee-support program to encourage homeownership.
3. The Proponent shall work with the Government of Nunavut to explore options regarding the development of homeownership support programs, including the development of a savings matching program for employees looking to save towards home ownership.

83.9 TMAC RESPONSE FOR GN-11

TMAC is not in agreement with the proposed Term and Condition as stated above. TMAC is open to ongoing engagement with the Government of Nunavut, Nunavut Housing Corporation (NHC), and other agencies and interested groups to identify measures to enhance access to housing, should there be the potential for a meaningful supporting role for TMAC. TMAC will reach out to third parties such as financial institutions to deliver financial management programs such as financial literacy, financial planning and personal budgeting (also see response to GN-7). In this regard, TMAC will reach out to the NHC as one of the third parties. TMAC will also support the communication to Project workers of

education and training materials developed by the NHC that focus on enhancing employee understanding and accessing housing options available in the community.

TMAC notes that as stated on the NHC website (<http://www.nunavuthousing.ca/home>), part of the Core Business of the Corporation is stated as "providing homeowner services in the area of finance and technical assistance". Specifically with respect to Homeownership Programs, the NHC website further states "through its Homeownership Programs and supports, the NHC assists residents who can afford the costs of homeownership to secure and maintain their house. As well, homeownership education and counseling services are provided to home owners. These services include consultations regarding purchase of existing homes or new home construction, repairs, renovations, bank financing and energy conservation." A search of the Government of Nunavut Staff Directory (<http://www.directory.gov.nu.ca/Search.aspx>) indicates that NHC currently maintains eight staff in Arviat, Nunavut specifically to support Nunavut residents, including residents of the Kitikmeot region, achieve homeownership including program manager, program analyst, coordinator and assistant staff positions. As such, the proposed Term and Condition would appear to require TMAC to undertake activities that are part of the Core Business of the NHC and for which the NHC is currently resourced with staff to accomplish.

84. ID #GN-12

84.1 DEPARTMENT

Environment

84.2 ORGANIZATION

Government of Nunavut

84.3 SUBJECT/TOPIC

Changes in the project description

84.4 REFERENCES

- FEIS Vol. 4, s. 2 - Air Quality, (p.2-1)
- FEIS Vol. 4, s. 3 – Noise, (p.3-1)

84.5 SUMMARY OF PROPONENT'S CONCLUSIONS

This comment has been prepared by the Government of Nunavut (GN) solely to summarize changes TMAC Resources Inc. (the Proponent) has made in the Final Environmental Impact Statement (FEIS).

In the FEIS, Proponent sets out changes provided since the Draft Environmental Impact Statement (DEIS) stage. These include:

- Updates in the site plan resulting in changes in source locations;
- Inclusion of assessment scenarios that address the potential for the Madrid North facility to be moved approximately 400-m north of the location assessed in the DEIS (referred to as the reference and alternative locations);
- Updates to the mining rate and operating life of the Boston site. The mining rate in the FEIS has increased and the operating life has decreased;
- Revision of the number of surface vehicles in the emission inventory based on the updated mining rate at Boston and required vehicle trips between camps.
- Revision to the Boston Processing Plant. The Proponent has amended its proposal such that the processing plant will be identical in design and capacity to the Doris processing plant. The processing plant will also include flotation, cyanide leach and

gold recovery.

- Inclusion of two wind turbines near the Doris site, two wind turbines near the Madrid North site and two wind turbines near the Boston site.

84.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Changes in the Project scope and description are reflected in Air and Noise assessment sections. The wildlife effect assessment does not reflect these proposed changes.

84.7 REVIEWER'S RECOMMENDATIONS

It is recommended that the Proponent confirms that the changes due to the proposed project modification detailed within Air and Noise assessment sections of its FEIS do not affect the assessment results for all other Valued Ecosystem Components (VECs), including wildlife.

84.8 PROPOSED TERM AND CONDITION/COMMITMENT

- N/A

84.9 TMAC RESPONSE FOR GN-12

TMAC confirms that the updates to the Project Description do not alter the outcome of the wildlife assessment. Traffic levels and wind turbines from the Project description were used in the wildlife assessment. Other changes to the Project Description did not alter the outcome of the wildlife assessment.

85. ID #GN-13

85.1 DEPARTMENT

Environment

85.2 ORGANIZATION

Government of Nunavut

85.3 SUBJECT/TOPIC

Exceedance of air quality standards for NO₂

85.4 REFERENCES

- FEIS Vol. 4, s. 2.6.5.3, p.2-61, Figure 2.5-2 - Air Quality
- Appendix Vol. 4-21. Madrid Boston Project: Air Quality Modeling Study, Figures E4 and J4
- FEIS Vol. 6, s. 5.4.4.2, p.5-121, Table 5.4-18 - Human Health and Environmental Risk Assessment
- Annex Vol. 8 8-2. Hope Bay Project Air Quality Management Plan, p.24.

85.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent states (FEIS Vol. 4, s. 2.6.5.3, p.2-61 - Air Quality):

“Exceedances of the newly introduced hourly CAAQS are predicted to occur within the LSAs for the Madrid-Boston Project and the Hope Bay Development, but no exceedances are predicted to occur with respect to the currently applicable Nunavut hourly NO₂ criteria.

In the Southern domain, exceedances are predicted to occur within 0.5 – 5 km of the PB (depending on direction), but infrequently (less than 20% of the time) outside of 1-km from the PB.

In the Northern Domain exceedances are predicted to occur within 2-10 km of the PB (depending on direction), but infrequently (less than 20% of the time) outside of 3.5 km from the PB.

Exceedances of the health-based hourly average NO₂ CAAQS are predicted

to occur in areas where there is expected to be infrequent human occupancy and therefore adverse health effects are unlikely. TMAC will consider additional NO_x mitigation measures to address the new NO₂ CAAQS as the Project design progresses."

The Proponent further states (FEIS Vol. 4, s. 2.6.5.3, p.2-61 - Air Quality):

"Hourly exceedances are predicted to occur in areas where human exposure is unlikely therefore, the change in ambient NO₂ concentrations is determined to be Not Significant for all Madrid-Boston Project phases."

The Proponent states (FEIS Vol. 6, s. 5.4.4.2, p.5-121 - Human health and Environmental Risk Assessment):

"During the Operational phase, there were also exceedances of air quality guidelines for NO₂, PM₁₀, and PM_{2.5} at two land user hunting and fishing locations (H1 and F2). However, the majority of HQs for the land user locations were below 2. The H1 location is just outside of the PDA, as it is only 0.43 km from an unpaved Project road. The F2 location is also just outside of the PDA, as it is only 0.16 km from an unpaved Project road. The PDA buffer for roads is 100 m either side; thus, both of these land user locations are just outside of the PDA. Although it is possible that a land user may pass through the area or use the road, it is unlikely that they would spend 24 hours (or more) adjacent to the road during the occasions when air quality guidelines are exceeded."

No provisions for hourly NO₂ monitoring have been made in the Hope Bay Project Air Quality Management Plan (Annex Vol. 8-2, p.24):

"Ambient monitoring for NO₂ will be conducted using passive sampling (PASS)... The sample media are installed in the field and exposed in protective shelters that are mounted to a support pole or small tripod for a period of 30 days... The collected monthly average samples will be converted to daily and hourly averaging periods following standard practice for comparison to the applicable NO₂ criteria."

85.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The Proponent assessed NO₂ emission exceedances as "not significant" with an argument that the potential exceedance occurs within a limited area and over a short duration. Figures E-4 and J-4 (Appendix Vol. 4-21) demonstrate substantial exceedance of the hourly average Canadian Ambient Air Quality Standards¹ (CAAQS) for NO₂ around the project. The area of predicted exceedance expands to the Regional Study Area (RSA) and the

exceedance lasts for at least one hour. According to the proposed significance criteria of the residual effects (see FEIS Vol. 4, s. 2.6.5.3, Table 2.6-5, p.2-49 - Air Quality) the NO₂ exceedance should be considered a significant effect that requires an adequate follow up and mitigation.

The Project's Human Health Assessment does not use the updated hourly average NO₂ CAAQS (113 µg/m³ (effective in 2020) and 79 µg/m³ (effective 2025)), but applies the existing CAAQS (400 µg/m³). The area of exceedance for the updated hourly average NO₂ CAAQS includes several receptors (see FEIS Vol. 4 Appendices, V4-21 Air Quality Modeling Study

¹“Canadian Ambient Air Quality Standards” (2014), online: Canadian Council of Ministers of the Environment

<https://www.ccme.ca/en/current_priorities/air/caaqs.html>.

Madrid-Boston Project, Appendix D: Ambient Air Quality Predictions at Discrete Receptor Locations, Table D1 and Figure 6-1) which could be exposed to NO₂ concentration above the hourly average CAAQS. The Human Health Assessment should reflect this finding and provide a discussion on potential effects on human activities at the affected points of reception based on the updated NO₂ CAAQS.

The proposed passive sampling of NO₂ level at two locations (Madrid and Boston) assumes averaging of measured concentration over 30 days which is not directly applicable to hourly average NO₂.

85.7 REVIEWER'S RECOMMENDATIONS

It is recommended that:

- the Proponent shall indicate the potential exceedance of hourly average CAAQS for NO₂ as a significant effect and discuss its potential impact on human health using the updated air quality standards (113 µg/m³ (effective in 2020); 79 µg/m³ (effective 2025)).
- the Proponent shall propose an hourly average air sampling program to confirm the results of air dispersion modeling for NO₂.
- the Proponent shall make a clear commitment in the Hope Bay Project Air Quality Management Plan to identify main sources of NO₂ emission and mitigate NO₂ effects if the potential exceedance of hourly average CAAQA is confirmed.

85.8 PROPOSED TERM AND CONDITION/COMMITMENT

The Proponent shall:

- Assess the potential impact on human health of hourly average NO₂ CAAQS exceedance using the updated air quality standards (113 µg/m³ (effective in 2020); 79 µg/m³ (effective 2025)).
- Propose an adequate follow up program to confirm the results of air dispersion modeling indicating the exceedance of hourly average CAAQS for NO₂.
- Propose a feasible technical solution and make a commitment in the Hope Bay Project Air Quality Management Plan to mitigate the exceedance of hourly average CAAQS for NO₂ if its potential is confirmed by a follow up program.

85.9 TMAC RESPONSE FOR GN-13

The air quality assessment conservatively utilized the most stringent published provincial, territorial or federal air quality criteria for each contaminant when assessing the Project predictions. Inclusion of the CAAQS in the air quality assessment was conservatively incorporated on the possibility that the Government of Nunavut (GN) may incorporate the CAAQS as a regulatory air quality objective. TMAC requests that the GN clarify if the CAAQS will replace the current Ambient Air Quality Guidelines for Nunavut.

Currently regulatory compliance for NO₂ in Nunavut is based upon the Nunavut Air Quality Objective (AQO). As noted in the Air Quality Assessment, the Project is predicted to be in compliance with this criteria.

The CAAQS were developed as part of the federal Air Quality Management System (AQMS) for air zone management purposes and not to determine the acceptability of industrial projects. Under the federal AQMS, achievement relative to a CAAQS is determined using regionally representative monitoring station data. Section 3.2 of the CCME document *Guidance Document on Achievement Determination: Canadian Ambient Air Quality Standards for fine Particulate and Ozone* describes the general siting criteria for CAAQS reporting stations. For rural or remote areas, a CAAQS reporting station should represent "Regional" scale and the guidance notes that the station should not be sited where it would be unduly influenced by a nearby industrial facility. Should the CAAQS not be adopted as a regulatory criteria by the government of Nunavut, then the NO₂ concentrations predicted in the air quality assessment in the vicinity of the Project would not represent non-achievement of the CAAQS, as CAAQS achievement would require assessing an area out of the influence of the Project.

The air quality assessment included several conservatisms in the emissions estimation methodology such as the power plant emission levels for the Madrid North and Boston sites, conservative assumptions on the utilization and load factors for on and off-road equipment, etc. TMAC is currently reviewing and updating the NO₂ air quality modelling for the Project to provide a refined assessment of the predicted ambient NO₂ concentrations relative to the CAAQS criteria. This additional assessment is expected to be completed by the end of April 2018 and will be provided to the GN and Environment and Climate Change Canada (ECCC).

TMAC's actions with respect to NO₂ mitigation measures will be dependent on how the CAAQS criteria are applied by the GN and the results of the refined NO₂ modelling. Mitigation measures that may be considered by TMAC to address this issue may include:

- Wind power generation may be pursued, which would be expected to reduce NO_x emissions due to reduced power plant operation.
- Consideration of taller stacks at the Madrid North and Boston power plants to promote greater dispersion.
- Consideration for additional NO_x emissions reductions during detailed Project design. These may include energy efficiency methodologies, allowances in design for inclusion of future control technologies in power plant design, etc.

Likewise, depending on how the CAAQS is applied by the GN and the results of the refined NO₂ modelling, the need for expanded ambient NO₂ monitoring over that currently included in the Hope Bay Air Quality Management Plan will be assessed.

86. ID #GN-14

86.1 DEPARTMENT

Environment

86.2 ORGANIZATION

Government of Nunavut

86.3 SUBJECT/TOPIC

Overpressure level at 2.8 km from the blasting point and cessation of above ground blasting

86.4 REFERENCES

- FEIS Vol. 4, s. 9 -Terrestrial Wildlife and Wildlife Habitat, p. 9-336
- Annex Vol. 8-3, Table 2.2-1, 2 - Hope Bay Project Wildlife Mitigation and Monitoring Plan.
- Annex Vol. 8-8, p.10 - Hope Bay Noise Abatement and Monitoring Plan.

86.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent states (FEIS Vol. 4, s. 2.6.5.3, p.2-61):

"Blast overpressure will meet Health Canada standards for children's hearing (120 dBZ) at approximately 320 m from the blast point, and will meet the Health Canada mitigation noise level for causing annoyance to adults and children from 100 blasts per day (105 dBZ) at approximately 1,450 m from the blast point. This comparison of a standard using 100 blasts per day is cautiously conservative because the actual blasting plan will only include one to two blasts per week during construction.... For caribou, mitigation for possible annoyance due to blasting will be conducted; blasting will be stopped if any caribou is observed within line of sight out to 2.8 km of the blasting point. This value is consistent with scientific literature that reports some ungulates will freeze or startle in response to blasting noises at 96 dBZ"

The Wildlife Mitigation and Monitoring Plan (FEIS. Annex Vol. 8-3, - Hope Bay Project Wildlife Mitigation and Monitoring Plan) provides for cessation of blasting until animals move > 2.8 km (Table 2.2-1) and 4 km (Table 2.2-2, during the Calving Period (June 5 to June 20) should the Calving Range Overlap the Project Site) from quarry or the line of sight from the quarry high point, whichever is closer.

The Noise Abatement and Monitoring Plan provides for only “cessation of above ground blasting when caribou is within 2.8 km” (p.10).

86.6 REVIEWER’S COMMENTS AND SUPPORTING RATIONALE

The Proponent agreed to:

“provide more justification in the FEIS on the use of a setback buffer for triggering mitigation activities at Project quarries, which will include a more in depth discussion of the literature and responses of wildlife to various sound levels and discussing any information gaps within the assessment” (NIRB Pre-hearing Conference Decision, Commitment GN-22, Appendix D).

The Proponent does not provide any value for its overpressure level at 2.8 km and 4 km. It is not clear if 96dBZ value will be met at this distance and no discussion is provided on why 96 dBZ is an appropriate threshold.

The Project’s Wildlife Mitigation and Monitoring Plan provides for 4 km setback buffer from the blasting site the case the calving range overlaps the project site, but lacks clarity on how to determine if the overlap occur.

The Project’s Noise Abatement Plan does not include the 4 km setback indicated in the Wildlife Mitigation and Monitoring Plan.

86.7 REVIEWER’S RECOMMENDATIONS

It is recommended that the Proponent:

- Present the predicted overpressure value at 2.8 km and 4 km from blasting point.
- Verify that the predicted overpressure value will not affect caribou outside the 2.8 km zone and 4 km zone in a calving period.
- Monitor the predicted overpressure value (less than 96dBZ) and prove the effectiveness of the proposed setbacks (e.g. caribou are not startled by blasting).
- Amend the Noise Abatement and Monitoring Plan to include monitoring of

the overpressure value at 2.8 km and 4 km from blasting point, as applicable.

- Present setbacks for caribou mitigation consistently through relevant management plans.
- Amend the Wildlife Mitigation and Monitoring Plan to include a procedure on how to determine if the calving range overlaps the project site.

86.8 PROPOSED TERM AND CONDITION/COMMITMENT

The Proponent shall:

- Monitor the predicted overpressure value from the blasts and prove the effectiveness of the proposed setbacks.
- Amend the Noise Abatement and Monitoring Plan to include monitoring of overpressure value (shall be less than 96dBZ) at 2.8 km and 4 km from blasting point as applicable and consistently present setbacks for caribou mitigation.
- Amend the Wildlife Mitigation and Monitoring Plan to include a procedure to determine if the calving range overlaps the project site.

86.9 TMAC RESPONSE FOR GN-14

TMAC has considered potential effects of noise emissions from quarry operations, and has endeavoured to address those concerns in the Wildlife Mitigation and Monitoring Plan (WMMP). The WMMP includes mitigation for caribou during above-ground blasting (quarries, road construction, etc.). Should caribou be observed within 2.8 km, then the blast is held until caribou depart. Section 9.8.3.2 of the FEIS describes the pre-blast surveys conducted on-site and the procedure for holding a blast, responsibilities, and response.

In response to the GN's concerns and proposed term and condition/commitment, TMAC commits to including the following additions to the WMMP:

1. Conduct noise measurements during quarry blasts at 2.8 and 4 km to confirm predictions in the FEIS and reporting these values in the WMMP Report.
2. Conducting behaviour monitoring during blasts if caribou are observed beyond 2.8 km to evaluate how caribou respond to blasts.
3. Updating the WMMP with the methods used to determine calving ground overlap with the Project.

Given these proposed updates to the WMMP, there is no need for a specific Project term or commitment.

Discussion:

1. Blasting Noise

Noise modeling was conducted for the FEIS using an estimated value for the quantity of explosives (AMFO) used. Following the FEIS, Tailings Management Area (TMA) confirmed with the blasting engineer on site, that the FEIS over-estimates the size of quarry blasts. TMAC is conducting supplementary noise modeling to provide an accurate measurement of blast noise. This value will be supplied to the GN within two weeks of the submission of this comment response.

The value of 96 dBZ was decided on as a threshold value in a meeting with the GN and KIA on April 11, 2016. TMAC had proposed a value of 105 dBZ based on reports from studies of caribou reactions to sonic booms. The KIA and GN suggested the lower value of 96 dBZ based on some other studies which reported ungulates reacting to noise at lower sound pressure values. The value of 2.8 km was used based on the results of noise modeling for blasting at other projects. A second value of 4 km was added for the unlikely event that a caribou herd moves its calving ground to overlap the Project site.

In the field, the standard rule is more conservative, where blasting managers hold blasts if a single caribou is within the line of sight from the quarry. Viewscape modeling in Section 9.8.3.2 of the FEIS shows that the area out to 2.8 km is clearly visible in most cases from the quarry.

During 2016 and 2017, TMAC held a series of caribou workshops to incorporate TK and Inuit perspectives into the FEIS during workshops and site visits. The workshops included Inuit Elders and land users who have experience harvesting caribou and have land use experience at the Project site. Many of the participants also had extensive experience working in the mining industry and have witnessed blasts and other mining operations. During one of the site visits, Inuit workshop participants met with the NUNA Logistics blasting manager at a quarry site to evaluate the mitigation measures. Stakes were placed at 2.8 km to give an impression of the distance at which blasts are stopped if caribou are present. Workshop participants agreed that the proposed mitigation for Madrid-Boston (Phase 2) would keep caribou safe.

2. Mapping Calving Grounds

Section 3.1.5.2 of the FEIS WMMP includes monitoring of the caribou calving ground to determine if there is an overlap with the Project:

"The Hope Bay Project does not overlap the calving grounds of any caribou herd, and no overlap has been indicated historically. To monitor the locations of calving grounds, TMAC will conduct a caribou collar analysis to determine the calving range for the Mainland (Beverly and Ahik herds) in each year that data are made available."

TMAC has committed (above) to add more detail on the methods for mapping caribou calving ground in the WMMP. The standard methods include kernel analysis.

87. ID #GN-15

87.1 DEPARTMENT

Environment

87.2 ORGANIZATION

Government of Nunavut

87.3 SUBJECT/TOPIC

Waste management: landfills

87.4 REFERENCES

- FEIS Vol. 3, Project Description and Alternatives.
- Volume 1 Annex V1-7 Type A Water Licence Applications. Package P4-13 Hope Bay Non-hazardous Waste Management Plan 2017.

87.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The proposed Non-hazardous Waste Management Plan 2017 does not include any details on the landfills arrangement, but states that incinerators bottom ash will be disposed of at the landfill if the bottom ash meets the Federal and Provincial Waste Regulations Class II Landfill Disposal criteria.

The Proponent states in V3 Project Description and Alternatives:

"A nonhazardous waste landfill has been approved under Project Certificate 003 Type AW.L. 2AM-DOH1323 at Doris."

The Madrid Advanced Exploration program includes a landfill (see Non-hazardous Waste Management Plan 2017, p. 3-7).

A nonhazardous waste landfill to contain generally dry, non-leachable waste materials will be constructed at Boston (see Non-hazardous Waste Management Plan 2017, p.4-30).

The Proponent states in Non-hazardous Waste Management Plan 2017, p.4-30 "Once completed the landfill will be capped with a 1 m thick rock fill cover of 150 mm minus (6 inch) clean compacted quarry rock material. The final surface of the landfill will be graded similar to the foundation base grade, of 1%, to

shed water and minimize infiltration. The capping material will move the active thaw layer away from the stored waste so it is expected that permafrost will partially aggrade into the landfill waste over time".

87.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The Proponent proposes a nonhazardous waste landfill at Boston (the "Boston Landfill") in addition to the existing landfill at Doris (the "Doris Landfill") which was designed without any liner and leachate control. The Proponent commits to disposal of only dry, non-leaching waste in the Boston Landfill.

The proposed criteria and standards for landfill site selection, construction and operation must comply with regulatory requirements². The GN states that these criteria and standards are not presented consistently in the FEIS.

An alternative to use only the Doris Landfill and not build the Boston Landfill is not discussed in the FEIS. The avoidance of potential environmental impacts from constructing and operating the Boston Landfill may offset some safety risks and environmental concerns related to waste transportation from the Boston site to the Doris Landfill.

87.7 REVIEWER'S RECOMMENDATIONS

The Proponent shall consistently present the proposed criteria and standards for landfill site selection, construction and operation which shall comply with applicable regulatory requirements.

The Proponent shall consider an alternative to use only the Doris Landfill and not build the Boston Landfill.

The Proponent shall present an environmental monitoring of the Boston Landfill in the Waste Management Plan.

87.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN requests the Proponent to commit to the following:

- TMAC shall update the Non-hazardous Waste Management Plan to include the description of landfill arrangements and relevant monitoring program.
- TMAC shall consistently present in the Non-hazardous Waste Management Plan the proposed criteria and standards for landfill site selection, construction and operation, all of which shall comply with applicable regulatory requirements.

87.9 TMAC RESPONSE FOR GN-15

- The description of landfill arrangements is provided in Annex V1-7, Section 4.5 of P5-28 Hope Bay Project Boston Surface Infrastructure Preliminary Design. TMAC did not include this information in the management plan as it is not required for the operational implementation of the Non-hazardous Waste Management Plan (Package P4-13) at this stage. Once Issue for Construction (IFC) designs have been prepared, and 60 days prior to operation of the proposed landfill, appropriate layouts will be included in the Non-hazardous Waste Management Plan.
 - Monitoring of waste facilities is described in Section 5 of Annex V1-7, P4-13 Hope Bay Non-hazardous Waste Management Plan. Monitoring of water collected in the landfill sump is addressed in Section 3.8 of Annex V1-7, P4-8 Hope Bay Project Boston Water Management Plan. TMAC considers that monitoring of the proposed landfill is adequately covered within these plans.
- The proposed criteria and standards for landfill site selection, construction and operation, and applicable regulatory references are provided in Section 4.5 of Annex V1-7, P5-28 Hope Bay Project Boston Surface Infrastructure Preliminary Design. TMAC considers that site selection and construction information is not appropriate for inclusion in operational management plans. Once IFC designs have been prepared, and 60 days prior to operation of the proposed landfill, additional specific operational criteria will be included in the Non-hazardous Waste Management Plan as appropriate.

88. ID #GN-16

88.1 DEPARTMENT

Environment

88.2 ORGANIZATION

Government of Nunavut

88.3 SUBJECT/TOPIC

Waste management: hazardous waste disposal in permafrost

88.4 REFERENCES

- FEIS Vol. 3, Project Description and Alternatives.
- P4-15 Hope Bay Hazardous Waste Management Plan 2017.

88.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent stated the following in Vol. 3 Project Description and Alternatives:

"Bottom ash generated from open burning and incineration will be characterized, and ash which conforms with criteria outlined in the Environmental Guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities (GN 2011) will be disposed of in the landfill, and ash which does not meet these criteria will be placed underground with backfill material or shipped off site for disposal" (s. 4.4.6.1 P4-15).

"There will be no hazardous waste disposal facilities on site. ... Hydrocarbon and ammonium nitrate fuel oil contaminated solids will be placed underground as backfill" (s. 4.4.6.2 P4-15).

"Hydrocarbon contaminated solids will be placed underground and or in a landfarm depending on quantities and the substrate" (s. 4.4.6.3 P4-15).

The Proponent stated in P4-15 Hope Bay Hazardous Waste Management Plan 2017.

"Materials which do not meet landfarm discharge criteria will stored onsite to be backfilled underground in the permafrost zone (for soils and gravel/rock), or deposited in the Tailings Impoundment Area (TIA) (water).

Plastic bags transported off site to a licensed disposal facility or if approved by the Inspector of Mines, backfilled underground with other ammonium nitrate contaminated waste"

Bottom ash that does not meet appropriate criteria will be transported off site to a licensed disposal facility (see Table 4.1 p. 11).

88.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The proposed waste management options include disposal of contaminated soils and hazardous incinerator ash in the mine space underground, or Tailings Impoundment Area (underwater). Placing hazardous waste in permafrost should not be recommended considering the potential contamination of ground water. Placing hazardous waste in the Tailings Area should not be recommended considering the potential contamination of surface and ground water.³

88.7 REVIEWER'S RECOMMENDATIONS

The Proponent shall prove that underground disposal of hazardous waste in permafrost or tailing area meets National and Territorial regulatory standards and will not cause contamination of ground and surface water.

Management of hazardous waste shall be consistently presented in the Waste Management Plans

88.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN suggests the following Terms and Conditions:

- The Proponent shall provide technical and regulatory justification for underground disposal of hazardous waste in permafrost or tailing area.
- The Proponent shall update the Hazardous Waste Management Plan to include the regulatory criteria for underground disposal of hazardous waste in permafrost or tailing area or exclude these options from the plan.

88.9 TMAC RESPONSE FOR GN-16

TMAC does not intend to dispose of hazardous waste in the Doris Tailings Impoundment Area (TIA) and the Hazardous Waste Management Plan (Annex V1-7, Package P4-15 Hope Bay Project Hazardous Waste Management Plan) will be updated accordingly.

As per Table 4 in Annex V1-7, P4-15 Hope Bay Project Hazardous Waste Management Plan, the only hazardous waste materials proposed for potential disposal within the underground

mines are materials which do not meet landfarm discharge criteria (hydrocarbon contaminated materials) and plastic bags from pre-packaged explosives containers, with approval from the mines inspector.

The practice of disposal of hydrocarbon contaminated material and plastic bags from pre-packaged explosives containers within the underground mine is an approved practice under the existing Doris Water Licence (2AM – DOH1323).

TMAC acknowledges the inconsistency between FEIS Vol. 3, Project Description and Alternatives and Annex V1-7, P4-15 Hope Bay Project Hazardous Waste Management Plan in regards to the disposal of bottom ash generated from open burning and incineration. To clarify, TMAC does not intend to dispose of bottom ash generated from open burning and incineration in the underground mines; this is consistent with the provided Hazardous Waste Management Plan (Annex V1-7, P4-15 Hope Bay Project Hazardous Waste Management Plan).

Boston Mine is located completely within permafrost as described in (Annex V1-7, P5-13 Hydrogeological Characterization and Modeling of the Proposed Boston, Madrid South and Madrid North Mines, Hope Bay Project). As a result there is no interaction with surface or groundwater. At Madrid North and Madrid South Mines, mining extends to the talik and as described in Section 5.3 of (Annex V1-7, Package P5-13 Hydrogeological Characterization and Modeling of the Proposed Boston, Madrid South and Madrid North Mines, Hope Bay Project) there could be groundwater flow from these mine to surrounding lakes. Windy Lake could observe 0.1 m³/day of flow from Madrid North mine while Patch Lake may receive 0.3 m³/day of flow from Madrid North mine and 0.6 m³/day from Madrid South mine but the travel time for reaching these lake is greater than 1,000 years. Considering the average annual flow-through for Windy and Path Lakes are 4.4 million m³ and 1.2 million m³, any groundwater flows from these mines are insignificant (0.003% and 0.007%) respectively.

89. ID #GN-17

89.1 DEPARTMENT

Environment

89.2 ORGANIZATION

Government of Nunavut

89.3 SUBJECT/TOPIC

Vegetation: rare plants

89.4 REFERENCES

- FEIS Main Volume, Sec 3.2.1. p.3-11
- FEIS Vol. 8, s. 8.3.2.2. p.8-38, 8.5.3.3 - Vegetation and Special Landscape Features

89.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent states in Main Volume, s. 3.2.1., p.3-11:

"Highlights of the mitigation measures incorporated into Project design included: establishing buffer zone from known rare plants"...

The Proponent states in Vol. 8, s. 8.3.2.2. p.8-38:

"Rare plant and lichen species surveys were primarily located in or near proposed Footprints. As a result, assessing effects to rare plants based on known locations does not provide an indication of effects to potential habitat in the LSA. Therefore, ecosystems and landscape features that have greater potential to support rare plant habitat such as cliffs, marine beaches and shores, and certain wetlands are included in the assessment of Special Landscape Features."

The Proponent states in Vol. 8, s. 8.5.3.3 Mitigation Measures for Specific Potential Effects or VECs. Rare Plant and Lichen Mitigation Measures:

"In addition to the avoidance measures identified for rare plants and lichens, management and mitigation measures for rare plants and lichens will include the following:

- include the location of known rare plants/lichens on Project maps to allow for incorporation into project planning;
- create exclusion zones (i.e., temporary fences) around priority rare plant and lichen habitats where these are close to proposed infrastructure to avoid disturbance; and
- make site-specific adjustments, where feasible, to avoid identified rare plants."

89.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Guidelines for the preparation of an Environmental Impact Statement for Hope Bay Mining Ltd.'s Phase 2 Hope Bay Belt Project, p. 59 (2012) require that the Proponent assess the "Potential impacts to abundance and diversity of vegetation due to Project activities", "Potential impacts to specific vegetation coverage and species composition...", provide a "Discussion of the management measures for minimizing/mitigation of disturbances to plant associations...". Rare and protected plants are typically presented as indicator of plant diversity and have to be included in the discussion about effects on plant associations. Inclusion of rare plants in the assessment of Special Landscape Features is noted, but it does not directly address the effects of the project on rare plants located within its footprint

The Proponent's commitment to avoid identified rare plants is noted and welcomed, however no rationale provided in the FEIS on the size of the exclusion zone and no information presented on how many locations would be avoided and how many would be destroyed by the project.

89.7 REVIEWER'S RECOMMENDATIONS

- The Proponent shall provide specific details on mitigation to avoid destruction of rare plant habitats.

89.8 PROPOSED TERM AND CONDITION/COMMITMENT

- TMAC shall develop a monitoring and management plan for rare plant habitats

89.9 TMAC RESPONSE FOR GN-17

TMAC will revise the WMMP to include a section on rare plant mitigation that addresses the reviewer concerns. TMAC will include a summary of potential rare plant habitat loss in its annual summary of habitat loss due to the Project footprint. This summary will be provided in the annual WMMP compliance report.

This commitment to including a section on Rare Plant mitigation of rare plant habitat loss to the Project footprint in the annual WMMP compliance reporting does not require there to be a specific management plan for vegetation or a Project Term or Commitment.

The mitigation plan will include the following components that have been included in the FEIS, that includes mitigation by Project design (i.e., avoidance of rare plant habitat) and operation.

The Hope Bay Project avoids sensitive ecosystems and rare plants and lichens where possible in a two-step process that follows the mitigation hierarchy of avoid and mitigate:

1) Avoiding ecosystems where possible which support more rare plants.

TMAC conducted sensitive ecosystem mapping prior to design of the Madrid-Boston (Phase 2) Project, which included rare plants. Project infrastructure was designed to avoid ecosystems that support rare plants, e.g., wetlands.

2) Where possible, avoiding rare plants observed during baseline surveys.

Mitigation measures identified in the FEIS to reduce effects to rare plant species include:

- a survey was conducted of the Project footprint by an expert rare plant botanist to determine the location of rare plant habitats and rare plants during baseline studies;
- implementing dust control on all-season roads;
- inclusion of the location of known rare plants/lichens on Project maps to allow for incorporation into project planning (i.e., avoidance); and
- making site-specific adjustments, where feasible, to avoid identified rare plants.

90. ID #GN-18

90.1 DEPARTMENT

Environment

90.2 ORGANIZATION

Government of Nunavut

90.3 SUBJECT/TOPIC

Disruption of Caribou Movements

90.4 REFERENCES

- FEIS Vol. 4, s. 9.8.4.7 - Significance Determination (Table 9.8- 24)
- FEIS Vol. 4, s. 9.2.6.2 - Baseline Data for Caribou
- FEIS Vol. 4, s. 9.8.1.2 - Effects Evaluated in the Assessment
- FEIS Vol. 4, s. 9.8.3.2 – Disturbance
- FEIS Vol. 4, s. 9.8.3.3 - Disruption of Movement
- FEIS Vol. 4, s. 9.9.5.3 – Disruption of Movement
- FEIS Vol. 4, s. 9.8.3.8 - Evaluating Impacts on Herds
- FEIS Vol. 4, s. 9.22.1 - Caribou
- FEIS Annex V8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, s. 3.1.5.3 - Road Crossing Monitoring
- Wilson et al. (2016).
- Kite et al. (2017).
- Vistnes, I. and C. Nellemann. (2007)
- Scrafford et al. (2018).

90.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Project is located within the core ranges of the Dolphin and Union (spring, winter and fall), Ahiak (fall and winter) and Beverly (winter) herds (FEIS Vol. 4, s. 9.2.6.2). Most notably, the Project lies within the spring and fall migratory corridors of Dolphin and Union caribou.

During preparation of the FEIS, elders and lands users participating in caribou workshops identified the potential for the “all-weather road and mine infrastructure to alter caribou migration as a possible effect with a high potential to impact caribou without mitigation because it could affect many caribou” (FEIS Vol. 4, s. 9.8.1.2). The Proponent addresses this potential impact by: (1) estimating the level of interaction between caribou and the project during migrations; (2) estimating the likely effects of the Project on migrating caribou;

(3) applying mitigation measures intended to reduce disruption of movements; (4) predicting the residual effects after mitigation has been applied; and (5) designing monitoring programs to verify the predictions.

Based on the outcome of this process, the Proponent concludes the residual effect following mitigation will be negligible in magnitude, medium in duration, of intermittent frequency, and reversible. This effect is rated as Not Significant for all herds surrounding the Project with a medium level of confidence (FEIS Vol. 4, s9.8.4.7). Similar determinations are reached for other species including grizzly bear.

90.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The Proponent's evidence does not support the level of confidence assigned. Applying the precautionary principle broadly, there are multiple areas within the FEIS and its associated management plans where: (1) effects have been potentially underestimated; (2) mitigation measures are applied that are of unproven effectiveness or are inadequate; and (3) proposed effects monitoring to verify impact predictions is absent or insufficient. Collectively, these areas of concern lead to compounded uncertainty around the residual impact prediction. The GN states that confidence in this residual impact prediction is arguably low. The following summarizes the areas of concern.

Levels of Caribou Interaction with the Project

Caribou from three herds regularly move through the area occupied by the proposed Project. Information from collars shows that the Dolphin and Union herd, for example, crosses the Project Development Area (PDA), including the proposed all-weather-road to Boston, during its spring and fall migrations, and while circulating within its winter range (see Figure 1 below). To assess the disturbance of caribou and the disruption of movements, the Proponent quantified the levels of interaction between collared caribou

and the PDA and the Project's zone-of-influence (ZOI). The Proponent used three hypothetical scenarios for the Project's potential ZOI were used that varied in size. The results indicated, for example, that 11% of collared Dolphin and Union Caribou entered the PDA and between 14 to 27% encountered the Project's ZOI depending on the scenario selected (Vol. 4, s. 9.8.3.2 and s. 9.9.5.3). Most of these encounters (75%) occurred during migrations, particularly during the fall. Assuming the movements of collared caribou are representative of a herd, these findings suggest that between 10-18% of Dolphin and Union caribou encounter the Project during migrations. Results for other herds showed similar levels of interaction in some seasons. For example, depending on the scenario, between 14 and 23% of Ahik collars encountered the Project's ZOI with most of these encounters being in the fall (75%).

The Proponent argued that the smaller ZOI scenario is more likely to represent the true ZOI. When using the smallest ZOI, between 10-14% of some herds are predicted to encounter the Project. The GN states that this is not an insignificant level of interaction. The GN further states that there are some problems with the Proponent's conclusions respecting a smaller ZOI. This issue will be further discussed at GN comment 21.

Overall, on the topic of herd level interactions with the Project, the GN concludes that: (1) a substantial proportion of caribou in some herds are likely to encounter the Project, in particular during migrations; (2) estimated encounter rates vary widely depending on the assumptions made; (3) predictions regarding the Project's ZOI are associated with considerable uncertainty; (4) this uncertainty should be incorporated in the assessment of movement disruption and reflected in the residual impact determination; and (5) the Proponent must determine the Project's actual ZOI as a key component of an effects monitoring program (see GN comment 21).

Permeability of the Project to Caribou Movements

The extent to which caribou movements are disrupted depends not only on the proportion of individuals within a herd that encounter the Project but also on the Project's permeability to caribou. The Project's permeability is dependent on several factors including the extent to which the physical structure or appearance of infrastructure presents a barrier or deterrent to caribou. Sensory disturbance of caribou in response to activities, such as traffic on haul roads or the operation of heavy equipment at mine sites, can also reduce permeability (create barriers) to movement.

With respect to physical barrier effects, the GN notes that:

- The Proponent did not provide sufficient information on final road design to properly assess potential effects.
- The Proponent's mitigation measures for road design to facilitate caribou movements are of unproven effectiveness.

- The development of an aerial or on-ground powerline alongside the Doris to Boston all-weather road alignment is an additional structure briefly noted (but not assessed) in the FEIS that may have added effects on permeability dependent on final design.

Further details are provided in GN comment 19 (Road Permeability to Caribou).

With respect to sensory disturbance from Project activities causing disruption of caribou movements, the GN notes that:

- The Proponent is focused on assessing and mitigating road traffic effects. However, activities at mine sites connected by these roads will also contribute to the disruption of movements and should be subject to heightened mitigation during key movement periods for caribou.
- The Proponent provided that traffic levels on Project roads are below levels documented to cause disruption of caribou movements (FEIS Vol. 4, s. 9.8.3.3 Disruption of Movement). However, the GN maintains, based on the available literature that is most relevant to the Project, that predicted traffic levels are within a range where significant disruption of movements could occur unless traffic is properly monitored and managed. Several inconsistencies in the traffic rates cited within the FEIS are also noted.
- In the WMMP, the Proponent proposed several mitigation measures to manage traffic activity on Project roads. These mitigation measures rely largely on incidental driver observations, lack intensity and are not triggered until caribou are already within what is likely the road's ZOI. Overall, the GN states these measures are inadequate.

Further details are provided in GN comments 20 and 22 (Traffic Monitoring and Management and Caribou Protection Measures, respectively).

Assessment of Herd Level Impacts

The Proponent assessed the impacts of disturbance on individual energetics and its consequences for body condition, reproduction, survival and ultimately population abundance in order to assess herd impact levels. This assessment is carried out using two modelling exercises (FEIS Vol. 4, s. 9.8.3.8). Although useful for assessing the significance of disturbance effects, there are several limitations in using this approach to make inferences about Project impacts resulting from disruption of movements:

- Like all models, those used in the assessment involve numerous assumptions. Although the models incorporate variance in parameter estimates, this only addresses the precision, and not the accuracy, of results. The accuracy of

model outputs is therefore uncertain until validated by observational data on caribou abundance changes.

- The energetics models consider individual encounter rates and duration of encounter (residency time) in order to estimate the immediate energetic cost of an encounter with a disturbance source. By this method, energetic cost is assumed to be proportional to residency time within a ZOI around the source. This approach may underestimate the costs of a disturbance event that disrupts movements such as a migration. For example, caribou encountering a road may be deflected along it until they find a suitable crossing point or away from it. This type of encounter could result in a failure to complete migration, a delay in migration, and/or a long deviation in travel route. Wilson et al. (2016) found that some caribou were delayed by up to 3 weeks in crossing a mine haul road during migration. The energetic costs of changes in travel time and distance of this magnitude may not be fully captured by estimating residency time within a ZOI. Migrating caribou may experience increased energetic costs long after exiting a ZOI. Indeed, a disturbed caribou's response is likely to involve exiting a ZOI as soon as possible, minimizing residency time but not necessarily the cost of disrupted travel.
- Changes in herd abundance are considered the most important effect in this approach. However, changes in the timing and routing of migration routes, and changes in distribution within seasonal ranges are themselves important impacts. Changes in migration timing or route, for example, could affect access to caribou by residents of the Kitikmeot. Changes in the timing or routing of the spring migration of Dolphin and Union caribou across the sea-ice to Victoria island could have consequences for survival or reproduction. Changes in seasonal range use, including reduced access to parts of a range, may lead to increased overlap between neighboring herds and/or overgrazing of parts of the range. Disruption of migration routes can lead to changes in distribution and range use that are not immediately apparent, but instead emerge gradually over years. Evidence suggests that migration and winter range use of the Lorrillard caribou herd is changing in response to the presence of the Meadowbank Mine and all-weather access road in the Kivalliq region of Nunavut (Kite et al. 2017). These changes may come about as a consequence changes in behavior (behavioral responses) rather than because of increased energetic expenditure associated with discrete disturbance events (and the resultant demographic consequences).

Based on the foregoing, the GN concludes that the Proponent's energetics-based herd level assessment has limited purposive value.

Monitoring Project Effects on Caribou Movements

Essential components of an effects monitoring program include monitoring Project effects on caribou movements, especially migratory behavior of the Dolphin and Union herd and connectivity within its winter range. Impact prediction verification is fundamental in this case given of the current uncertainty in the assessment process.

Project effects on caribou movements will need to be rigorously monitored. During review of the DEIS, the GN recommended revising the WMMP to include a program to periodically analyze caribou collar data using methods such as those used by Wilson et al. (2016) and Blum et al. (2015) to: (1) detect changes in caribou speed and direction of movement in relation to the Project; and (2) assess the permeability of the Project to caribou (GN technical comment 16).

Current plans in the WMMP for monitoring disruption of caribou movements are as follows (FEIS Annex Vol. 8-3, s. 3.1.5.3):

- "TMAC will conduct an analysis of collar data to determine if caribou are avoiding crossing Project roads following the methods described in Wilson et al. (2016) and Blum et al. (2015). This analysis will be conducted following construction of the Boston road comparing pre-and post-construction movement patterns across the road, should the data prove suitable (e.g., sample size, location reporting period) for robust analysis.
- During migration, TMAC will conduct height of land surveys during spring and fall migration to examine if caribou are present up to 4 km from the road. "Should height- of-land surveys determine that caribou are turning around and moving away from the road, TMAC will work with the Inuit Environmental Advisory Committee (IEAC) to evaluate if the design and execution of snow track surveys is required and/or acceptable to monitor caribou tracks as they approach the road."

This monitoring program is inadequate for the following reasons:

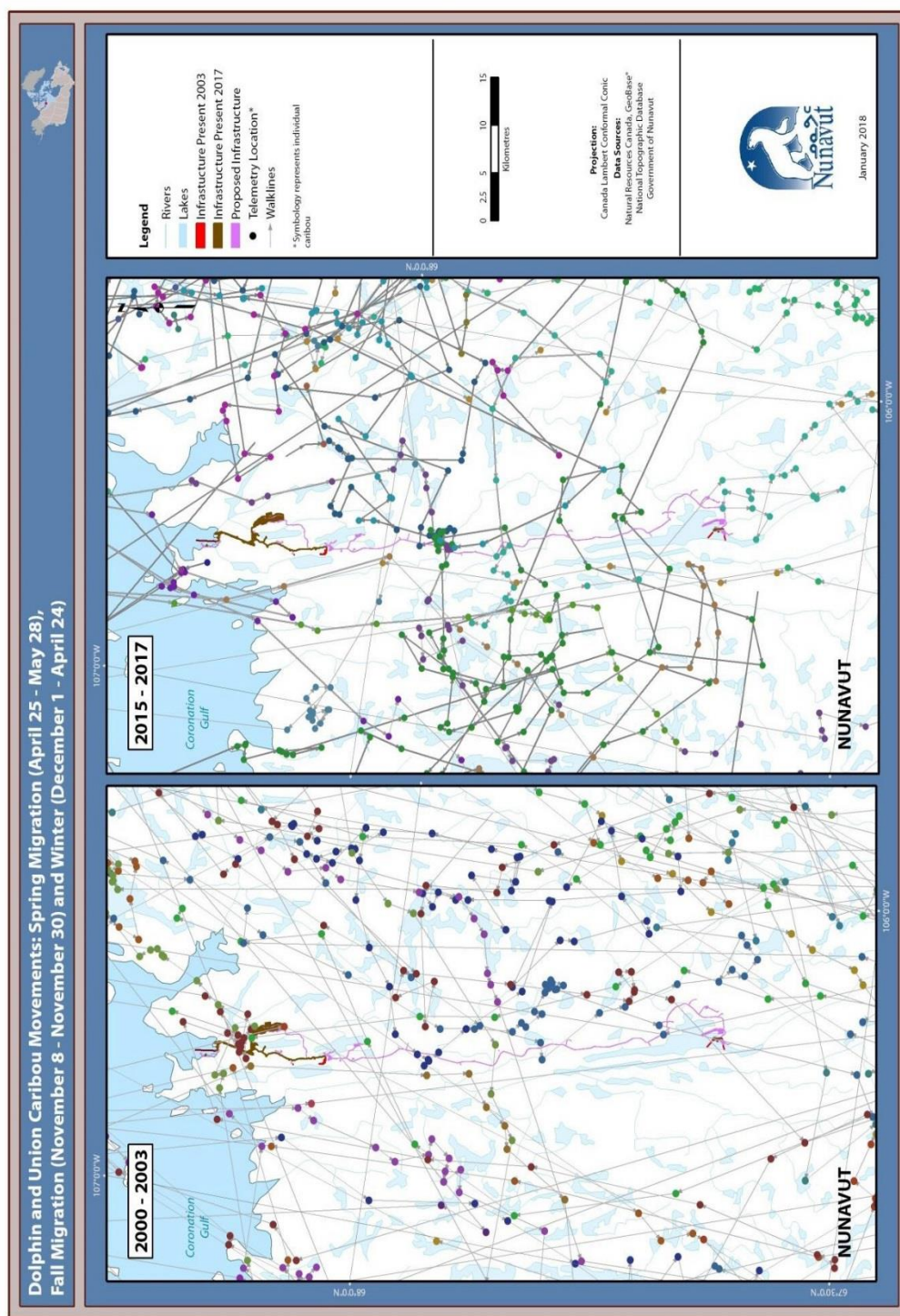
- The analysis of collar data is planned only once following construction of the Boston road.
- The analysis of collar data relies on there being sufficient collar data to support an analysis. However, there is no specified commitment on the part of the Proponent to ensuring sufficient collar data are obtained. A recent study of caribou movements near the Meadowbank mine highlighted the importance of obtaining adequate collar data to monitor Project effects (Kite et al. 2017). In this case, despite 10 years of operating a mine and access road, there were insufficient data to draw definitive conclusions about impacts on the movements of caribou. Disruption of movements is an important effect necessitating a strong commitment from the Proponent to obtain an adequate

dataset.

- The proposed height-of-land (HOL) surveys are of unspecified study design and intensity (spatially and temporally) making it impossible to determine whether they will be useful for assessing this effect. Although the GN supports use of HOL observations to trigger caribou mitigation measures (see GN comment 22 – Caribou Protection Measures), they are not adequate as the primary or sole means of monitoring disruption of caribou movements. Notwithstanding the lack of details on HOL methods, these types of behavioral observations may be too insensitive and are typically conducted at too small a spatial scale to capture the landscape or herd level responses to human activities (see Vistnes and Nellemann (2007)). Wilson et al. (2016) detected disruption of caribou within a 14 km ZOI around a mine haul road. Wilson et al. (2016). used GPS radio-telemetry (collars) to collect high-resolution, landscape scale data on movements. The effects on caribou revealed by these high- resolution data would likely not be detected by HOL monitoring. Also of note is a recent study in northern Alberta which demonstrated that wolverine avoid and increase their speed of movement near industrial roads with traffic levels < 2.5 vehicles per hour (Scrafford et al. 2018). This study also used GPS radio-telemetry to demonstrate clearly that even low-use roads such as those proposed for the Project can significantly affect the movement of wildlife and that such effects can be detected if appropriate methods are used.
- The proposed monitoring is only planned for roads. Other parts of the Project may disrupt the movements of caribou. Monitoring of this effect should be extended to cover all components of the Project.
- Snow track surveys are a potentially useful method for monitoring road permeability to caribou at a local scale. However, use of this method is dependent on results from HOL surveys.

Additional concerns, related to caribou monitoring, are noted in GN comment 21 and 22 (Caribou Effects – Zone-of-Influence Monitoring; Caribou Protection Measures, respectively).

Figure1. Track lines of collared Dolphin and Union caribou in proximity to the Project and Hope Bay Belt infrastructure.



90.7 REVIEWER'S RECOMMENDATIONS

The GN recommends that:

- The Project's effects on caribou movements (e.g. speed, direction, tortuosity) should be monitored at a regional scale, throughout the life of the Project, using caribou collar data. The collar monitoring program should be designed and resourced by the Proponent to ensure it has sufficient statistical power to detect possible Project effects on caribou movement, including effects related to roads and mine sites. The study area should encompass all components of the Project, including mine sites and roads. Methods of study design and data analysis should be guided by relevant literature. Analyses of collar data to estimate Project effects on caribou movements should be conducted and reported during the initial operations phase of the Project (once sufficient data have been acquired) and then updated periodically throughout the life of the Project when changes in Project scale, intensity or nature occur.

The Government of Nunavut collects data from collared caribou to monitor the movements of herds at a regional scale. These GN collar programs are not designed to monitor Project-specific effects but the data collected by these programs may be useful in Project effects monitoring. The GN will make caribou collar data, collected by its regional collar programs, available to TMAC for use in the Project effects monitoring required under this term and condition.

- The Project's effects on caribou movements should be monitored at a local scale using behavioral observations from height-of-land surveys and a snow track study. The snow track study should be designed to quantify road permeability to caribou using a series of transects parallel to and at varying distances from the road. These local studies may be limited to the area along the Boston to Doris all-weather road and may be discontinued after definitive results are obtained, as determined by NIRB.

90.8 PROPOSED TERM AND CONDITION/COMMITMENT

- The Project's effects on caribou movements (e.g. speed, direction, tortuosity) shall be monitored at a regional scale, throughout the life of the Project, using caribou collar data. The collar monitoring program shall be designed and resourced by the Proponent to ensure it has sufficient statistical power to detect possible Project effects on caribou movement, including effects related to roads and mine sites. The study area shall encompass all components of the Project, including mine sites and roads. Methods of study design and data analysis shall be guided by relevant literature. Analyses of collar data to estimate Project effects on caribou movements shall be conducted and reported during the initial operations phase

of the Project (once sufficient data have been acquired) and then updated periodically throughout the life of the Project when changes in Project scale, intensity or nature occur.

The Government of Nunavut collects data from collared caribou to monitor the movements of herds at a regional scale. These GN collar programs are not designed to monitor Project-specific effects but the data collected by these programs may be useful in Project effects monitoring. The GN shall make caribou collar data, collected by its regional collar programs, available to Proponent for use in the Project effects monitoring required under this term and condition. For greater certainty, should the GN's aforementioned data be insufficient for the Proponent to fulfil this Term and Condition, the Proponent shall provide additional resources to the GN to operationalize this requirement. Any additional resources shall be provided pursuant to an appropriate contribution agreement agreed to by the Proponent and the GN.

- The Project's effects on caribou movements shall be monitored at a local scale using behavioral observations from height-of-land surveys and a snow track study. The snow track study should be designed to quantify road permeability to caribou using a series of transects parallel to and at varying distances from the road. These local studies may be limited to the area along the Boston to Doris all-weather road and may be discontinued after definitive results are obtained, as determined by NIRB.

90.9 TMAC RESPONSE FOR GN-18

TMAC understands the importance of migration and movement of caribou and based on experience from the existing Doris Project and best available TK and science information, has designed the Madrid-Boston (Phase 2) Project with appropriate engineering and mitigation to allow caribou to cross the road. The Government of Nunavut (GN) asked for four items in it's comment: 1) regional monitoring of caribou crossing the Project using collars, 2) funding for collars, and 3) behaviour surveys, and 4) snow track surveys.

TMAC has already committed to conduct monitoring of crossings using satellite collars and cameras in the WMMP, and TMAC already has a Memorandum of Understanding (MOU) to provide funds for regional monitoring, including collars.

TMAC commits to updating the WMMP with more information on the proposed studies to monitor caribou crossing the Project site, including:

- Making it clear that the analysis of collared caribou crossing the site will be conducted periodically during the life of the Project.

- Conduct behaviour monitoring during height of land surveys, using standardized techniques.
- Conduct snow track surveys.

The GN also recommended that TMAC contribute to collar monitoring, stating: "The collar monitoring program shall be designed and resourced by the Proponent". TMAC already has a(MOU) with the GN whereby TMAC provides funds or in-kind support for the GN to conduct regional monitoring work on Dolphin and Union caribou, including the purchase of collars. The GN provides collar monitoring data to TMAC as it is public information and is a requirement in the MOU. This four year agreement expires in 2019. TMAC understands the importance of regional monitoring for caribou and is open to discussing a new MOU prior to the expiry of the existing MOU.

With this commitment to update the WMMP, no additional terms or conditions are required.

Discussion:

More information on the three types of monitoring is provided below:

1. Satellite Collar Analysis to Examine Caribou Crossing the Project

TMAC has already committed to conducting a scientific analysis of satellite collar data in the Madrid-Boston (Phase 2) WMMP as described by the GN in their comment. Section 3.1.5.2 of the WMMP (Volume 8, Annex V8-3) states that TMAC will conduct monitoring for caribou crossing the Project following the request made by the GN during the review of the DEIS, including:

"TMAC will conduct an analysis of collar data to determine if caribou are avoiding crossing Project roads following the methods described in Wilson et al. (2016) and Blum et al. (2015). This analysis will be conducted following construction of the Boston road comparing pre-and post-construction movement patterns across the road, should the data prove suitable (e.g., sample size, location reporting period) for robust analysis."

This monitoring is intended to be conducted periodically during the life of the Project. There appears to be confusion on this point, and so TMAC has committed (above) to clarify that this analysis will be conducted periodically during the life of the Project.

TMAC would like to point out that ensuring statistical power to detect possible Project effects is not possible as it is partly dependent on the number of caribou occurrences within the Local Study Area. The density of caribou surrounding the

Doris Project has historically been very low. It may not be possible to conduct the proposed analysis if insufficient collared caribou naturally use the Project area.

2. Behaviour Monitoring

Section 3.1.5.3 of the WMMP (Volume 8, Annex V8-3) describes that TMAC is planning to conduct surveys from the height of land during periods of caribou migration in locations where caribou are known to cross the road. The WMMP states:

"During spring and fall migration, when data indicates that the majority of road crossing events occur, TMAC will conduct additional monitoring to evaluate if caribou are near the road and guide mitigation. TMAC will continue to engage with the IEAC to identify locations where caribou are more likely to cross the Boston road. During migration, TMAC will conduct height of land surveys during spring and fall migration to examine if caribou are present up to 4 km from the road (the expected maximum sighting distance from hill tops). Survey methods will be refined with the IEAC prior to construction. Surveys will examine 1) if caribou are present, 2) caribou reactions to vehicles, 3) compliance with road rules to stop when caribou are near the road. Observations of caribou approaching the road will be communicated to the Environmental Manager, who will alert drivers to approaching caribou and remind them of the management steps should caribou be observed closer to the road."

These hilltop surveys include behaviour monitoring surveys (underlined above). The Government of NWT is currently developing a standardized method for behaviour monitoring to investigate short termed behavioural responses to stressors, such as vehicles. This monitoring is also designed to collect information useful for establishing energetic costs to caribou. TMAC will engage with the GNWT to use their standardized methods and include this information in the WMMP.

3. Snow Track Monitoring

Section 3.1.5.3 of the WMMP describes that TMAC is planning to conduct snow track surveys should the height-of-land surveys determine that caribou are avoiding the road, as described below:

"Should height-of-land surveys determine that caribou are turning around and moving away from the road, then TMAC will work with the IEAC to evaluate if the design and execution of snow track surveys is required and or acceptable to monitor caribou tracks as they approach the road. The survey transects and complete study design would be developed in consultation with the GN and IEAC. Results of the survey would be used to evaluate if and what kind of mitigation may be required for traffic on the AWR."

As discussed above, TMAC will update the WMMP so that it is clear that snow track surveys will be conducted for the Boston road. Should this method not collect sufficient data for analysis of caribou movements and road/Project crossing, then it may be discontinued in future iterations of the WMMP.

91. ID #GN-19

91.1 DEPARTMENT

Environment

91.2 ORGANIZATION

Government of Nunavut

91.3 SUBJECT/TOPIC

Road Design – Permeability to Caribou

91.4 REFERENCES

- FEIS Vol. 4, s. 9.8.4.7 - Significance Determination.
- FEIS Vol. 4, s. 9.8.3.3 - Disruption of Movement
- FEIS Vol. 4, s. 9.9.5.3 - Disruption of Movement
- FEIS Vol. 3, s. 3.7.4.2 - Animal Crossings
- FEIS Vol. 3, s. 3.7.4.1 – Typical Cross Section
- FEIS Vol. 3, s. 4.4.10 - Power
- FEIS Vol. 4, s. 9.8.1.1 - Caribou Workshops with Elders and Land Users.
- Wolfe et al. 2000
- Reimers and Colman 2006
- ERM 2014 and 2016
- Bissonette and Adair 2008
- Ruediger 2001
- Clevenger. and Huijser. 2009
- DDEC 2017

91.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent examined the potential for the Project to disrupt caribou movements leading to changes in migratory behavior, connectivity between seasonal ranges, and movements within seasonal ranges. The Proponent concluded that the residual effect on caribou movements following mitigation will be negligible in magnitude, medium

in duration, of intermittent frequency, and reversible. The Proponent rated this effect as "Not Significant" for all herds surrounding the Project with a medium level of confidence (see FEIS at [insert citation]).

Regardless of traffic levels, Project roads may present a physical barrier and deterrent to the movements of caribou. The Proponent's conclusion that caribou movements will not be significantly disrupted depends on the application of several mitigation measures for road design and maintenance that are intended to facilitate caribou movement. Specifically:

- "Mitigation currently in use for the Doris Project is proposed for Madrid-Boston to ensure that caribou can easily cross the all season road, including: 1) maintaining a low road height wherever possible, 2) blading snowbanks down to prevent snow drifts as part of normal road maintenance, and 3) installing road crossing structures where caribou are known to regularly cross". (FEIS Vol. 4, s. 9.8.3.3).

The Proponent further states that:

- "Mitigations for all season and winter roads are becoming standardized across the Canadian Arctic. Projects are designing road structures that promote caribou crossing, including low height and crossing structures such as ramps and bridges" (FEIS Vol. 4, s. 9.9.5.3 Disruption of Movement); and
- "It is expected that animals will be able to move freely across the majority of the all- weather road" (FEIS Vol. 3, s. 3.7.4.2).

91.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Despite their standard use in the Arctic, the Proponent's analysis in the FEIS lacks evidence that the proposed road design and maintenance mitigation measures will be effective. This creates uncertainty about the residual effects conclusion that there will be no significant disruption of caribou movements. The following issues are noted:

Road Design

While designing roads to promote caribou crossing is necessary, empirical evidence supporting the effectiveness of specific road design features is limited. The Proponent states that roads will be constructed to minimize their height above the surrounding land. Four types of road profiles may be used, dependent on underlying substrate conditions and permafrost considerations. These have minimum heights of 0.3, 1.0, 1.5 and 2.0 m above ground. The Proponent notes that less than 1% of road surfaces are predicted to be greater than 3 m high (and requiring an additional safety). The height of the remaining 99% of road surface is not predicted or estimated, including that along the 53 km Boston to Doris road (FEIS Vol. 3, s. 3.7.4.1). The extent to which Project roads will present a physical barrier or visual deterrent to caribou is therefore hard to assess. To be as cautious

as possible, the GN assumes an average height of 1.5m. Roads of this height are associated with the following issues.

For barren-ground caribou, behavioral observations suggest that caribou may be deflected by pipeline berms, elevated roads and snow berms greater than 1.5m high, because these present a visual barrier preventing caribou from seeing habitat on the other side of a road (Wolfe et al. 2000; Reimers and Colman 2006). Wolfe et al. (2000) recommended a road height of less than 1.2 m above ground level.

Camera trapping studies at the Ekati mine suggested less than 1% of caribou were deflected from haul roads (ERM 2014). The locations where caribou crossed roads were not significantly affected by road characteristics including height, shoulder slope, and grain size. Grain sizes of less than 0.3m (consisting of predominantly less than 0.1m grain), shoulder slopes of 18-27 degrees and road heights of between 1.2 to 1.75m above surrounding land appeared conducive to caribou crossing (ERM 2016). The GN notes two limitations from these studies. Small sample sizes may have limited statistical power. Additionally, the cameras used in this study provided a narrow view of the road and may not have caught all impacts of the road.

The lack of evidence to support specific road design features makes it challenging to assess road effects on caribou movements with certainty, even when a final road design is specified. Compounding this uncertainty, however, is the lack of information within the FEIS on the final structure of the Project's 90+ kilometers of roads.

The above-noted concerns about road height do not consider the added issue of snow accumulation and clearing along roads that may create snow banks that further raise the height of the barrier caribou face. The FEIS includes plans to clear snow from roads and blade snow banks down to as low a height as possible. However, the extent to which road maintenance will be successful in avoiding the development of snow banks along roads is unclear.

The Proponent has included a proposal to build power line in the FEIS. The proposed power line will be aerial or on ground between the Doris to Boston sites that runs alongside the 53 km road (FEIS Vol. 3, s. 4.4.10). Studies suggest caribou appear to be more sensitive to the roads when they run parallel to other linear feature such as pipelines (reviewed by Wolfe et al. 2000). Accordingly, the power line may be a further barrier to caribou. The design of the power line is not specified in the FEIS, making it difficult to assess impacts on caribou.

We invite the Proponent to provide the following in order to conduct a more accurate analysis of the foregoing issues:

- a best predication of the heights of the roads;

- additional information is required with respect to snow accumulation and clearing along the roads; and
- additional information regarding the design of the powerline.

In the absence of this information, it is reasonable assume that a large portion of the roads will have a height of greater than 1.5 m, since 2 of the 4 types of road profile planned for the Project have minimum heights of greater than this. One can then infer that a substantial portion of the Project's roads will exceed recommendations reported in the literature for caribou. These concerns about road height do not consider the added issue of snow accumulation and clearing along roads that may create snow banks that further raise the height of the barrier caribou face. The FEIS includes plans to clear snow from roads and blade snow banks down to as low a height as possible. However, the extent to which road maintenance will be successful in avoiding the development of snow banks along roads, such as the 53 km Doris to Boston section, is unclear.

Included within the FEIS is a proposal to build power line (aerial or on ground between the Doris to Boston sites that runs alongside the 53 km road (FEIS Vol. 3, s4.4.10). This is an added feature that may further contribute to the barrier effect of the road on caribou movements. Studies suggest caribou appear to be more sensitive to the roads when they run parallel to other linear feature such as pipelines (reviewed by Wolfe et al. 2000). However, the design of this power line is not specified in the FEIS so it is impossible to assess its effects on caribou movements.

The GN acknowledges the challenges in predicting the final structural attributes of roads at this stage in the Project. However, the absence of this information, combined with uncertainties about the effectiveness of snow mitigation and design of the power line, reduces the ability to accurately assess potential roads effects and reduces confidence in the residual impact conclusions for caribou.

Wildlife Crossing Structures

The Proponent included construction of wildlife crossing structures at various points along Project roads as a key mitigation measure in the FEIS (FEIS Vol. 4, s. 9.8.1.1.) These structures, including ramps, culverts or bridges, will be engineered to facilitate the movement of wildlife thereby reducing residual impacts on caribou movements. The Proponent states that these structures will help to minimize road effects on caribou migration (FEIS Vol. 3, s. 3.7.4.2).

The Proponent did not provide evidence as to the effectiveness of wildlife crossing structures. Pursuant to the studies referenced herein, the effectiveness of engineered wildlife crossings as a means to increase the permeability of roads to the movements of caribou and other wildlife on open tundra is unproven but likely low.

Studies on high-use roads in southern Canada and globally, have demonstrated that engineered crossing structures are generally only effective in facilitating wildlife movement across roads when: (a) They are accompanied by structures such as exclusion fencing or natural land-forms that have the effect of funneling animals towards the crossings (Clevenger, and Huijser, 2009), and (b) they are spaced appropriately, typically at intervals of less than 2 km for large mammals like caribou (Bissonette and Adair 2008; Ruediger 2001).

The migratory pathways and other movements of caribou generally span broad fronts such that herds may interact with a road at numerous points. This generality has exceptions such as water crossings and land bridges. The Proponent will need a high number of focal crossing structures in order for this method to be effective. Unless designed to be permeable along most of their alignment, roads may block the movements of some caribou entirely, delay crossing or result in deflections alongside the road until a suitable crossing point is located. At the Ekati Diamond mine, caribou crossing structures were originally used as a key mitigation measure to facilitate caribou crossing of haul roads. Subsequently, based on input from stakeholders, roads were designed and constructed to facilitate crossing along most of their length. In particular, crossings were placed along sections where important migration corridors overlapped the road (DDEC 2017).

Figure 1 shows the movements of collared Dolphin and Union caribou during the seasons they are present around the Project (i.e. fall migration, winter, spring migration). These caribou cross the Doris to Boston road at numerous points along its length. In order for this mitigation strategy to be viable, crossings will have to be responsive to this data.

The GN does not oppose building wildlife crossing structure along Project roads. However, the GN notes that the Proponent has not provided systematic evidence to support the use of these structures to enhance road permeability to wildlife movements. The GN cautions that the FEIS's reliance on these structures as a key mitigation measure for reducing road effects is highly speculative and reduces confidence in the residual impact conclusions for caribou.

91.7 REVIEWER'S RECOMMENDATIONS

- Following construction, the Proponent should undertake a survey to map the final structural attributes including height and slope of the Project's roads along the length of each road segment. The Proponent should use this data to generate maps showing road heights and shoulder slopes for inclusion in the annual report. These data should be made available for further assessment of potential road effects and for wildlife effects monitoring.
- The Project's Wildlife Mitigation and Monitoring Plan (WMMP) should be revised to include a systematic study to verify the viability of using wildlife crossing

structures significantly as a mechanism to increase the permeability of the Project's roads to caribou and other wildlife.

- The proposal to develop a power line between the Doris North and Boston sites should be removed from consideration as part of the current Project application. This proposal should be reviewed at a later date, as part of a separate application to NIRB, when details of the final design are available for review.
- The Proponent should revise the Project's WMMP to include a program to monitor and report snow bank heights along Project roads that allows for estimation of mean height and variance at a series of designated monitoring locations that are representative of snow conditions along roads.
- The Proponent should undertake additional effects monitoring programs to assess the permeability of the Project's roads to caribou. (See GN comment 21 – Caribou Effects Zone of Influence Monitoring and GN comment 16 Distribution of Caribou Movements)

91.8 PROPOSED TERM AND CONDITION/COMMITMENT

Following construction, the Proponent shall undertake a survey to create a geo-spatial model of the final structural attributes including height and slope, of the Project's roads along the length of each road segment. The data from this survey should be used to generate maps showing road heights and shoulder slopes for inclusion in the annual report. This model should also be made available for all intervenors for further assessment of potential road effects and for wildlife effects monitoring.

- The Project's Wildlife Mitigation and Monitoring Plan shall be revised to include a systematic study to verify the viability of using wildlife crossing structures to increase the permeability of the Project's roads to caribou and other wildlife.
- The Project's Wildlife Mitigation and Monitoring Plan shall be revised to include a program to monitor and report snow bank heights along Project roads that allows for estimation of mean height and variance at a series of designated monitoring locations that are representative of snow conditions along roads.

91.9 TMAC RESPONSE FOR GN-19

TMAC understands the importance of migration for caribou and has worked to ensure that the proposed Phase 2 roads are permeable to caribou. Further, we understand the GN's request for data to help them quantify the potential disturbance characteristics of the Phase 2 development on wildlife.

Based on the discussion below, the data requests of the GN, and suggestions for mitigation are addressed in the existing FEIS and the WMMP material, except for snow bank height monitoring. To that end:

TMAC commits to including methods and frequency of monitoring snowbank heights in the WMMP. This program will continue until operational snow management is characterized.

Based on the revisions to the WMMP, there is no required Project Term or Condition.

Discussion:

TMAC has designed the Boston all weather road to be easily crossed by all wildlife, including caribou. Mitigation to facilitate caribou crossing roads includes:

- TMAC produced environmental sensitivities mapping, which including high value travel habitats for caribou, such as eskers. This mapping was delivered to engineers to aid in the placement and design of the road.
- TMAC designed the road to be as low as possible to facilitate caribou crossing the road, while still protecting permafrost and maintaining road durability.
- Bridges over creeks and rivers are high enough to accommodate caribou to transit underneath the road (2 m; Plate GN-19-2). In total, there are 8 bridges of this type on the Boston road (Figure GN-19-1).
- TMAC worked with Elders and harvesters to identify areas that may require caribou ramps due to landscape features or observed caribou trails along the Boston road route as part of a focused survey of the AWR route in August, 2018. The majority of these trails were oriented north-south, parallel to the road. Elders and landusers identified locations of caribou trails and groups of caribou trails crossed the road route. Caribou ramps are planned for these locations (Figure GN-19-1).
- Following construction of the road, TMAC will work with Elders and harvesters through the Inuit Environmental Advisory Committee (IEAC) to assess if additional areas for the installation of caribou ramps are required.
- Following construction, TMAC will monitor the road crossing success of caribou using a GIS analysis of satellite collars that examines turning and movement speeds in relation to the road.
- TMAC will also monitor caribou ramps with wildlife cameras to examine their use.

In order to incorporate Traditional Knowledge and Inuit perspectives, TMAC conducted a series of caribou workshops with Inuit Elders and land users familiar with the Project location and region, who are active caribou harvesters, and many of

whom have extensive experience working at operating mines in Nunavut and NWT. TMAC held three workshops in 2016 and 2017, which included two site visits in April and August, 2017. Elders and land users reviewed the existing mitigation at the Doris site, the proposed mitigation for the Phase 2 Project and evaluated the Boston road route for caribou trails and identified locations where caribou ramps should be installed. After construction of the road Elders and land users through the Inuit Environmental Advisory Committee (IEAC), will be invited to inspect the constructed crossings.

The existing caribou ramps at Doris were inspected by the workshop participants (Plate GN-19-1) as well as the bridge structures (Plate GN-19-2) and road culverts. The existing road ramps were constructed in locations identified by Inuit Elders during a site visit. Workshop participants noted that caribou actively used all of the structures – there were caribou trails crossing at each structure (Plates GN-19-1 and 2). The planned Phase 2 road ramps have a similar design: 5:1 slope, small grained material, and approximately 10 m long.

Figure GN-19-1 displays the proposed Boston all weather road and the planned free-span bridges over creeks. The locations where Elders and landusers identified caribou trails and groups of caribou trails crossing the road are also displayed. Caribou ramps will be constructed at these locations. The satellite collar data for Dolphin and Union caribou during fall are overlaid on the road and proposed bridges and caribou ramps. Fall was chosen because that is when most of the road crossing events occur (FEIS Section 9.8.3.2, Figure 9.8-17). Most satellite collared caribou crossed the proposed road route at locations where Elders and landusers observed tracks on the tundra and suggested caribou ramps for the road (Figure GN-19-1).

At the completion of the workshop, participants provided suggestions for additional mitigation based on their accumulated experience with caribou, they agreed that the planned mitigation measures for caribou were appropriate, would protect caribou, and allow them to cross the road.

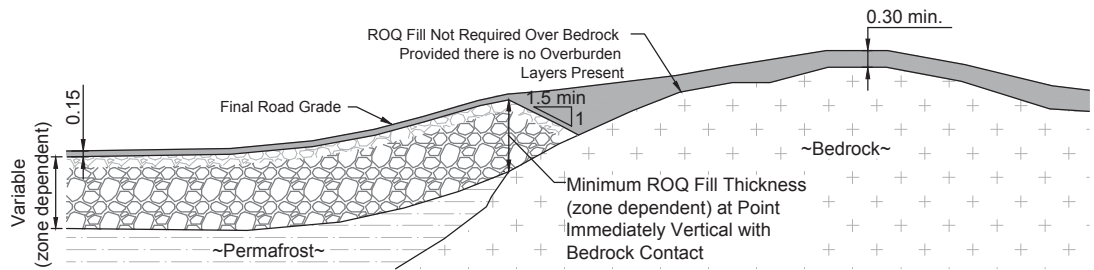
More information is provided below to address the GN's list of recommendations:

1. Structural Attributes of the Madrid-Boston Road

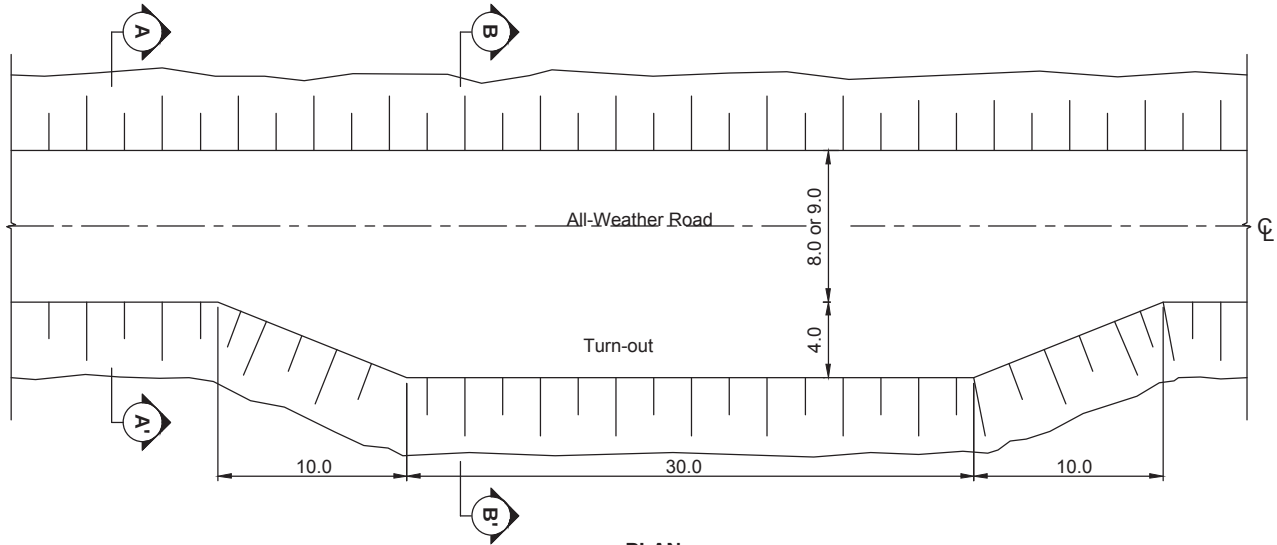
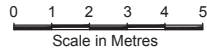
In comment GN-19, the GN reviewer states:

"The height of the remaining 99% of road surface is not predicted or estimated, including that along the 53 km Boston to Doris road (FEIS Vol. 3, s. 3.7.4.1). The extent to which Project roads will present a physical barrier or visual deterrent to caribou is therefore hard to assess."

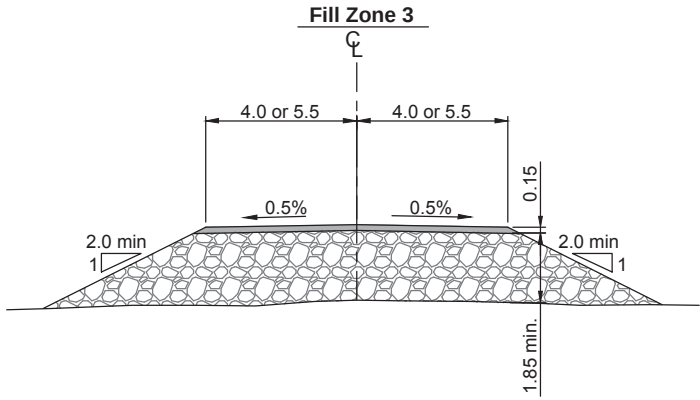
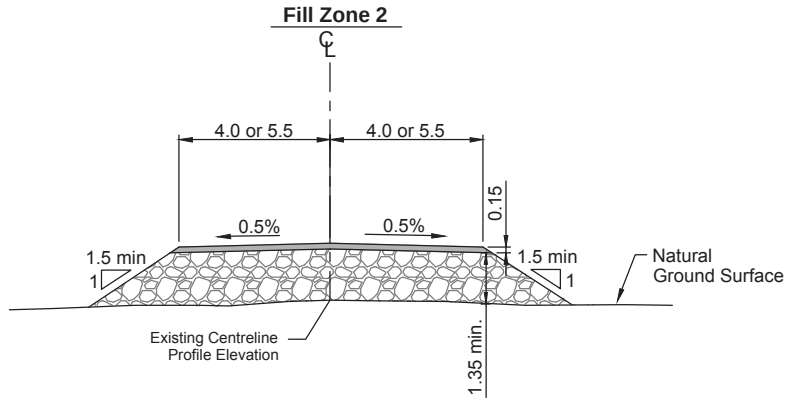
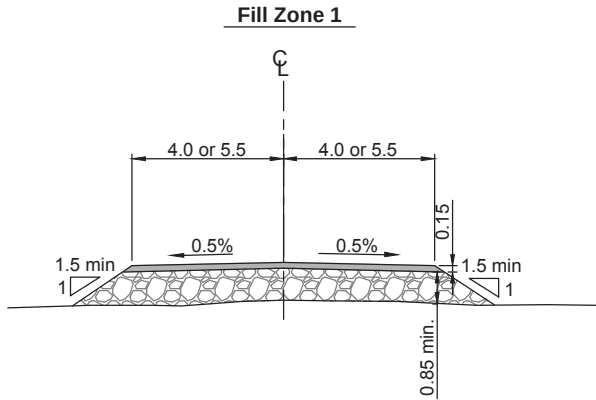
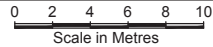
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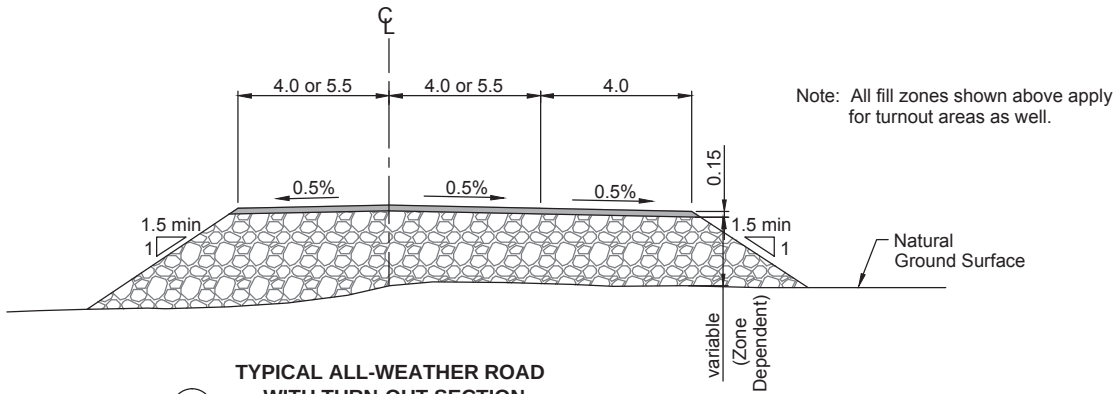
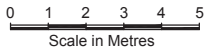
ALL-WEATHER ROAD PROFILE
TRANSITION FROM PERMAFROST TO BEDROCK



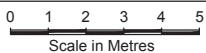
PLAN
TYPICAL ALL-WEATHER ROAD & TURNOUT



TYPICAL
ALL-WEATHER ROAD SECTIONS



TYPICAL ALL-WEATHER ROAD
WITH TURN-OUT SECTION



LEGEND

- Surfacing Material
- Run of Quarry Material

NOTES

- All dimensions in metres unless noted otherwise.
- Minimum design thickness must be maintained for all sections of the all-weather road including turnouts.
- Notes in this drawing apply to all other active drawings.

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Plate GN-19-1. Caribou trail leading to road crossing structure for the existing Doris to Madrid road.



Plate GN-10-2. Caribou trail leading under the bridge over a wetland area on the Doris to Madrid road.

To assess the height of the road, the GN assumed that most of the road is greater than 1.5 m high and requested a post-construction survey to map the road attributes. However, this information was included in the FEIS.

The design of the Madrid-Boston all weather road is described in the Project Description (Section 3.7) which directs the reader to the road design memo (Package P5-11; Hope Bay Project: Madrid-Boston All-Weather Road Preliminary Design). The height of the road is separated into 4 classes, based on the ground type, as listed on page six of Package P5-11 and summarized in Table GN-19-1.

Table GN-19-1. Road Height Characteristics of the Proposed Boston Road.

Road Zone	Ground Type	Slope Position	Height above ground	Shoulder Slope (rise:run)	Proportion of the road
Bedrock	exposed bedrock outcrop that may be blasted if necessary	Tops of hills	0.3 m	to be determined in the field	7.4%
Zone 1	even, un-patterned ground	Upslope and tops of hills	1 m	1.5:1	34.6%
Zone 2	transitional, un-patterned ground with indications of drainage areas, but no frost polygons	sides of hills	1.5 m	1.5:1	34.8%
Zone 3	patterned ground with observable frost polygons or wet areas	Wetlands, lowlands, and pans	2 m	2.0:1	23.1%

Overall, 42% of the road is ≤ 1 m tall, and 76.9% of the road is 1.5 m tall or less. Only 1% of the road is ≥ 3 m tall and will require safety berms. As stated by the GN:

For barren-ground caribou, behavioral observations suggest that caribou may be deflected by pipeline berms, elevated roads and snow berms greater than 1.5 m high.

76.9% of the road will be ≤ 1.5 m high. Therefore, the majority of the road will be easily crossed by caribou (without any designed ramps). Package P5-11, shows the distribution of the road Zones along the proposed road route. The route transitions between Zones on a fairly small scale (50-200 m). Therefore, regardless of where caribou encounter the road, there will be a segment below 1.5 m nearby that will allow them to cross the road.

Taller sections of the road (Zone 3; 2 m tall) will have lower shoulder slopes of 2:1 instead of the 1.5:1 used for Zones 1 and 2. This will aid caribou in crossing the road structure.

The road design memo (Package P5-11; Hope Bay Project: Madrid-Boston

All-Weather Road Preliminary Design) lists the design for crossing ramps in Figure GN-19-2, with the following design:

“Animal crossings [e.g., caribou ramps] will generally be located at horizontal bends in the road alignment and at junctions, with the final location of animal crossings to be determined by elders after construction has been completed. Animal crossings will consist of 10 m wide sections of the roadway where the shoulders are flattened to 5H:1V and topped with surfacing material. Typical plans and cross sections can be seen in Drawing MBR-36 (Attachment 2).”

Road cross sections are attached below as Figures GN-19-1 and 2.

The FEIS presented that the majority (76.9%) of the road is ≤ 1.5 m high. Therefore, caribou will be able to cross the road easily even without the installation of caribou ramps. With this information being presented in the FEIS, no post-construction survey of road dimensions is required.

2. Study of Crossing Ramps

TMAC has been evaluating the crossing of the existing Doris Project road by caribou, and will continue that evaluation for the Phase 2 development.

The GN's request to test the viability of caribou ramps to increase the permeability of the road has several methodological issues. Testing if caribou ramps increase the permeability of the road would require a road without road crossing structures as a control. The proposed monitoring plans will evaluate whether caribou cross the road at road crossings. Any study on when and where caribou cross the road is inherently biased because road crossing structures are preferentially placed at locations with greater numbers of caribou trails and where Inuit Elders and harvesters indicate that caribou are more likely to travel. For example, see Figure GN-19-1 where historic caribou movements across the proposed road route largely occur at locations where Elders and harvesters suggested installation of caribou ramps.

Despite these methodological concerns, TMAC has been evaluating the crossing of the road by caribou. The FEIS WMMP includes two studies to examine crossings by caribou of the road:

- a) Satellite collar analysis of caribou to examine their movements before and after crossing the road to determine if they are hesitating before crossing the road. This analysis can be updated to examine where caribou cross the road relative to the location of crossing structures.
- b) Camera monitoring of road crossing structures to determine if caribou are using these structures.

3. Transmission Line

TMAC will be producing power from diesel generators and is planning to add a set of six wind turbines to supplement diesel power generation. TMAC will have sections of transmission line connecting wind turbines to nearby facilities. Following completion of the Boston site, TMAC is also proposing to add an aerial transmission line from Madrid to Boston along the proposed all weather road at a later date. This transmission line will reduce potential environmental effects of fuel transfer, storage and gain efficiencies and safety for power generation belt wide.

The FEIS evaluated the potential effects of the Madrid to Boston all weather road on caribou. Disturbance was evaluated as indirect habitat loss in a zone of influence (ZOI). Disruption of movement was evaluated using reports from the Doris Project, other mining projects, and the scientific literature. This assessment of the all-weather road included the potential effects of the transmission line. A residual effect of habitat loss and disruption of movement was predicted for the Project. Mitigation has been proposed for both residual effects and no significant effects were predicted for caribou. TMAC has committed to monitoring for avoidance and crossing of the road by caribou.

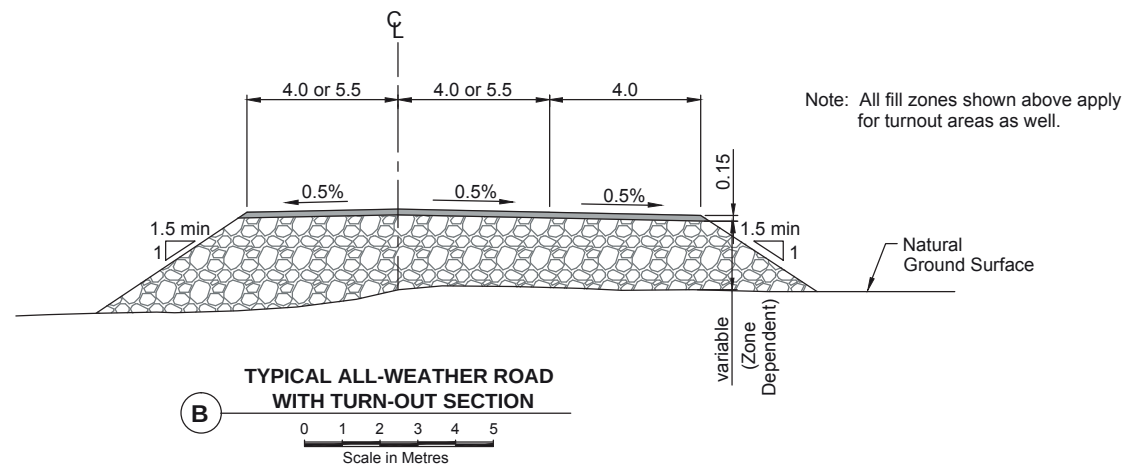
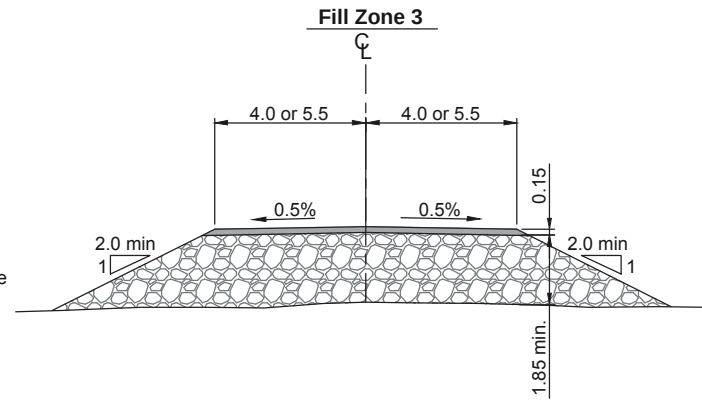
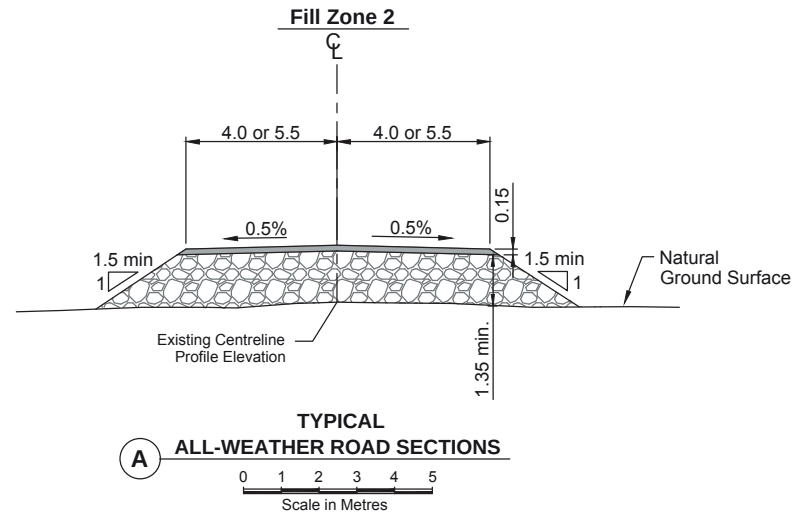
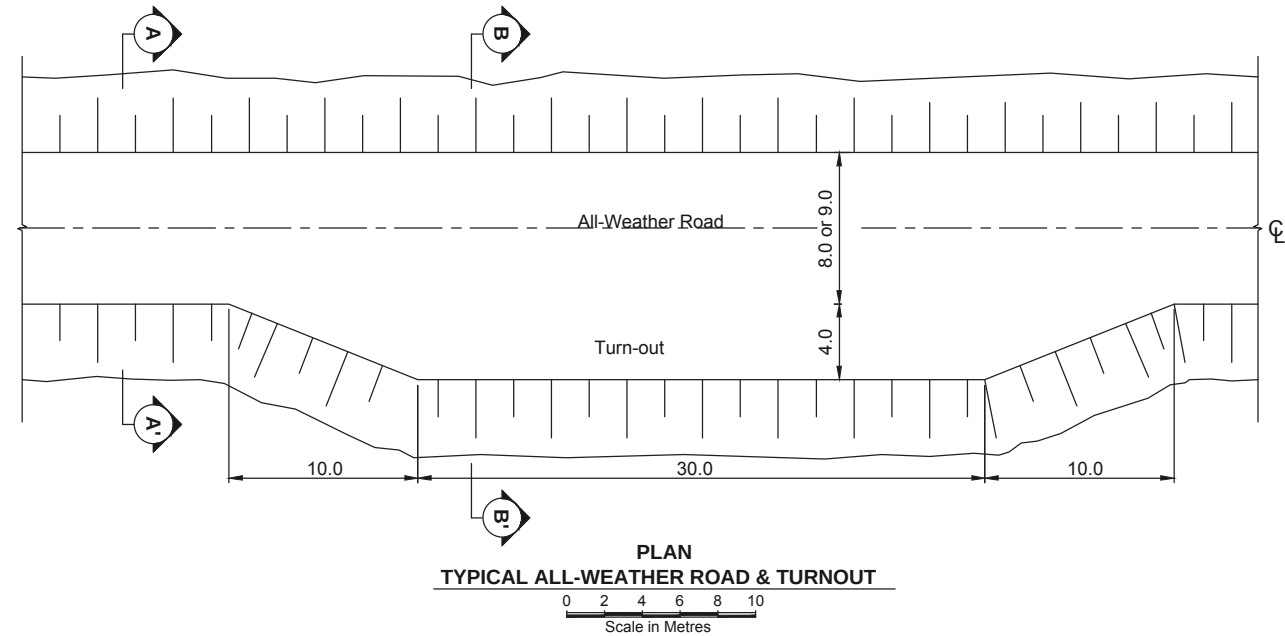
As described above, Elders and harvesters toured the Doris Project to evaluate the existing road and mitigation measures to help caribou cross the road. Elders and harvesters agreed that the road would not disrupt caribou movement.

The best available science on effects of transmission lines comes from Norway, where multiple transmission lines cross the alpine, treeless plateau through the range of multiple reindeer herds. Long-term, before-after studies using GPS collars indicate that reindeer will avoid a transmission line during construction when work crews are present, but quickly return to their former distribution during operations of the line in calving/post calving (Eftestol et al. 2016) and during spring, summer and fall (Colman et al. 2015). Likewise, no effect on reindeer movement or distribution was reported from a 22 year study using aerial surveys (Reimers et al. 2007) and a long-term study comparing historic travel routes and current movements using GPS collars (Panzacchi et al. 2013).

These long-term studies indicate that the caribou will not avoid or hesitate to cross the transmission line route and the addition of the transmission line will have a negligible effect on caribou reaction to the road. The potential effects of the Madrid-Boston all weather road have already been assessed for habitat loss and disruption of movement in the FEIS and TMAC has already committed to monitoring both avoidance of and crossing of the road.

4. Snow banks

The maintenance of snow on Project roads is done to maintain the safety of Project personnel and operability of Project roads. Following a snow event, the road is plowed with a grader and then the snowbanks are bladed flat to prevent snowdrifts from forming. Plate GN-19-3 illustrates the bladed road verge on the existing Doris to Windy camp road which are 5-30 cm during the April, 2017 site visit.



NOTES

1. All dimensions in metres unless noted otherwise.
2. Minimum design thickness must be maintained for all sections of the all-weather road including turnouts.
3. Notes in this drawing apply to all other active drawings.

[illegible]

Left un-bladed, the wind would cause a snow drift to form relatively quickly on certain areas of the road surface. It is therefore key for TMAC to blade the snowbanks down to maintain operability of the road. Regardless, TMAC will institute measurements of snow banks until a time that operational snow management is characterized.



Plate GN-19-3 Typical snow surface following blading of plowed snow.

5. Permeability monitoring

Please see TMAC's response to GN comment 21 – Caribou Effects Zone of Influence Monitoring.

References:

Colman JE, Tsegaye D, Flydal K, Rivrud IM, Reimers E, Eftestøl S (2015) High-voltage power lines near wild reindeer calving areas. *Eur J Wildlife Res* 61:881–893.

Leblond M, Dussault C, Ouellet JP (2013) Impacts of human disturbance on large prey species: do behavioral reactions translate to fitness consequences? *PLoS ONE* 8:e73695.

Nellemann C, Vistnes I, Jordhøy P, Strand O (2001) Winter distribution of wild reindeer in relation to power lines, roads and resorts. *Biol Conserv* 101:351–360.

Panzacchi M, Van Moorter B, Jordhøy P, Strand O (2013) Learning from the past to predict the future: using archaeological findings and GPS data to quantify reindeer sensitivity to anthropogenic disturbance in Norway. *Landsc Ecol* 28:847–859.

Reimers E, Dahle B, Eftestøl S, Colman JE, Gaare E (2007) Effects of a power line on migration and range use of wild reindeer. *Biol Conserv* 134:484–494.

Reimers E, Flydal K, Korslund L, Eftestøl S, Colman JE, Tsegaye D (2015) Power lines, reindeer and UV. *Biol Conserv* 184:471.

Vistnes I, Nellemann C (2001) Avoidance of cabins, roads, and power lines by reindeer during calving. *J Wildl Manage* 65:915–925

Vistnes I, Nellemann C, Jordhøy P, Strand O (2001) Wild reindeer: impacts of progressive infrastructure development on distribution and range use. *Polar Biol* 24:531–537

Vistnes I, Nellemann C, Jordhøy P, Strand O (2004) Effects of infrastructure on migration and range use of wild reindeer. *J Wildl Manage* 68:101–108.

92. ID #GN-20

92.1 DEPARTMENT

Environment

92.2 ORGANIZATION

Government of Nunavut

92.3 SUBJECT/TOPIC

Traffic Monitoring and Management

92.4 REFERENCES

- FEIS Vol 4, s. 9.8.3.3 - Disruption of Movement
- FEIS Vol. 4, s. 9.8.4.7 - Significance Determination
- FEIS Vol. 3 - Tables 1-1 and 5.2-1
- FEIS Vol. 1 - Executive Summary
- Alexander et al. 2005
- Clevenger and Huijser 2009
- Vistnes and Nellemann 2007
- Wolfe et al. 2000
- Kite et al. 2017
- Murphy and Curatolo (1984)
- Reimers and Coleman 2006
- Wilson et al. (2016)
- Scrafford et al. 2018

92.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The disruption of migratory routes is a recognized threat to barren-ground caribou (COSEWIC 2016). There is potential for the Project to disrupt caribou movements

leading to changes in migratory behavior, connectivity between seasonal ranges, and movements within seasonal ranges.

The Proponent concluded that the residual effect on movements of caribou following mitigation will be negligible in magnitude, medium in duration, of intermittent frequency, and reversible. This effect is rated as "Not Significant" for all herds surrounding the Project with a medium level of confidence (FEIS Vol. 4, s. 9.8.4.7). The Proponent reached similar conclusions for other species including grizzly bear.

This conclusion is dependent to a large degree on the predicted traffic levels on the Project's roads. The Proponent stated that:

"The proposed 53 km Boston will make up 85% of the road from Boston to Doris and will carry approximately 25 to 33 return trips per day (2.1 to 2.8 vehicle passes per hour; Table 9.8-20). The existing 9.5 km road from Madrid to Doris makes up approximately 15% of the Boston to Doris road and will carry traffic both for Boston and Madrid, with approximately 51 to 98 return trips per day (4.3 to 8.2 vehicle passes per hour). The existing 4.8 km road from Doris to Roberts Bay, over which fuel and other supplies for Madrid-Boston are transported, will carry approximately 10 to 12 return trips per day (0.8 to 1 vehicle passes per hour).

These traffic rates are below the traffic volumes reported to cause caribou to avoid crossing roads." (FEIS Vol. 4, s. 9.8.3.3)

92.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The GN's comments respecting the Proponent's conclusion that caribou movements will not be significantly disrupted by the Project will be contained in GN comment 18 (Disruption of Caribou Movements).

In the within comment, the GN will address the issue of the effects caused by traffic on Project roads.

1. Effects of Traffic on Wildlife

While the physical appearance and/or structure of roads may create a barrier to the movement of caribou (See GN comment 19 - Road Design – Permeability to Caribou), the intensity of traffic, including the rate and type of traffic, is likely one of the most important factors influencing the movements of wildlife across or near roads (e.g. Alexander et al. 2005; Clevenger and Huijser 2009; Vistnes and Nellemann 2007; Wolfe et al. 2000).

The Proponent concluded that traffic levels on Project roads will be below levels reported to disrupt caribou movements. The Proponent's evidence to support this conclusion included the following:

- “Scientific studies report caribou may be impeded from crossing roads when traffic volume exceeds certain levels (Kite et al. 2017). A study of caribou movement in Alberta indicated that roads were not a barrier to caribou movement unless traffic was present (Dyer et al. 2002a). Studies in Alaska reported that caribou crossing of a pipeline road was impeded by traffic rates higher than 20 vehicles per hour (Murphy and Curatolo 1984; W. A. Smith and Cameron 1985). Likewise, Murphy (1988) reported that caribou in the Kuparuk Oilfield in northern Alaska reported that road crossings by barren ground caribou were only impeded once traffic rates were greater than 1 per minute (1440 per day).” (FEIS Vol. 4, s. 9.8.3.3).

It is also noted by Elders and land users that caribou appear to be crossing the existing winter road between the Doris North and Boston sites, and that workers at Doris North regularly see caribou crossing the site.

2. GN Concerns with respect to the Proponent's assessment of Project traffic effects

Lack of empirical evidence

There is little empirical evidence relating road traffic volumes to effects on wildlife in the Arctic. Most studies of the effects of traffic volume on the movements of large mammals, such as bears and caribou, have focused on: (1) Major highways or high traffic secondary roads; (2) roads running through forested, well vegetated and/or mountainous terrain unlike Nunavut; and/or (3) did not include studies of tundra sub-species or eco-types of the wildlife species. These studies have generally found that roads impeded wildlife movements at traffic rates >15 vehicles per hour, in some cases >100/hour (e.g. Alexander et al. 2005; Vistes and Nellemann 2007; Waller and Servheen 2005; Wolfe et al. 2000), although some have found barrier effects at much lower rates (e.g. Dyer et al 2002). The relevance of these studies to conditions in Nunavut is uncertain.

Studies respecting impacts of traffic levels

The Proponent cited several studies in the FIED respecting impacts of traffic levels on caribou movements. The GN states that these studies have limited probative value with respect to the Project. The Proponent cited Smith and Cameron (1985) and Murphy and Curatolo (1984) as evidence that traffic rates need to exceed 20 vehicles per hour before disrupting caribou. These studies did not examine the effects of varying traffic levels. Specific to barren-ground caribou, Smith and Cameron (1985) observed caribou in proximity to a pipeline/road complex that had an average traffic rate of 20 vehicles per hour. A large portion of the caribou observed in this study avoided crossing the road, made repeated attempts to cross or were deflected along the road for 20-30 km before crossing. Murphy and Curatolo (1984)

observed caribou in proximity to roads where average traffic rates were 15 vehicles per hour. The authors noted that:

"caribou exhibited mostly severe or moderate reactions to traffic throughout all seasons investigated.....The relatively high degree of reactions observed probably relates to the motion of the vehicle, which stimulates a predator avoidance response."

These studies indicate that caribou movements are significantly disrupted by traffic levels between 15-20 vehicles per hour. They do not provide any insight into the effects of lower traffic rates. The GN has concerns that the studies in question (namely, Smith and Cameron (1985) and Murphy and Curatolo (1984)) were largely responsive to caribou that are more tolerant of human activity. Makers of such caribou include being "insect harassed" (see Reimers and Coleman 2006; Vistnes and Nellesman 2007), as the animals in Smith and Cameron (1985) were observed to be. The presence of caribou near roads may also indicate that these animals are tolerant of human activity.

The third study cited in the FEIS as evidence of traffic levels affecting caribou movements, Murphy (1988), has similar design issues associated with making behavioral observations near roads. Taken together, the relevance of these studies to the Project is uncertain.

When limiting a literature review to the effects of roads on barren-ground caribou in open tundra, there are few studies of relevance to the Project. Specific to barren-ground caribou, the FEIS cites Smith and Cameron (1985) and Murphy and Curatolo (1984) as evidence that traffic rates need to exceed 20 vehicles per hour before disrupting caribou. However, it should be noted that these studies did not examine the effects of varying traffic levels. Smith and Cameron (1985) observed caribou in proximity to a pipeline/road complex that had an average traffic rate of 20 vehicles per hour. A large portion of the caribou observed in this study avoided crossing the road, made repeated attempts to cross or were deflect along the road for 20-30 km before crossing. Murphy and Curatolo (1984) observed caribou in proximity to roads where average traffic rates were 15 vehicles per hour. The authors note that "caribou exhibited mostly severe or moderate reactions to traffic throughout all seasons investigated.....The relatively high degree of reactions observed probably relates to the motion of the vehicle, which stimulates a predator avoidance response". These studies indicate that caribou movements are significantly disrupted by traffic levels between 15-20 vehicles per hour. They do not provide any insight into the effects of lower traffic rates. It should also be noted that these studies observed animals in proximity to roads thereby potentially biasing the results towards animals that were

more tolerant of human activity and more likely to cross a road. In the case of Smith and Cameron, the observed animals were also described as “insect harassed”. Such caribou are thought to be more tolerant of human activity (Reimers and Coleman 2006; Vistnes and Nellemann 2007) thus adding further potential for bias in observations. The third study cited in the FEIS as evidence of traffic levels affecting caribou movements, Murphy (1988), has similar design issues associated with making behavioral observations near roads.

Lack of probative value of early studies

Many early studies of caribou responses to human activities were based on local scale behavioral studies that failed to account for larger, landscape level effects such as changes in migration patterns (see: Vistnes and Nellemann (2007)). The Proponent relied on these types of early studies. Most recent studies are regional in scale and use telemetry or aerial surveys. These tools have started to reveal that even low levels of traffic can significantly affect the movement patterns and distribution of caribou and other wildlife. These studies suggest that the movements of barren-ground caribou under conditions similar to those of the Project may be significantly impeded by roads at traffic rates in the range of 4 vehicles per hour.

Wilson et al. (2016) found that approximately 30% of caribou from the Central Arctic Herd were delayed by 3-4 weeks in migrating across a mine haul road where traffic volume averaged 4 vehicles per hour. Wilson et al. (2016) is particularly relevant to this set of facts. There are many similarities between that study and the Project. For example, the studied road is operated as a private haul road with restricted and/or no public use. Traffic consisted primarily of large mine haul trucks. The road was regularly used. The company operating the road “instituted measures to halt traffic along the road when caribou are on or near the road” similar to the caribou protection measures proposed for the Project (see GN comment 22 – Caribou Protection Measures). Wilson et al. (2016) suggested that their findings may be explained in part by the large size of the vehicles using the road and the regularity of traffic.

The GN states that Wilson et al.'s findings of this study are related to the methods used. With advances in technology, including GPS collars, it is now possible to obtain more detailed data on landscape scale movements of herds. This data that could not be obtained by means of the types of local scales studies of caribou behavior conducted earlier years. This has allowed a more sensitive assessment of road effects on caribou. Wilson et al. also noted that the demographic consequences of the movement effects they observed are unknown. This highlights an important area of uncertainty. (As an aside, a recent study in northern Alberta, demonstrated that wolverine avoid and increase their speed of movement near industrial roads with traffic levels < 2.5 vehicles per hour (Scrafford et al. 2018). This study also used GPS

radio-telemetry to demonstrate clearly that even low-use roads such as those proposed for the Project can significantly affect the movement of wildlife and that such effects can be detected if appropriate methods are used.)

Anecdotal Information

Reference made within the FEIS to observations of individual caribou crossing the Doris site is anecdotal information. This provides no basis for a quantitative impact assessment of herd level effects.

The Proponent referenced caribou crossing the winter road to the Boston site. This reference appears to be based on data showing that some collared caribou cross the location of this road. The GN notes that the winter road was not in operation when a large portion of the collar data were collected. Additionally, rates of traffic on the winter road are not presented for comparison to traffic rates for the Project. This information is therefore anecdotal and less useful in conducting a rigorous assessment.

Conclusions on Traffic Impacts on Caribou

Based the available evidence, and contrary to the Proponent's conclusions, the GN states that the predicted traffic rates on Project roads are within the range where disruption of caribou movements should be expected. Of particular concern is the road segment between Doris North and Madrid North where traffic is predicted to be most intense. Careful management of traffic flow on these roads is required, combined with rigorous effects monitoring to resolved outstanding uncertainty in the magnitude and significance of effects.

3. Predicted Traffic

Given concerns about traffic levels on the Project's 90+ Km of roads, it is important to have an accurate understanding of the maximum predicted traffic rates (vehicles/hour) that are being proposed as part of the Project application. Since submitting the draft environmental impact statement (DEIS), the Project proponent has made several amendments to the Project proposal that have reduced anticipated traffic rates. The decision to construct a full process plant at Boston has reduced the number of ore and concentrate trucks transiting the 53 km long Boston to Doris all-weather road. The use of larger (55 versus 40 ton) haul trucks has also reduced traffic rates on roads. These amendments have reduced, although not eliminated, concerns about Project effects on caribou movements. The GN will address remaining concerns in the following paragraphs.

Discrepancies

There are discrepancies between the traffic rates presented in the project

description (FEIS Vol. 3) in tables 1-1 and 4.5-1. For example, from table 4.5-1 peak predicted traffic on the Boston to Doris road is 66 transits per day (2.75/hr). This is a reduction from 5.4/hr in the DEIS. This includes a peak in ore trucks of 16/day in years 4 to 6 of the Project. In contrast, table 1-1 (Vol. 3), indicates there will be 84 ore truck transits per day for 3 years. The GN notes that table 1-1 was not part of the DEIS so this table seems to be new addition to the impact statement. A similar discrepancy is noted between these table for the information related to traffic on the Madrid North to Doris road segment. These discrepancies should be clarified.

Clarity on Proponent Predictions

It is unclear whether the predicted traffic rates presented in the FEIS represent estimates for all traffic that will use the Project's roads. Table 4.5-1 (FEIS Vol 3) presents traffic estimates for "Project Vehicle Traffic". In addition to the Madrid-Boston project, do these Project predictions include all traffic related to the Doris Project (NIRB Project Certificate 003, NWB Type A Water Licence 2AM-DOH1323), the Hope Bay Regional Exploration Project (NWB Type B Water Licence 2BE-HOP1222), the Madrid Advanced Exploration Program (NWB Type B Water Licence 2BB-MAE1727) and the Boston Advanced Exploration Project (NWB Type B Water Licence 2BB-BOS1727)?

4. Traffic Monitoring

The GN states that the FEIS and its associated management plans do not appear to contain a traffic monitoring program. Given the importance of road traffic with respect to effects on wildlife movement, the absence of this program is concerning. Monitoring is necessary to confirm predicted traffic levels in the FEIS which are themselves closely linked to the effects assessment. Monitoring of traffic will also facilitate other effects monitoring programs such as those looking at the movements of caribou.

92.7 REVIEWER'S RECOMMENDATIONS

Recognizing that wildlife, in particular caribou, are sensitive to traffic, there is a need to monitor and management traffic rates on Project roads, in-order to reduce effects on wildlife. Accordingly, the GN recommends the following:

- That the Proponent clarify which of the tables presented within the FEIS most accurately details proposed Project traffic rates (vehicles/hour), including peak predicted traffic levels on the different road segments.
- That the Proponent clarify whether the traffic rates include all traffic including that associated with the Doris Project (NIRB Project Certificate 003, NWB Type A Water Licence 2AM-DOH1323), the Hope Bay Regional Exploration Project

(NWB Type B Water Licence 2BE-HOP1222), the Madrid Advanced Exploration Program (NWB Type B Water Licence 2BB-MAE1727) and the Boston Advanced Exploration Project (NWB Type B Water Licence 2BB-BOS1727)?

- If the Project proceeds, the Proponent should implement a traffic monitoring and reporting program to accurately estimate the rates and composition of traffic using each of the Project's road segments (as identified in FEIS Vol. 3, table 4.5-1). This information should be used for comparison with the traffic rates predicted in the FEIS and to support Project monitoring for wildlife effects. Monitoring should be conducted no less than every 2nd year during years 1-13 of the Project, to cover the period when traffic is predicted to peak; thereafter at least every 3 years for the life of the Project.
- The peak traffic rates as presented in table 4.5-1 of FEIS Vol. 3 of (or those identified by the Proponent during the Project's NIRB review) should be established as Project monitoring thresholds.
- If the annual or seasonal traffic rates estimated from Project monitoring exceed the established thresholds by greater than 25% in 2 consecutive monitoring periods, a Project screening should be submitted to NIRB.
- Additional caribou protection measures should be implemented to manage traffic levels on Project roads with an emphasis on the spring and fall migratory periods and road sections with highest traffic levels (See GN comment 22 – Caribou Protection Measures).
- Noting that all Project infrastructure including but not limited to, roads has the potential to disrupt caribou movements, additional effects monitoring programs are recommended. (See GN comment 21 – Caribou Effects- Zone of Influence Monitoring)

92.8 PROPOSED TERM AND CONDITION/COMMITMENT

- The Proponent shall implement a traffic monitoring and reporting program to accurately estimate the rates and composition of all traffic using each of the Project's road segments (as identified in FEIS Vol. 3, table 4.5-1). This information shall be used for comparison with the traffic rates predicted in the FEIS and to support Project monitoring for wildlife effects. Monitoring should be conducted no less than every two years during years 1-13 of the Project, to cover the period when is traffic is predicted to peak; thereafter at least every three years for the life of the Project.
- The peak traffic rates as presented in table 4.5-1 in FEIS Vol. 3 (or those identified by the Proponent, during the Project's NIRB review shall be established as Project monitoring thresholds.

- If the annual or seasonal traffic rates estimated from Project monitoring exceed the established thresholds by greater than 25% in 2 consecutive monitoring periods, a Project screening shall be submitted to NIRB.

92.9 TMAC RESPONSE FOR GN-20

TMAC assessed traffic as a potential disturbance activity in the FEIS. As follow up, a traffic level monitoring system will be included in the WMMP. The quantification of traffic will be reported annually with relationship to traffic predictions in the FEIS. This annual reporting will be included in the WMMP compliance report.

TMAC clarifies that Table 4.5.1 presents traffic rates associated with the Hope Bay Project – the Doris Project, Madrid-Boston (Phase 2) Project and exploration activities.

Exceedance of predicted traffic levels in two consecutive years will not trigger further Project screening unless there is a reasonable suggestion of an effect beyond that predicted in the FEIS that cannot be managed adaptively. TMAC suggests this based on the following reasons:

- The GN has not supported their statement that “wildlife, in particular caribou, are sensitive to traffic, there is a need to monitor and management traffic rates on Project roads, in-order to reduce effects on wildlife” with any published studies or demonstrations of caribou being disturbed by slow-moving haul trucks.
- The GN has conflated caribou avoiding predation (harvest) with avoidance of traffic. In the examples presented, and with most other northern roads that are studied (Meadowbank road, Tibbitt to Contwoyto Winter Road, Dempster Highway), the roads are connected to a highway network or a community. Caribou interacting with those roads experience substantial harvest from those roads.
- To date, there is no evidence that project roads have been used for harvesting and the road to Boston will be closed to non-Project vehicles and a no hunting boundary exists around Project infrastructure for safety reasons which to date has been well respected with support from the KIA and Hunters and Trapper Organization (HTO's). Caribou will experience only slow, managed haul trucks and service vehicle traffic that follow traffic mitigation procedures on the Madrid-Boston road.

With this commitment to update the WMMP to include a traffic monitoring plan, no additional terms or conditions are required.

93. ID #GN-21

93.1 DEPARTMENT

Environment

93.2 ORGANIZATION

Government of Nunavut

93.3 SUBJECT/TOPIC

Caribou Effects – Zone-of-Influence Monitoring

93.4 REFERENCES

- FEIS Vol. 4, s. 9.8.4.7 - Significance Determination. (Table 9.8- 24)
- FEIS Vol. 4, s. 9.8.3.2 – Disturbance
- FEIS Vol. 4, s. 9.22.1 - Caribou
- FEIS Vol. 4, s. 9.8.3.3 - Disruption of Movement
- FEIS Annex Vol. 8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, s. 3.1.2.2 - Wildlife Zone of Influence Monitoring.
- FEIS Annex Vol. 8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, s. 3.1.5.3 - Road Crossing Monitoring

93.5 SUMMARY OF PROPONENT'S CONCLUSIONS

After application of planned mitigation measures, residual impacts of the Project on caribou due to disturbance and the disruption of movements were concluded to be negligible and Not Significant "(sic)" with medium confidence (FEIS Vol. 4, s. 9.8.4.7).

93.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The assessments for caribou disturbance and disruption of movements are key components of the effects assessment for wildlife. They require rigorous monitoring to confirm impact predictions, design mitigation measures and inform adaptive management. Project monitoring for disruption of caribou movements is discussed in GN comment 18 (Disruption of Caribou Movements). With respect to monitoring disturbance of caribou , the following additional concerns are noted:

Zone-of-Influence (ZOI) Monitoring

In assessing disturbance and disruption of movements, the Proponent applied estimates of the ZOI the Project may exert on caribou. Three ZOI scenarios of differing sizes were applied. The smallest of these scenarios (scenario 1) used ZOIs of 4 km and 1.5 km for mine sites and roads, respectively (FEIS Vol. 4., s. 9.8.3.2). The largest ZOIs (scenario 3) were 14 km and 4 km for mine sites and roads, respectively. Based on evidence such as aerial surveys around one of the Project's early exploration camps, a camera study around the Doris North project and a review of literature on caribou ZOIs, the Proponent provided that scenario 1 was a conservative prediction of true ZOI (FEIS Vol. 4, s. 9.22.1). Scenario 1 was used in reaching the final impact conclusions.

The GN does not agree that the scenario 1 ZOI will be the true ZOI of the Project. Pursuant to GN Technical Comment 28 on the DEIS, the GN has concerns with the Proponent's evidence to support the scenario 1 ZOI. Notably, the Windy Lake exploration camp aerial survey results, the Doris North camera program and the literature review of ZOIs provide unreliable evidence. The GN's concerns are not alleviated by the additional information presented in the FEIS. The FEIS includes an expanded literature review. However, this review includes numerous studies of questionable relevance to the Project because they: (1) involve woodland caribou and reindeer; (2) do not relate to mining or roads; (3) do not relate to open tundra environments; and/or (4) used local behavioral observations that may significantly underestimate the size ZOIs (Vistnes and Nellemann 2007). These studies are factually different from the Project and their conclusions are less relevant to the within set of facts.

Pursuant to Wilson (2016) and Benítez-López et al. (2010), ZOIs will tend to be larger in open habitats such as tundra. There are few relevant, landscape scale studies of barren-ground caribou, on tundra. Report ZOIs around low use, all-season roads including industrial access roads passing through barren-ground caribou calving areas have been approximately 4 km (e.g. Nellenman et al. 2003; Vistnes and Nellemann 2001; Cameron et al. 1992, 1995). Wilson et al. (2016) found changes in the movements of migrating caribou within 14 km of a mine haul road with traffic levels comparable to the Project. Boulanger et al. (2012) found a ZOI of up to 14 km around a mine. More recently, changes in caribou distribution and movements were detected within 35 km of the Meadowbank mine and access road (Golder 2017; Kite et al. 2017).

Figure 1 suggests that herds are avoiding the Doris site. During review of the DEIS, the GN recommended that the Proponent analyze the available collar data to estimate the ZOI around the current Doris North mine. In the FEIS, the Proponent provides that there were insufficient collar data to support this type of analysis. The GN concurs with this finding and notes that there is need to obtain sufficient collar data to revisit this analysis if the Project proceeds.

Based on the evidence presented in the FEIS, and that available elsewhere, the GN concludes that the potential ZOI of both the Project's mine sites and roads is unknown. The evidence supporting scenario 1 ZOI is unreliable. The GN acknowledges the Proponent's efforts to address this uncertainty in the FEIS by employing multiple ZOI scenarios. This is illustrated, for example, in the calculation of indirect habitat loss. Without accounting for habitat quality (since the habitat quality model in the FEIS has not yet been validated), the Project and its ZOI would occupy between 0.7 and 2.7% of the winter range of the Dolphin and Union herd depending on the ZOI scenario applied (FEIS Vol 4., s9.8.3.2). In terms of cumulative effects, up to 6.7% of the herds winter range would be occupied (FEIS Vol 4., s9.8.3.2). This wide variation in estimates of indirect habitat loss illustrates the importance of obtaining an accurate estimate of the Project's ZOI since the relationship between ZOI and indirect loss is not a linear one in most cases.

The ZOI of the Project is also relevant to the issue of disrupting movements such as caribou migrations. Encounter rate analyses in the FEIS suggest that between 14 and 27% of the Dolphin and Union herd will encounter the Project or its ZOI depending on size of the ZOI (FEIS Vol 4., s. 9.9.3.3), predominantly during migratory periods. For the Ahiak herd this range is 14 to 23%. These levels of herd interaction with the Project are arguably high if the Project significantly disrupts movements (see GN Comment 18 – Disruption of Caribou Movements).

Results of the FEIS clearly highlight the need to accurately estimate the ZOI around mine sites and roads, rather than relying on uncertain assumptions about size. Monitoring the ZOI is necessary to: (1) confirm impact assessment conclusions about indirect habitat losses and the potential for disruption of movements; and (2) design appropriate mitigation measures. For example, traffic management measures to reduce sensory disturbance of caribou should begin when caribou are at a range corresponding to the ZOI of a road. Applying mitigation when caribou are well within the ZOI may result in a too-little-too-late scenario in which caribou are already disturbed by the time mitigation is applied (see GN comment 22 – Caribou Protection Measures).

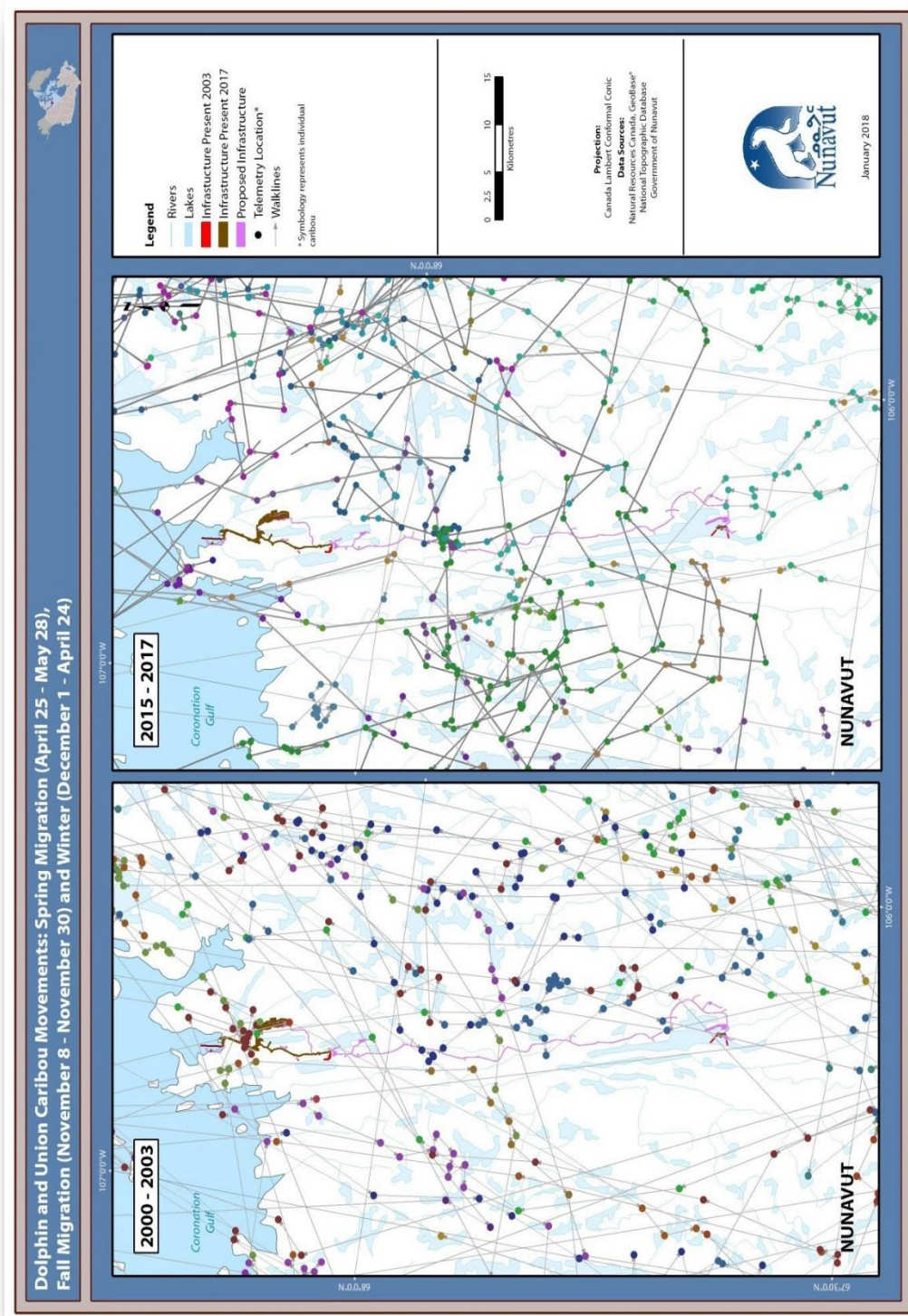
The Project's WMMP includes a monitoring program using motion triggered cameras positioned in three zones around the Project. These cameras will detect the presence of wildlife, including caribou. It is noted that "the wildlife camera monitoring will focus on whether there is an effect of the mines on grizzly bears and wolverine and may also be used to look at caribou densities with distance from infrastructure" (FIES Annex Vol. 8-3, s. 3.1.2.2). Although useful for wildlife effects monitoring, this program has several limitations with respect to estimating ZOI for caribou including:

- Caribou appear to be a secondary consideration in the design of the camera study raising concerns about the adequacy of study design.
- The monitoring program will only occur around the Doris and Boston sites. It will not be applied to Project roads. The Northwest Territories' Caribou Zone of Influence

Technical Task Group recommends monitoring the ZOI around a road when its footprint extends beyond the predicted ZOI of a mine site (GNWT ENR 2015). Some Project roads such as the Doris to Boston road meet this criterion. Given its length (53 Km) and level of interaction with caribou, estimation of the ZOI around this road is strongly recommended.

- Boulanger et al. 2012 and Russell and Johnson 2014 have argued that (i) the mode of collection of data and (ii) the analytical methods used can have impacts on the outcome of the ZOI analysis. It is unclear if camera data alone will provide a reliable ZOI. It is advisable to calibrate the camera monitoring program against a second method.
- Motion-triggered cameras capture the presence of caribou within a study area but do not capture caribou behavior. Accordingly, this type of monitoring program may miss important features of ZOI avoidance effects such as changes in direction, speed, and tortuosity of movements as a function of distance from the Project. These effects may extend over a greater range than presence or absence data alone may suggest. Such effects were recently documented within 35 km of the Meadowbank mine (Kite et al. 2017).
- Use of cameras may not be an appropriate way to estimate the size or strength of ZOI effects during migratory periods. During these seasons, caribou are making directional movements and their distribution is likely determined to a lesser degree by risk-based foraging strategies than by the selection of travel corridors. At this time, camera data could provide misleading results. For example, increasing densities of animals closer to a site of disturbance may be demonstrated if animals are deflected or delayed.

Figure 1. Track lines of collared Dolphin and Union caribou in proximity to the Project and Hope Bay Belt infrastructure.



93.7 REVIEWER'S RECOMMENDATIONS

The Proponent's plans to estimate the ZOI for the Project are inadequate to test impact predictions, design mitigation measures and inform adaptive management. Accordingly, the GN recommends the following:

- The Project's ZOI on caribou should be monitored initially using two methods: Collars and motion-triggered cameras. Following comparison of results, monitoring by means of one method may be discontinued. The Government of Nunavut collects data from collared caribou to monitor the movements of herds at a regional scale. These GN collar programs are not designed to monitor Project-specific effects but the data collected by these programs may be useful in Project effects monitoring. The GN will make caribou collar data, collected by its regional collar programs, available to TMAC for this analysis.
- Both of the aforementioned methods should be designed and resourced by the Proponent to ensure the resulting data have sufficient statistical power to detect possible Project effects.
- The study area for ZOI monitoring for caribou should include all components of the Project, including mine sites and roads.
- Separate estimates of ZOI should be derived for the Boston to Doris road and mine sites, to the extent possible.
- ZOI should be estimated and reported during the initial operations phase of the Project and then updated periodically when changes Project scale, intensity or nature occur.

93.8 PROPOSED TERM AND CONDITION/COMMITMENT

The Project's ZOI on caribou shall be monitored initially using two methods: Collars and motion-triggered cameras. Following comparison of results, monitoring by means of one method may be discontinued. Both programs shall be designed and resourced by the Proponent to ensure the resulting data have sufficient statistical power to detect possible Project effects. The study area for ZOI monitoring for caribou shall include all components of the Project, including mine sites and roads. Separate estimates of ZOI shall be derived for the Boston to Doris road and mine sites, to the extent possible. ZOI shall be estimated and reported during the initial operations phase of the Project and then updated periodically when changes Project scale, intensity or nature occur. The Government of Nunavut collects data from collared caribou to monitor the movements of herds at a regional scale. These GN collar programs are not designed to monitor Project-specific effects but the data collected by these programs may be useful in Project effects monitoring. The GN shall make caribou collar data, collected by its regional collar

programs, available to Proponent for use in the Project effects monitoring required under this term and condition. For greater certainty, should the GN's aforementioned data be insufficient for the Proponent to fulfil the Term and Condition, the Proponent shall provide additional resources to the GN to operationalize this requirement. Any additional resources shall be provided pursuant to an appropriate contribution agreement agreed to by the Proponent and the GN.

93.9 TMAC RESPONSE FOR GN-21

TMAC has dedicated extensive time and resources to measure the Zone of Influence (ZOI) for the existing Doris Project. Historically, TMAC quantified the possible ZOI in three ways: 1) using aerial surveys, 2) using wildlife cameras, and 3) using an updated design of wildlife cameras in collaboration with the GN and KIA.

ZOI monitoring is already being conducted at the Doris Project using wildlife cameras, following methods designed by TMAC in collaboration with the KIA and GN. The FEIS Wildlife Mitigation and Monitoring Plan (WMMP) includes a plan to expand this monitoring to the Madrid and Boston sites, and that study will use the best available data, technology and analytical techniques at a level of effort appropriate to the likelihood of there being a significant effect.

The GN recommended that TMAC conduct ZOI monitoring using satellite collars. TMAC commits to updating the WMMP to include an analysis of zone of influence (ZOI) for caribou using collar data for the Dolphin and Union and Beverly/Ahiak herds during early operations of the Project. This analysis will be for the Project as a whole and individual Project components, where data is sufficient.

The GN also recommended that TMAC contribute to collar monitoring, stating: "The collar monitoring program shall be designed and resourced by the Proponent". TMAC already has a Memorandum of Understanding (MOU) with the GN whereby TMAC provides funds or in-kind support for the GN to conduct regional monitoring work on Dolphin and Union caribou, including the purchase of collars. The GN provides collar monitoring data to TMAC as it is public information and is a requirement in the MOU. This four year agreement expires in 2019. TMAC understands the importance of regional monitoring for caribou and is open to discussing a new MOU prior to the expiry of the existing MOU.

In addition to collar data, TMAC is committed to reviewing lines of evidence and information, including Inuit Qaujimajatuqangit, local land user knowledge and observations, and discussion with the Inuit Environment Advisory Committee (IEAC) to ensure a holistic perspective of caribou distribution, movement and abundance is well understood, beyond reliance on collar data alone.

With this commitment to continue with the monitoring and analysis identified in the WMMP, no additional terms or conditions are required.

94. ID #GN-22

94.1 DEPARTMENT

Environment

94.2 ORGANIZATION

Government of Nunavut

94.3 SUBJECT/TOPIC

Caribou Protection Measures

94.4 REFERENCES

- FEIS Vol. 4, s. 9.8.4.7 - Significance Determination. (Table 9.8- 24)
- FEIS Vol. 4, s. 9.8.2 Identification of Mitigation and Management Measures for Caribou
- FEIS Vol. 4, s. 9.8.3.2 – Disturbance
- FEIS Vol. 4, s. 9.8.3.3 - Disruption of Movement
- FEIS Annex Vol. 8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, s. 3.1.2.2 - Wildlife Zone of Influence Monitoring.
- FEIS Annex Vol. 8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, s. 3.1.5.3 - Road Crossing Monitoring
- FEIS Annex Vol. 8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, tables 2.2-1 and 2.2-2

94.5 SUMMARY OF PROPONENT'S CONCLUSIONS

After application of planned mitigation measures, residual impacts of the Project on caribou due to disturbance and the disruption of movements were concluded to be negligible and Not Significant ("sic") with medium confidence (FEIS Vol. 4, s. 9.8.4.7).

During the preparation of the FEIS, the Proponent held workshops with a group of elders and land users to discuss caribou related aspects of the Project. Participants identified concerns and recommended mitigation measures to address those concerns (FEIS Vol. 4, s. 9.8.2). However, many of the caribou protection measures proposed by workshop participants were not adopted by the Proponent. For example (from Table 9.8-2):

- “Limit road activity during migration” – The FEIS does not propose reductions in road use during migration.
- “Establish minimum distance allowed between vehicles” – This is essentially a traffic rate recommendation. The FEIS does not propose a minimum distance or other traffic rate measures.
- “Monitoring of roads during migration” – The FEIS proposes height-of-land monitoring along roads to a range of 4 km during caribou migration periods but does not specify monitoring design and intensity (spatially and temporally) making it impossible to determine whether this will be useful for detecting caribou. Additionally, there is no prescribed response to manage traffic to reduce disturbance of caribou and disruption of their migration when observed from height-of-land monitoring (FEIS Annex V8-3, s3.1.5.3).

Caribou-specific mitigation measures to reduce sensory disturbance and disruption of movements are described in tables 2.2-1 and 2.2-2 of the WMMP.

94.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

GN concerns about the potential for the Project to disturb caribou and disrupt their movements have been discussed elsewhere in this submission (see GN comments 18,20, and 21 on Disruption of Caribou Movements, Traffic Monitoring and Management, Caribou Effects – Zone-of-Influence Monitoring, respectively). Pursuant to these comments, the GN states that the Project's caribou protection measures should be strengthened. GN concerns about the Project's caribou protection measures were previously presented during the review of the DEIS (see GN technical comments 12 and 13). The GN's concerns relating to roads and operation of heavy equipment have not been alleviated by the additional information in the FEIS.

Roads

Management of road traffic is a key area of concern (See GN comment 20- Traffic Monitoring and Management).

There is no management of traffic to reduce disturbance of caribou and disruption of their movements until caribou are within 500 m of roads (WMMP table 2.2-1). At this point, table 2.2-1 in the WMMP indicates that the Driver Flow Chart (Figure 2.2-1) applies to “On-site Roads”. Figure 2.2-1 outlines a set of driver rules (also discussed in FEIS Vol. 4, s9.8.3.3). These include vehicle stoppages if caribou are observed within 500m and appear to be moving towards the road.

Table 2.2-1 in the WMMP indicates that the Driver Flow Chart (Figure 2.2-1) applies to “On-site Roads” but does not define this term. For clarity, “On-site Roads” should be defined to mean any, and all, Project roads including the Doris to Boston all-weather road.

These driver rules have several weaknesses with respect to mitigating effects. First, the 500m distance threshold is too short. This is likely within the ZOI that will exist for Project roads and is less than the smallest road-ZOI applied in the effects assessment. As noted in the FEIS and in the literature on caribou responses to human activities, caribou are more likely to react adversely to moving objects. In open terrain, moving vehicles especially large haul trucks, will be visible well beyond 500m. By waiting until caribou are within 500m, mitigation is applied after part of the effect on caribou has occurred. While it is acknowledged that drivers are unlikely to detect caribou effectively beyond 500 m, effort is needed to detect and respond to approaching caribou at greater distances, until such time as Project effects monitoring proves otherwise (See GN comment 21:Caribou Effects – Zone-of- Influence Monitoring; and comment 18: Disruption of Caribou Movements). This enhanced effort must be a priority during the migratory periods and on road sections with highest traffic levels (see GN comment 20 – Traffic Monitoring and Management).

Second, the rules indicate that drivers should respond to caribou that are moving towards the road only. The GN states that animals moving away from the road also require mitigation efforts. Animals moving away from the road may be doing so as a result of being disturbed or disrupted. These individuals may be less tolerant of human activity and warrant a greater degree of mitigation than potentially more tolerant individuals moving towards the road.

The WMMP proposes height-of-land surveys during migration periods to detect caribou at up to 4 km from roads. However, as noted above, the design and intensity of these surveys is not specified and there is no prescribed response to manage traffic when caribou are observed at this range.

Operation of Heavy Mobile Equipment

Pursuant to the current WMMP, the operation of heavy mobile equipment is not managed to reduce disturbance of caribou and disruption of their movements except during calving season when caribou are observed within 250m. This distance threshold is too short. It is within the Project's predicted ZOI and lower than standards at other projects recently reviewed and approved by NIRB (e.g. AEM 2017; Sabina 2017). Unlike other projects, there is also no management of heavy mobile equipment during other seasons such as migratory periods or during the winter when caribou interactions with the Project peak. From a project- specific perspective, the timing of this mitigation measure does synchronize with caribou presence near the Project.

94.7 REVIEWER'S RECOMMENDATIONS

The following enhancements to the Project's caribou protection measures are recommended:

- Establish a second tier in road traffic management that is triggered in response to groups of caribou detected within 1.5 km of roads during the spring and fall migration and winter periods. This distance is consistent with that established for road management at a project recently reviewed by NIRB (NIRB 124683 / 16MN056).
- When caribou at or above a specified Group Size Threshold (GST) are detected within 1.5 km of a Project road, traffic movement on that section of road will be suspended until caribou have moved beyond 1.5 km.
- The GST for triggering this measure will be set on an interim basis at 10 caribou (see GN Technical Comment 12). This threshold should be modified based on season-specific caribou group size data collected during the height-of-land monitoring program described in the WMMP. Consistent with caribou protection measures for several projects recently reviewed by NIRB (NIRB 124683 / 16MN056; NIRB 124149 / 12MN036), the intent is to trigger this measure at a GST that affords protection to at least 70% of caribou that are detected in proximity to roads.
- This second tier of traffic management should be supported by height-of-land monitoring that is of sufficient spatial and temporal intensity to: (1) detect a majority of caribou within the 1.5 km distance threshold during migratory periods and during winter along the (9.8km) section of road between the Doris North processing plant and the Madrid North site; and (2) detect caribou within 1.5 km of other Project road segments during migration periods. These criteria are intended to focus monitoring efforts to sections of road where traffic is expected to be highest and during periods when caribou interactions with Project roads peak.
- Operation of heavy mobile equipment should cease when caribou are within 500m during any season. During calving this distance should increase to 750m for equipment within line of sight of caribou. These measures are consistent with caribou protection measures for several projects recently reviewed by NIRB (NIRB 124683 / 16MN056; NIRB 124149 / 12MN036).
- Implementation of these enhanced caribou protection measures should continue throughout the life of the Project unless, as determined by NIRB, Project effects monitoring proves they are unnecessary.

94.8 PROPOSED TERM AND CONDITION/COMMITMENT

- When caribou at or above the specified Group Size Threshold (GST) are detected within 1.5 km of a Project road, traffic movement on that section of road shall be suspended until caribou have moved beyond 1.5 km. The GST for triggering this measure will be set on an interim basis at 10 caribou. This threshold should be modified based on season-specific caribou group size data collected during the height-of-land monitoring program described in the WMMP. This traffic

management measure shall be supported by height-of-land monitoring that is of sufficient spatial and temporal intensity to: (1) detect a majority of caribou within the 1.5 km distance threshold during migratory periods and during winter time along the (9.8km) section of road between the Doris North processing plant and the Madrid North site; and (2) detect caribou within 1.5 km of other Project road segments during migration periods.

- Operation of heavy mobile equipment should cease when caribou are within 500m of the equipment during any season. During calving this distance should increase to 750m for equipment within line of sight of caribou.

94.9 TMAC RESPONSE FOR GN-22

The suggested protection measures for caribou in the Wildlife Mitigation and Monitoring Plan (WMMP) are conservative and precautionary based on experience from existing operations, knowledge from other operations, and from engagement and approval of local land users, Elders and harvesters.

Based on the years of operational experience and input from elders and harvesters, TMAC is not proposing to include the extra mitigation as the Government of Nunavut (GN) is suggesting. The effects assessment and risk assessment conducted with the elders and harvesters show low magnitude and low risk of impact to caribou, and the extra mitigation suggested by the GN does not appreciably mitigate any further an already low magnitude effect.

Discussion

In response to the GN recommendations:

1. Section 3.1.5.3 of the FEIS WMMP already includes a plan for height of land surveys to determine the presence of caribou and conduct appropriate management actions (copied below).
2. TMAC commits to update the WMMP with additional detail on the plan for height of land monitoring.
3. As described in the FEIS WMMP, the monitoring plan consists of:
 - a) TMAC will work with the Inuit Environmental Advisory Committee (IEAC) to determine the appropriate methods and locations for monitoring. As a starting point for the WMMP, TMAC will use:
 - Observations on the Doris to Madrid South road and at other locations identified by the IEAC as a migration corridor for caribou;

- During spring and fall migration; and
- Will include behaviour monitoring.

b) Mitigation will include:

- Observations of caribou will require the driver decision tree, as mitigation and communicating the observation to the Environment Manager to inform other drivers as appropriate.

c) Monitoring and mitigation will be reported in the WMMP.

d) This monitoring and mitigation will be updated as needed or discontinued if Project effects monitoring proves they are unnecessary.

With this commitment to update the WMMP, no additional terms or conditions are required.

The description of road crossing monitoring in the FEIS WMMP states:

3.1.5.3 Road Crossing Monitoring

TMAC will conduct an analysis of collar data to determine if caribou are avoiding crossing Project roads following the methods described in Wilson et al. (2016) and Blum et al. (2015). This analysis will be conducted following construction of the Boston road comparing pre-and post-construction movement patterns across the road, should the data prove suitable (e.g., sample size, location reporting period) for robust analysis.

During spring and fall migration, when data indicates that the majority of road crossing events occur, TMAC will conduct additional monitoring to evaluate if caribou are near the road and guide mitigation. TMAC will continue to engage with the IEAC to identify locations where caribou are more likely to cross the Boston road. During migration, TMAC will conduct height of land surveys during spring and fall migration to examine if caribou are present up to 4 km from the road (the expected maximum sighting distance from hill tops). Survey methods will be refined with the IEAC prior to construction. Surveys will examine 1) if caribou are present, 2) caribou reactions to vehicles, 3) compliance with road rules to stop when caribou are near the road. Observations of caribou approaching the road will be communicated to the Environmental Manager, who will alert drivers to approaching caribou and remind them of the management steps should caribou be observed closer to the road.

Should height-of-land surveys determine that caribou are avoiding the road, then TMAC will work with the IEAC to evaluate if the design and execution of snow track

surveys is required and or acceptable to monitor caribou tracks as they approach the road. The survey transects and complete study design would be developed in consultation with the GN and IEAC. Results of the survey would be used to evaluate if and what kind of mitigation may be required for traffic on the AWR.

95. ID #GN-23

95.1 DEPARTMENT

Environment

95.2 ORGANIZATION

Government of Nunavut

95.3 SUBJECT/TOPIC

Mitigation for Grizzly Bear

95.4 REFERENCES

- FEIS Vol.4, s.9.10.3.2 – Disturbance
- FEIS Annex Vol.8-3,s.2.4, Table 2.4-1 – Specified Wildlife Periods and Associated Mitigation, Hope Bay Project Wildlife Mitigation and Monitoring Plan
- FEIS Vol.4, s.9.10.4.2 – Disruption of Movement
- GN technical comment DEIS TC#14

95.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent assessed the potential for the Project to disturb denning grizzly bears and concluded that:

- "With mitigation, disturbance due to Project-related activities conducted during the denning period (November to May) is not anticipated to result in a residual effect to grizzly bears." (FEIS Vol.4, s.9.10.3.2).

The Proponent's planned mitigation measures that contribute to this position are to:

- 1) Conduct pre-construction surveys for dens if ground clearing occurs during the denning period (FEIS Annex Vol.8-3, Table 2.4-1); and
- 2) Establish a buffer around active dens. Should a 1 km buffer be impractical for construction purposes, TMAC will work with qualified personnel and the Government of Nunavut Department of Environment to designate an appropriate setback distance for the specific circumstances, e.g. the specific planned activities and risk of disturbance to the den (FEIS Annex Vol.8-3, Table 2.4-1).

The Proponent also assessed the potential for the Project to disrupt the movements of grizzly bears and concluded that:

- “The probability of the effect occurring is likely, as traffic volumes along a short section of the AWR will carry traffic volumes above thresholds, although the confidence in assessment is medium, given that there are few applicable studies for grizzly bear to determine whether movements may be altered at the projected traffic volumes. The residual effect of disruption of movement on grizzly bear is Not Significant “(sic)” for both Phase 2 and the Hope Bay Project” (FEIS Vol.4, s.9.10.4.2).

95.6 REVIEWER’S COMMENTS AND SUPPORTING RATIONALE

Grizzly Bear Dens: no-disturbance buffer

Carnivore dens have protected status under the Nunavut Wildlife Act (see TC-GN-14). Nevertheless, the monitoring and mitigation measures for grizzly bear dens specified in the FEIS have shortcomings:

In the FEIS, the Proponent provided a review of the literature on human disturbance of denning bears, noting:

“Some research reports that grizzly bears are sensitive to disturbance at their dens, resulting in bears abandoning their dens (H. V. Reynolds, Curatalo, and Quimby 1976) and potentially their young (Schoen et al. 1987), as well as potential displacement from high-quality denning habitats (Craighead Jr. and Craighead 1972; Linnell et al. 2000). However, research has shown that hibernating bears are unlikely to be disturbed by anything but extreme noise events (Amstrup 1993; Linnell et al. 2000). Even the noise resulting from blasting may have a limited effect on hibernating grizzly bears, as the dens are usually acoustically isolated when covered with snow (Linnell et al. 2000)” (FEIS Vol. 4, s.9.10.3.2).

The statement that blasting may have a limited effect on grizzly bears, due to the acoustic properties of dens, is misleading. The cited study was conducted on polar bear dens—not grizzly bears. There have been no studies looking at the effects of blasting on grizzly bears. Indeed, there have been relatively few studies looking at the effects of human activity of any kind on denning bears.

Based on a literature review, Linnell et al. (2000) recommended a general no disturbance buffer of 1 km around bear dens (not species-specific), noting that bears appear to be tolerant of some activities at closer distances but not within 200m. However, that review focused on evidence of den abandonment as a metric of disturbance, which is the most extreme response to human activity. Pigeon et al. (2014) found that grizzly bears in Alberta selected den sites that were at least 300m from oil and gas well sites. Elfstrom and

Swenson (2009) found that for brown bears in Sweden abandoned dens were located closer to plowed roads (mean of 1km) than dens used successfully all winter (mean of 1.8 km).

The Proponent proposed in the Project's Wildlife Mitigation and Monitoring Plan (WMMP) to set a 1-km no-disturbance buffer around active dens during construction, whenever possible. When it is not possible to maintain this buffer, the Proponent will work with qualified personnel and the Government of Nunavut Department of Environment "to designate an appropriate set-back distance for specific circumstances". However, there is no specification for what constitutes an appropriate setback distance. Specification is necessary, because it be vary from, for example, a distance that ensures a den is not abandoned to a distance that ensures construction work can continue. Consequently, clarification on this point is necessary to know when construction will continue and to evaluate the effects on grizzly bear denning.

Grizzly Bear Dens: pre-construction surveys

The Proponent proposed in the WMMP to conduct pre-construction surveys for bear dens. The design and study area for these surveys is not specified, which limits the evaluation of this measure's effectiveness. More detail is needed in the WMMP to ensure these surveys are effective, because the surveys are assumed to be effective in the residual effects conclusion of the FEIS.

Grizzly Bear Dens: operation phase monitoring and mitigation

As per the current version of the WMMP, monitoring and mitigation for denning bears is only during the construction phase. There appear to be no similar measures during the operations phase, which is the bulk of the Project's lifespan. Since application of monitoring and mitigation measures contributed to the residual effects conclusion of not significant for disturbance of bears, the assumption is that the conclusion is with respect to the construction phase only. This leaves disturbance of grizzly bear denning during the operations phase an un-assessed and unmitigated portion of the Project. To address this gap, annual monitoring and on-going mitigation for denning bears should be continued through construction into the operations phase, if the Project proceeds.

Disruption of Grizzly Bear Movements.

Overall, as noted in the FEIS, there is a lack of empirical evidence from the available scientific literature to determine with high confidence the effects of Project traffic on the movements of carnivores such as grizzly bears. At least one study suggests that grizzly bears strongly avoid roads where traffic levels exceed 4 vehicles per hour (Northrup et al. 2015), although it was unclear from this study whether the association was entirely related to disturbance by traffic or other human activities around roads. A recent study in northern Alberta demonstrated that wolverine avoid and increase their speed of movement near industrial roads with traffic levels less than 2.5 vehicles per hour (Scrafford

et al. 2018). This study demonstrates clearly that even low-use roads such as those proposed for the Project can significantly affect the movements of wildlife.

Uncertainty, regarding effects on movement also creates uncertainty about Project effects on connectivity within the regional grizzly bear population(s), the delineation and size of which is itself unclear.

Current plans for mitigating possible effects on the movements of grizzly bears are limited to giving bears right-of-way when they are crossing Project roads. However, there is no monitoring to support this measure except incidental observations by drivers, which are likely limited in range to a few hundred meters either side of roads. There is also no mitigation to reduce disturbance of bears as they are approaching roads.

Given the uncertainties regarding traffic effects on movements and connectivity within the regional bear population(s), greater caution is warranted in mitigating possible effects. As noted by the Proponent, the volumes of traffic along at least one of the Project's roads, the 10-km Doris to Madrid North section, "exceed the levels where it is assumed grizzly bear may avoid roads [...]" (FEIS Vol.4, s.10.4.5.2). The area around this section of road, in particular, should be subject to enhanced monitoring to detect approaching bears at longer ranges, beyond the view of drivers. Enhanced mitigation should also be implemented to manage traffic when bears are detected at these longer ranges.

95.7 REVIEWER'S RECOMMENDATIONS

To strengthen provisions for protection of denning bears, the Government of Nunavut recommends that the Proponent revise the Project's WMMP to include the following:

- Prior to any construction activities during denning season, surveys will be conducted to locate active dens within 2 km of the Project. Survey design will consider grizzly bear distribution, density, and denning habitat selection in order to stratify and apply sufficient search effort to locate a majority of dens in the study area.
- If an active den is located within 1 km of the Project during construction, activities will immediately cease within a specified no-disturbance buffer around the den. A den-specific management plan will be developed in consultation with the Government of Nunavut Department of Environment.
- For management of construction activities near bear dens in Nunavut, the Government of Nunavut recommends application of a general no-disturbance buffer of 1 km. This objective applies to all activities including the operation of vehicles, heavy equipment, drilling and blasting. This buffer may be modified for certain activities based on development of a den-specific management plan in consultation with the Government of Nunavut. Minimums for modified buffers are 1 km for blasting and drilling, 750 m for operation of heavy equipment, and 250 m for

light vehicle traffic. The same buffers are recommended for wolverine and wolf. Exceptions to these minimums may require a permit from the Government of Nunavut under section 74 of the Nunavut Wildlife Act. A den-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and den success), speed limit reductions and posting of signs in proximity to the den, driver notifications, use of convoys, reductions of traffic and temporary work stoppages during sensitive stages in denning or den emergence.

- After construction of the Project, surveys will be conducted annually to identify active den sites within 2 km of the Project that may require mitigation. All active dens within 1 km will have a den-specific management plan, developed in consultation with the Government of Nunavut Department of Environment. A den-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and den success), speed limit reductions and posting of signs in proximity to the den, driver notifications, use of convoys, reductions of traffic, temporary work stoppages during sensitive stages in denning or den emergence.

To strengthen provisions for minimizing disturbance of grizzly bears due to traffic on Project roads, the Government of Nunavut also recommends that the Proponent revise the Project's WMMP to include the following:

- Height-of-land monitoring for Grizzly bears along road sections where traffic levels exceed 4 vehicles per hour is to be incorporated. Monitoring should be sufficient to detect most bears approaching within 4 km (or as far as is feasibly possible using scopes or binoculars). This monitoring may occur concurrently with similar monitoring recommended for caribou (see GN Comment 22 – Caribou Protection Measures).
- When a bear is observed by within 4 km of a road, its behavior should be monitored to determine (a) its reaction to traffic and other activities; and (b) its direction of travel. Bears that appear to be moving towards the road should be subject to heightened mitigation beginning with issuance of alerts to drivers and operations managers and leading to temporary road closure (traffic suspension) when a bear reaches the 1.5-km mark from the road. For clarity, use of deterrents such as noise-making devices or vehicles is not an appropriate mitigation to measure for moving bears outside these monitoring and mitigation zones for the purpose of continuing Project operations.

95.8 PROPOSED TERM AND CONDITION/COMMITMENT

The Government of Nunavut proposes the following terms and conditions:

The Proponent shall revise the Wildlife Mitigation and Monitoring Plan to include the following:

- Prior to any construction activities during denning season, surveys shall be conducted to locate active dens within 2 km of the Project. Survey design shall consider grizzly bear distribution, density, and denning habitat selection in order to stratify and apply sufficient search effort to locate a majority of dens in the study area.
- If an active den is located within 2 km of the Project during construction, activities shall immediately cease within a specified no-disturbance buffer around the den. A den-specific management plan shall be developed in consultation with the Government of Nunavut Department of Environment.
- For management of construction activities near bear dens in Nunavut, the Government of Nunavut recommends application of a general no-disturbance buffer of 1 km. This objective applies to all activities including the operation of vehicles, heavy equipment, drilling and blasting. This buffer may be modified for certain activities based on development of a den-specific management plan in consultation with the GN. Recommended minimums for modified buffers are 1 km for blasting and drilling, 750 m for operation of heavy equipment, and 250 m for light vehicle traffic. The same buffers are recommended for wolverine and wolf. Exceptions to these minimums may require a permit from the Government of Nunavut under section 74 of the Nunavut Wildlife Act. A den-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and den success), speed limit reductions and posting of signs in proximity to the den, driver notifications, use of convoys, reductions of traffic and temporary work stoppages during sensitive stages in denning or den emergence.

After construction of the Project, surveys shall be conducted annually to identify active den sites within 2 km of the Project that may require mitigation. All active dens within 1 km shall have a den-specific management plan, developed in consultation with the GN Department of Environment (FEIS Annex Vol.8-3,s.2.4, Table 2.4-1) . A den-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and den success), speed limit reductions and posting of signs in proximity to the den, driver notifications, use of convoys, reductions of traffic, temporary work stoppages during sensitive stages in denning or den emergence.

- Height-of-land monitoring shall be conducted for grizzly bears along road sections where traffic levels exceed 4 vehicles per hour. Monitoring should be sufficient to detect most bears approaching within 4 km (or as far as is feasibly possible using scopes or binoculars). This monitoring may occur concurrently with similar monitoring

recommended for caribou (see GN Comment 22 – Caribou Protection Measures).

- When a bear is observed within 4 km of a road, its behavior shall be monitored to determine
 - (a) its reaction to traffic and other activities; and (b) its direction of travel. Bears that appear to be moving towards the road shall be subject to heightened mitigation beginning with issuance of alerts to drivers and operations managers and leading to temporary road closure (traffic suspension) when a bear reaches the 1.5-km mark from the road. For clarity, use of deterrents such as noise-making devices or vehicles is not an appropriate mitigation to measure for moving bears outside these monitoring and mitigation zones for the purpose of continuing Project operations.

95.9 TMAC RESPONSE FOR GN-23

The Wildlife Mitigation and Monitoring Plan (WMMP) already includes pre-construction monitoring for grizzly bear dens and setbacks during construction (Volume 8, Annex V8-3, Section 2.4; Construction Management; pg. 12):

- *“Ground clearing in areas likely to support grizzly bear dens conducted outside of denning periods for grizzly bears, where possible.*
- *Pre-construction surveys if ground clearing occurs during the specified period. The establishment of a buffer around active dens.*
- *Should a 1 km buffer be impractical for construction purposes, TMAC will work with qualified personnel and the GN-DoE to designate an appropriate setback distance for the specific circumstances; e.g. the specific planned activities and risk of disturbance to the den.”*

TMAC produced maps of high quality denning habitat as part of the FEIS. These maps will be used to determine the locations for den surveys.

TMAC will update the WMMP Plan to indicated that if a bear den is located within 1 km of planned construction, that TMAC will prepare a den management plan. With this commitment, no terms or conditions are warranted for bear dens during construction.

Height of Land monitoring will be used for all wildlife observations, including grizzly bear. Behaviour studies are not warranted for grizzly bears in the Project area. The primary objective of mitigation and monitoring grizzly bears is to manage the Project site to make it unattractive to bears and to monitor bear usage or avoidance or the Project site. These mitigation and monitoring measures are already in place for the Doris Project and will be used for the Phase 2 Project. Standard road mitigation for grizzly bears at Arctic mines is to stop vehicles when they are on the road and to stop and allow them to cross when

they are observed approaching a road. No further traffic stoppages are warranted for grizzly bears.

The WMMP will not include den surveys during operations. Those surveys will not be conducted for the following reasons:

1. Bear den surveys require low-level flying. There is an overall effort to reduce the required number of aircraft overflights to minimize potential disturbance to wildlife. Locating denning bears during operations will have little utility for managing Project effects should bears choose to den near consistent and on-going Project-related activities. There is no perceived benefit of locating bear dens within 2 km of an operational project that supersedes the potential negative effects of the low-level flights required for the survey.
2. TMAC has a comprehensive monitoring program for grizzly bears at the Doris Project and has proposed additional measures in the FEIS for the Phase 2 Project. The first priority for mitigation and management of bears is to manage the Project site to reduce the chance of attracting bears and producing problem animals. A second priority for mitigation is managing activities to address the potential for disturbance of bears or the disruption of their movements across Project roads.
3. During operations of the Project, should a grizzly bear, wolverine or wolf choose to den near the Project, TMAC will respect that choice, but no additional mitigation is required beyond the existing mitigation and monitoring plans. For example, there are already mitigation measures in place to avoid dens when using helicopters. Annual surveys for grizzly bear dens surrounding the operating Project are unwarranted, particularly given that the population of bears in the Project area is stable or increasing and bear populations surrounding the much larger Ekati and Diavik mines are likewise stable or increasing.

These proposed changes to the WMMP do not require a specific term or condition.

96. ID #GN-24

96.1 DEPARTMENT

Environment

96.2 ORGANIZATION

Government of Nunavut

96.3 SUBJECT/TOPIC

Raptor Nests

96.4 REFERENCES

- FEIS Vol. 4, s. 9.16.3.2 - Disturbance
- FEIS Vol. 8, Annex V8-3 Hope Bay Project Wildlife Mitigation and Monitoring Plan, Table 2.4-1. Specified Wildlife Periods and Associated Mitigation.

96.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent assessed the potential for the Project to disturb nesting raptors. It concluded that there was no evidence of a Project-related effect on raptor nest occupancy, and some evidence of a localized (<1.5 km from infrastructure) effect on raptor breeding at the existing Doris mine. There was not sufficient data to assess raptor productivity statistically. Overall it concluded that the Project would have no significant residual impact on raptor populations (FEIS Vol. 4, s. 9.16.3.2).

The planned mitigation measures that contribute to this conclusion are to:

- Conduct nest surveys prior to clearing construction.
- Establish a 200m avoidance buffer around active nests during construction.
- Should this buffer be impractical for construction purposes, TMAC will work with qualified personnel and the GN-DOE to designate an appropriate setback distance or other authorized mitigation for the specific circumstances.
- A permit from GN DOE will be obtained should the Project need to dissuade raptors from nesting on quarry walls or an inactive nest be removed.

(FEIS Vol. 8, Annex V8-3, Table 2.4-1. Specified Wildlife Periods and Associated Mitigation).

96.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Notwithstanding the protected status of raptor nests under the *Wildlife Act*, SNU 2003, c26 (see GN Technical Review Phase comment #25), the GN has several issues with respect to the monitoring and mitigation measures for raptor nests:

Pre-construction Nest Surveys and Avoidance Buffers

- The design of preconstruction nest surveys is not specified.
- The 200m avoidance buffer is too small. This buffer is not responsive to findings from nest monitoring conducted at the Doris mine. These findings suggested effects on breeding within 1.5 km. General no-disturbance buffers applied by industry in Nunavut as operating objectives typically range from 500m – 1000m (e.g. NIRB 11MN034 / 124106; NIRB 124149 / 12MN03). In other jurisdictions, government guidelines for no-disturbance buffers during construction near raptor nests vary from 300m to 1000m (AER 2013; Dillon 2014; BC MFLNR 2014; BC Guidelines for Raptor Conservation 2013; US DOI-BLM 2012). Buffers for species such as peregrine falcons and golden eagles typically range between 600-1000m. Based on an extensive review of available field studies and professional judgment, Ruddock and Whitfield (2007) suggested buffers of 500-750m are reasonable for golden eagles and peregrines. Based on a meta-analysis of 201 species of birds (including raptors), Benítez-López et al. (2010) found a tendency for decreased abundance within 1 km of roads and other development activities. It should also be noted that these buffers are primarily based on information regarding Flight Initiation Distances (FID). FID is the range at which a bird flushes or otherwise moves away from an approaching disturbance source. This reflects one of the more extreme responses to disturbance and thus likely underestimates the range at which raptors are disturbed.

When it is not possible to maintain this 200m buffer, the Proponent proposed to work with qualified personnel and the GN-Department of Environment “to designate an appropriate set-back distance for specific circumstances” (FEIS Annex Vol.8-3,s.2.4, Table 2.4-1). What constitutes an appropriate setback distance is not specified. The GN requires clarification of the setback intended.

- Ruddock and Whitfield (2007) emphasized the need for buffers to be context specific; noting that each nest differs in key attributes such as species, stage of breeding, nest site elevation, the extent of territory core, history of prior disturbance, line of sight to disturbance source and security of the nest. These attributes affect the size of the required buffer. Accordingly, development of nest specific management plans for nests located within a specified distance of the Project is necessary.

Nest Monitoring and Mitigation During Operations Phases.

- Pursuant to the current version of the WMMP, monitoring and mitigation for nesting raptors is only applied during the construction phase. There appear to be no similar measures in effect during the operations phase, which is the bulk of the Project's lifespan. Since application of these measures contributed to the residual effects conclusion of Not Significant for disturbance of raptors, it is assumed that this conclusion applies to the construction phase only. This leaves disturbance of raptors during the operations phase an un-assessed and unmitigated portion of the Project. To address this gap, annual monitoring and on-going mitigation for raptors should be continued through construction into the operations phase.
- The area around the Project contains relatively high densities of nesting raptors. The WMMP should include continued monitoring of raptor nest occupancy and productivity. This should be expanded to include the new roads and the Boston mine site proposed by the Proponent. The GN recommends monitoring to assess the effectiveness of no-disturbance buffers and other mitigation measures, the ZOI, and as a contribution to regional raptor monitoring. It is noted that two mine operators have set effects thresholds for nesting raptors of no more than a 10-20% difference in occupancy and productivity between nest sites near Project infrastructure and nest sites far from Project infrastructure (NIRB 11MN034 / 124106; NIRB 123910 / 08MN053)

96.7 REVIEWER'S RECOMMENDATIONS

To strengthen provisions for protection of nesting raptors, the Project's WMMP should be revised to include the following:

- Prior to any construction activities during raptor nesting seasons, surveys shall be conducted to locate nests within 2 km of the Project. Survey design should consider species distribution, density, and habitat selection in-order stratify and apply sufficient search effort to locate a majority of nests. Timing of surveys should also account for species differences in the timing of nesting that will affect the ability to locate active nests.
- If an active nest is located within 1 km of the Project during construction, activities shall immediately cease within a specified no-disturbance buffer around the nest. A nest-specific management plan shall be developed in consultation with the GN Department of Environment, subject matter experts and other relevant parties.
- For management of construction activities near active raptor nests in Nunavut, the GN recommends application of a general no-disturbance buffer of 1 km. This objective applies to all activities including the operation of vehicles, heavy equipment, drilling and blasting. This buffer may be modified for certain activities based on development of a nest-specific management plan that has been reviewed and approved by the GN, subject matter experts and other relevant

parties. Minimums for modified buffers are 1 km for blasting and drilling, 500 m for operation of heavy equipment and 300 m for light vehicle traffic. Exceptions to these minimums may require a permit from the Government of Nunavut under sections 72 and 74 of the Nunavut Wildlife Act. Where a raptor builds a nest on project infrastructure such as a service building, the recommended cessation of construction activities within a no-disturbance buffer does not apply but development of a nest-specific management plan is recommended. A nest-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and nest success), speed limit reductions and posting of signs in proximity to the nest, driver notifications, use of convoys, reductions of traffic, temporary work stoppages during sensitive stages in nesting.

- After construction of the Project, surveys shall be conducted annually to identify active nest sites within 2 km of the Project that may require mitigation. All active nests within 1 km shall have a nest-specific management plan, developed in consultation with the GN Department of Environment.
- The success of nests that are subject to a management plan should be monitored and compared with those further away from the Project. A recommended objective for these managed nests is to obtain a level of success equal to 80% of that at undisturbed nests. This effects monitoring may be focused one or two of the species that are most abundant near the Project, excluding ravens.

96.8 PROPOSED TERM AND CONDITION/COMMITMENT

The WMMP shall be revised to include the following:

- Prior to any construction activities during raptor nesting seasons, surveys shall be conducted to locate nests within 2 km of the Project. Survey design should consider species distribution, density, and habitat selection in-order stratify and apply sufficient search effort to locate a majority of nests. Timing of surveys should also account for species differences in the timing of nesting that will affect the ability to locate active nests.
- If an active nest is located within 1 km of the Project during construction, activities shall immediately cease within a specified no-disturbance buffer around the nest. A nest-specific management plan shall be developed in consultation with the GN Department of Environment, subject matter experts and other relevant parties.
- For management of construction activities near active raptor nests in Nunavut, the Government of Nunavut (GN) recommends application of a general no-disturbance buffer of 1 km. This objective applies to all activities including the operation of vehicles, heavy equipment, drilling and blasting. This buffer may be modified for certain activities based on development of a nest-specific

management plan that has been reviewed and approved by the GN, subject matter experts and other relevant parties. Minimums for modified buffers are 1 km for blasting and drilling, 500 m for operation of heavy equipment and 300 m for light vehicle traffic. Exceptions to these minimums may require a permit from the Government of Nunavut under sections 72 and 74 of the Nunavut Wildlife Act. Where a raptor builds a nest on project infrastructure such as a service building, the recommended cessation of construction activities within a no-disturbance buffer does not apply but development of a nest-specific management plan is recommended. A nest-specific management plan may include mitigation measures such as increased monitoring (to assess responses to disturbance and nest success), speed limit reductions and posting of signs in proximity to the nest, driver notifications, use of convoys, reductions of traffic, temporary work stoppages during sensitive stages in nesting.

- After construction of the Project, surveys shall be conducted annually to identify active nest sites within 2 km of the Project that may require mitigation. All active nests within 1 km shall have a nest-specific management plan, developed in consultation with the GN Department of Environment.
- The success of nests that are subject to a management plan shall be monitored and compared with those further away from the Project. A monitoring threshold for these managed nests is to obtain a level of success equal to 80% of that at undisturbed nests. This effects monitoring may be focused one or two of the species that are most abundant near the Project, excluding ravens.

96.9 TMAC RESPONSE FOR GN-24

TMAC has completed 10 years of intensive monitoring for raptors around the existing Doris site and associated infrastructure, in consultation with the KIA and GN. This monitoring for the Doris Project has not detected any effect on the regional raptor population due to the construction and operation of the Doris Project; measured as the proportion of territories occupied (Figure GN-24-1).

However, TMAC acknowledges the information and guidance provided by the GN on mitigating disturbance to cliff-nesting raptors. The WMMP includes monitoring and setbacks for nests should construction occur in the raptor breeding season. Based on the GN comments, TMAC will revise the WMMP to further ensure protection with the following additional mitigation:

- 1) Should construction of new areas occur in the raptor breeding period, TMAC will conduct a pre-construction survey of potential cliff-nesting habitat within 2 km of the Proposed Phase 2 development prior to construction to ensure sites have been accounted for from previous surveys.

- 2) TMAC will include site-specific nest mitigation plan for raptor cliff-nest sites within 1 km of the Project footprint. Those plans will apply during construction and operation stages. These plans can be developed in consultation with the GN Department of Environment subject matter experts.

Other components of monitoring, as requested by the GN, are already a part of the WMMP.

These proposed updates to the WMMP do not require additional Project Terms and Conditions.

Discussion:

The current mitigation and monitoring program for the Doris Project protects raptors from disturbance, while maintaining the operability of the Project. The raptor monitoring program results include:

1. The Doris Project has not affected the number of raptor territories being used in the raptor study area (measured as % of nests occupied).
2. There is no measurable zone of influence of the Project on raptor occupancy – whether they establish nests (with distance measured as a continuous variable).
3. There is no measurable zone of influence of the Project on the success of raptor nests – whether they produce chicks (with distance measured as a continuous variable).
4. However, when all data is grouped into less than and greater than 1.5 km from the Project, the data show a difference in nest success (producing chicks) within 1.5 km between years that the Project is active and inactive.

This effect represents a 22% difference in nest success within 1.5 km during years that the Project is active; measured as the difference in productivity between test and control areas when the Doris Project was active vs. care and maintenance. That impact is consistent with the identified threshold of concern (10-20% difference between near and far nests) suggested by the GN. This is also consistent with the Doris FEIS prediction of minor effects to movement and behaviour (nest success) within <1-10 km² of the Project. For perspective, this effect equates to an average difference of 1.8 nests, within a population of approximately 100 raptors in the raptor study area. This level of disturbance within the ZOI is unlikely to result in a population level effect and there is no evidence of a population level effect in the monitoring results.

TMAC has implemented a robust set of management and monitoring programs to reduce disturbance to raptors. These include:

- The Phase 2 Project was designed to avoid raptor nests. Raptor nests were identified as a sensitive landscape feature, along with carnivore dens, wetlands, fisheries streams and archaeological sites. Environmental sensitivity maps were delivered to Project engineers, who designed the physical footprint of the Project to avoid these features, where possible.

For example, areas identified as potential quarries for the Project have avoided known raptor nest (see Figures 9.2-32a and 9.2-32b of Volume 4, Chapter 9) and only one raptor nest site, identified as marginal and only occupied in one of the last 10 years, will be lost during Project construction.

- Construction of the Project will be conducted outside of the breeding period for a number of wildlife species (spring and summer), wherever possible.
- General noise reduction techniques, including instructing pilots to avoid nests with helicopters.
- Any sic sic mortalities will be removed from the road to avoid attracting raptors to the road.
- Where not possible to construct the Project outside of sensitive periods for wildlife, TMAC will conduct pre-construction surveys and set up management buffers surrounding active raptor nests.

Due to the long history of monitoring at the Doris site, the raptor populations within the Doris and Phase 2 study areas are well understood. Table GN-24-1 provides a description of each territory within 1 km of the proposed Phase 2 project, including the number of nest sites in each territory, the distance of each nest to the footprint, a description of each nest site, and a description of the monitoring results – the number of years the nest site has been occupied.

Most raptor territories include multiple nesting sites, with typically only one nesting site used per year. Many of these nesting locations are screened from proposed Phase 2 activities by topography (i.e., they are located on the opposite side of the many rocky dykes/outcrops in the study area). The relative importance of each nest site is also well understood, with 10 years of monitoring for occupancy and productivity. For instance, many territories and nest sites have only been used one or two times in 10 years, while some nest sites are consistently productive. This long-term monitoring data will allow the nest management plan to be specific to the location, history and quality of the nest site.

Once construction and operations are underway, if a raptor chooses to nest on or adjacent to the Project footprint then TMAC will not take any further action — the raptor choose to nest in that location despite the Project activities. Due to the topography of the Project area, each raptor territory generally includes multiple nesting sites. Therefore, raptors have choice in whether to nest adjacent to the Project, and that further indicates

that TMAC's project infrastructure can coexist with raptors as our monitoring already suggests.

Monitoring of raptor occupancy and breeding success to verify predictions is already a component of the WMMP, although TMAC notes that there are still ongoing discussions with the Government of Nunavut, the KIA, and ECCC regarding whether monitoring will proceed at the Doris site and as part of the Phase 2 Project given that predictions of the FEIS have already been tested.

Figure GN-24-1

Proportion of Available Territories Occupied
by Raptors during 10 years of Monitoring at the Doris Project

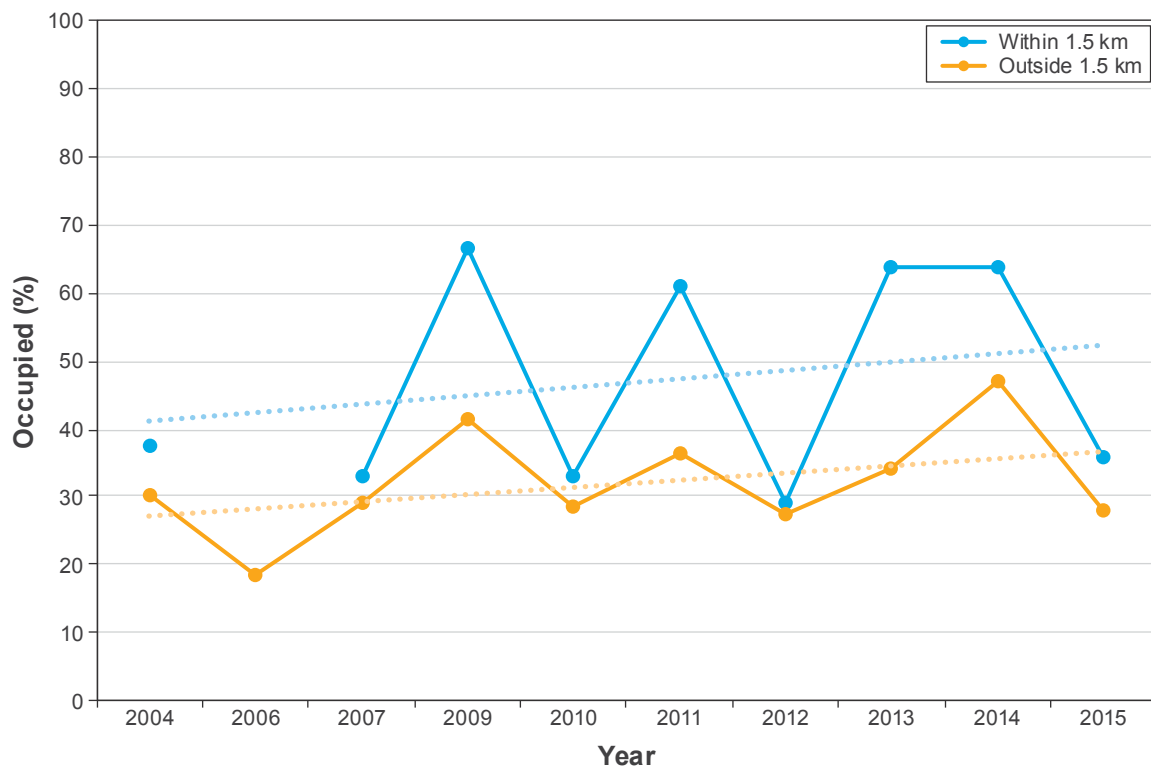


Table GN-24-1: Cliff-nesting raptor sites that may require a site-specific management plan.

Territory No.	Species	Years Surveyed	No. Used Nests in Territory ¹	In Project Development Area	Distance of Nests to Madrid-Boston Infrastructure (m)	Madrid-Boston Features	Summary Notes	Comments
104	Golden Eagle	2004, 2006, 2007, 2009-2015 (10 years)	2	No	847, 1,027	Crown Pillar Recovery Trench Access Road	Territory on north side of Doris Mountain, one nest site beyond 1 km of proposed infrastructure; Madrid-Boston infrastructure on south side of Doris Mountain. Hence, nest sites will have both visual and auditory screening from Project activities.	Occupied in multiple years (6 years; 2007, 2010-2012, 2014-2015)
114	Golden Eagle	2004, 2006, 2007, 2009-2015 (10 years)	3	No	223, 435, 1,775	Madrid-Boston Road	Territory includes different nesting sites on adjacent rocky dykes/cliffs. Furthest occupied nest beyond 1 km of proposed infrastructure and on east side of a rocky dyke/cliff. Closer occupied nests on west side of a different dyke and overlaps with territories of peregrine falcon (Territory 415), rough-legged hawk (Territory 222) and gyrfalcon (Territory 309). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, closer nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in multiple years (4 years; 2011, 2013-2015). Occupation unlikely affected other species nesting in closer proximity, as other species appear to select sites further away from golden eagle nests due to possible risk of predation from golden eagles (e.g., Poole and Bromley 1988).
119	Golden Eagle	2004, 2006, 2007, 2009-2015 (10 years)	1	No	549	Quarry M	Territory on rocky dyke/cliff with nest sites facing southwest. Territory overlaps with rough-legged hawk (Territory 246) and peregrine falcon (Territory 421). Madrid-Boston infrastructure located on opposite side of cliff to the northwest. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in two years (2009 and 2013). Occupation could influence/be influenced by other species with nearby territories.
204	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	4	No	238, 426, 567, 859	Crown Pillar Recovery Trench Access Road	Territory on south side of Doris Mountain and faces existing Doris infrastructure; multiple nest sites used over time. Territory overlapping with peregrine falcon (Territory 404). Nest sites are in line of sight of proposed Madrid-Boston activities with no topographic barriers to provide visual/auditory screening.	Occupied in multiple years (6 years; 2007, 2009, 2010, 2011, 2013, 2014). Occupation could influence/be influenced by other species with nearby territories.
206	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	1	Yes	0	Tailings Impoundment Area	Nest site will be lost to Project development; site considered marginal and only used in one year but has been surveyed in multiple years.	Occupied in one year (2013)
207	Rough-legged Hawk	2012-2015 (4 years)	1	No	142	Turbine Pad	Territory on west side of rocky dyke/cliff adjacent to existing Doris-Windy AWR; Madrid-Boston infrastructure located on opposite side of dyke to the east. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in two years (2013, 2014)
208	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	1	No	908	Madrid North-TIA Road	Territory on rocky ledge/cliff along west shoreline of Doris Lake with nest ledge facing east. Nest site will face towards proposed infrastructure on east side of Doris Lake and does not have any topographic barriers to provide visual/auditory screening.	Occupied in one year (2013)
209	Rough-legged Hawk	2009-2015 (7 years)	1	No	708	Doris Fresh Water Intake	Territory on rocky ledge/cliff along east shoreline of Windy Lake with nesting ledge facing west. Madrid-Boston infrastructure is located at end of rocky ledge/cliff to the south. Nest ledge will have partial topographic barrier to provide visual/auditory screening from Project activities.	Occupied in multiple years (5 years; 2009, 2010, 2012-2014)

Territory No.	Species	Years Surveyed	No. Used Nests in Territory ¹	In Project Development Area	Distance of Nests to Madrid-Boston Infrastructure (m)	Madrid-Boston Features	Summary Notes	Comments
210	Rough-legged Hawk	2009-2015 (7 years)	1	No	447	Doris Fresh Water Intake	Territory on same rocky ledge/cliff as Territory 209 but is located further south. Madrid-Boston activities will be located closer to Territory 210 than 209, so nest site will have less visual/auditory screening based on proximity to Project activities	Occupied in two years (2011, 2015).
211	Rough-legged Hawk	2004, 2009-2015 (8 years)	2	No	778, 795	Madrid North-TIA Road	Territory on rocky ledge/cliff along east shoreline of Windy Lake with nesting ledge facing west; territory overlapping with gyrfalcon (Territory 304). Madrid-Boston infrastructure located to the south/southeast. Nest ledge will have a partial topographic barrier to provide visual/auditory screening from Project activities	Occupied in multiple years (5 years; 2010, 2011, 2013-2015). Occupation could influence/be influenced by other species with nearby territories.
212	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	2	Yes	115, 122	Madrid North-TIA Road	Territory on rocky ledge/cliff with nest sites facing north/northwest. Nest sites are in line of sight of proposed Madrid-Boston activities to north with no topographic barriers to provide visual/auditory screening.	Occupied in multiple years (7 years, 2004, 2007, 2009-2011, 2013, 2014)
214	Rough-legged Hawk	2006, 2007, 2009, 2011-2015 (8 years)	2	Yes	370, 520	Crown Pillar Recovery Trench	Territory on rocky ledge/cliff along west shoreline of small lake with nesting ledge facing east. Madrid-Boston infrastructure located beyond south end of the rocky ledge/cliff. Hence, nesting ledges have a partial topographic barrier to provide visual/auditory screening from Project activities.	Occupied in 5 years (2006, 2007, 2011, 2013, 2014)
216	Rough-legged Hawk	2007, 2009, 2013-2015 (5 years)	1	Yes	12	Quarry AH	Territory on rocky ledge/cliff on outer edge of Quarry AH at the Madrid North Site. Hence, nest site will not have a topographic barrier from Project activities.	Occupied in 4 years (2007, 2009, 2013, 2014)
219	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	2	No	520, 609	Turbine Pad (609), Quarry AH (520)	Territory on west side of rocky dyke/cliff. Territory overlaps with gyrfalcon (Territory 306) and peregrine falcon (Territory 412). Quarry AH located to northwest and turbine pad located to southeast; both features are located on opposite side and upslope of this rocky dyke. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 7 years (2004, 2006, 2007, 2009, 2011, 2013, 2014). Occupation could influence/be influenced by other species with nearby territories.
222	Rough-legged Hawk	2006, 2007, 2009-2015 (9 years)	3	No	346, 353, 373	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with peregrine falcon (Territory 415) and gyrfalcon (Territory 309). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 4 years (2006, 2009, 2014, 2015). Occupation could influence/be influenced by other species with nearby territories.
226	Rough-legged Hawk	2006, 2007, 2009-2015 (9 years)	1	No	197	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with peregrine falcon (Territory 419) and gyrfalcon (Territory 311). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 1 year (2013). Occupation could influence/be influenced by other species with nearby territories.
227	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	1	No	230	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with a gyrfalcon (Territory 311). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 2 years (2010, 2014). Occupation could influence or be influenced by nearby territories.

Territory No.	Species	Years Surveyed	No. Used Nests in Territory ¹	In Project Development Area	Distance of Nests to Madrid-Boston Infrastructure (m)	Madrid-Boston Features	Summary Notes	Comments
228	Rough-legged Hawk	2006, 2007, 2010-2015 (8 years)	1	No	146	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with a gyrfalcon (Territories 311 and 312). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 3 years (2010, 2011, 2014). Occupation could influence/be influenced by other species with nearby territories.
234	Rough-legged Hawk	2006, 2007, 2009-2015 (9 years)	2	No	135, 155	Quarry Z	Territory on rocky ledge/cliff along east shoreline of small lake with nest sites facing west. Territory overlaps with gyrfalcon (Territory 317) and peregrine falcon (Territory 425). Nest sites are in line of sight of proposed Madrid-Boston activities to east with no topographic barriers to provide visual/auditory screening.	Occupied in 2 years (2013, 2014). Occupation could influence/be influenced by other species with nearby territories.
235	Rough-legged Hawk	2006, 2007, 2009-2015 (9 years)	1	No	159	Quarry Z	Territory on rocky ledge/cliff along east shoreline of small lake with nest sites facing west. Territory overlaps with gyrfalcon (Territory 317). Nest sites are in line of sight of proposed Madrid-Boston activities to east with no topographic barriers to provide visual/auditory screening.	Occupied in 2 years (2009, 2011). Occupation could influence/be influenced by other species with nearby territories.
236	Rough-legged Hawk	2013 (1 year)	1	No	227	Quarry T	Territory on rocky ledge/cliff along east shoreline of Aimaokatalok Lake with nest site facing west. Madrid-Boston infrastructure located on opposite side of cliff to the east. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 1year (2013)
245	Rough-legged Hawk	2004, 2006, 2007, 2009-2015 (10 years)	1	No	562	Quarry M	Territory on rocky dyke/cliff with nest sites facing southwest. Territory overlaps with golden eagle (Territory 119) and peregrine falcon (Territory 421). Madrid-Boston infrastructure located on opposite side of cliff to the northwest. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 2 years (2004, 2006). Occupation could influence/be influenced by other species with nearby territories.
304	Gyrfalcon	2009-2015 (7 years)	2	No	788, 795	Madrid North-TIA Road	Territory on rocky ledge/cliff along east shoreline of Windy Lake with nesting ledge facing west; territory overlapping with rough-legged hawk (Territory 211). Madrid-Boston infrastructure to the south/southeast. Nest ledge will have partial visual/auditory screening from Project activity	Occupied in 2 years (2009, 2015). Occupation could influence/be influenced by other species with nearby territories.
306	Gyrfalcon	2004, 2006, 2007, 2009-2015 (10 years)	2	No	520, 606	Quarry AH	Territory on west side of rocky dyke/cliff. Territory overlaps with rough-legged hawk (Territory 219) and peregrine falcon (Territory 412). Quarry AH located to northwest; feature is located on opposite side and upslope of this rocky dyke. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 4 years (2011, 2013-2015). Occupation could influence/be influenced by other species with nearby territories
309	Gyrfalcon	2006, 2007, 2010-2015 (8 years)	3	No	342, 353, 435	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with peregrine falcon (Territory 415), rough-legged hawk (Territory 222), and golden eagle (Territory 114). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 3 years (2013-2015). Occupation could influence/be influenced by other species with nearby territories.

Territory No.	Species	Years Surveyed	No. Used Nests in Territory ¹	In Project Development Area	Distance of Nests to Madrid-Boston Infrastructure (m)	Madrid-Boston Features	Summary Notes	Comments
311	Gyrfalcon	2004, 2006, 2007, 2009-2015 (10 years)	5	No	197, 229, 231, 232, 286	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with rough-legged hawk (Territories 226 and 227) and peregrine falcon (Territory 419). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 5 years (2009, 2012-2015). Occupation could influence/be influenced by other species with nearby territories.
312	Gyrfalcon	2004, 2006, 2007, 2009-2015 (10 years)	1	No	185	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with rough-legged hawk (Territory 228). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 1 year (2011). Occupation could influence/be influenced by other species with nearby territories.
317	Gyrfalcon	2004, 2006, 2007, 2009-2015 (10 years)	2	No	155, 160	Quarry Z	Territory on rocky ledge/cliff along east shoreline of small lake with nest sites facing west. Territory overlaps with peregrine falcon (Territory 425) and rough-legged hawk (Territories 234 and 235). Nest sites are in line of sight of proposed Madrid-Boston activities to east with no topographic barriers to provide visual/auditory screening.	Occupied in 6 years (2009-2011, 2013-2015). Occupation could influence/be influenced by other species with nearby territories.
404	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	4	No	631, 721, 729, 850	Crown Pillar Recovery Trench Access Road	Territory on south side of Doris Mountain and faces existing Doris infrastructure; multiple nest sites used over time. Territory overlapping with rough-legged hawk (Territory 204). Nest sites are in line of sight of proposed Madrid-Boston activities with no topographic barriers to provide visual/auditory screening.	Occupied in 9 years (2004, 2007, 2009-2015). Occupation could influence/be influenced by other species with nearby territories.
406	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	3	No	517, 549, 588	Doris Fresh Water Intake	Territory on west side of rocky dyke/cliff adjacent to existing Doris-Windy AWR; Madrid-Boston infrastructure located to southeast and upslope from this dyke. Hence, nest site will have a partial topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 9 years (2004, 2006, 2007, 2009-2011, 2013-2015)
409	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	2	No	796, 902	Crown Pillar Recovery Trench	Territory located on rocky island in north arm of Patch Lake; occupied nest sites have been located on either side of island (east and west facing). Nest ledges on west side of island are in line of sight of proposed Madrid-Boston activities with no topographic barriers to provide visual/auditory screening, while the ledges on the opposite site will have a topographic barrier to afford visual/auditory screening.	Occupied in 5 years (2004, 2011, 2013-2015)
412	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	3	No	520, 606, 609	Turbine Pad (609), Quarry AH (520. 606)	Territory on west side of rocky dyke/cliff. Territory overlaps with gyrfalcon (Territory 306) and rough-legged hawk (Territory 219). Quarry AH located to northwest and turbine pad located to southeast; both features are located on opposite side and upslope of this rocky dyke. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 3 years (2004, 2007, 2009). Occupation could influence/be influenced by other species with nearby territories.

Territory No.	Species	Years Surveyed	No. Used Nests in Territory ¹	In Project Development Area	Distance of Nests to Madrid-Boston Infrastructure (m)	Madrid-Boston Features	Summary Notes	Comments
415	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	3	No	279, 342, 353	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with rough-legged hawk (Territory 222), gyrfalcon (Territory 309), and golden eagle (Territory 114). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 6 years (2004, 2007, 2009-2011, 2013). Occupation could influence/be influenced by other species with nearby territories.
419	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	4	No	206, 222, 231, 233	Madrid-Boston Road	Territory on west side of rocky dyke/cliff. Territory overlaps with rough-legged hawk (Territory 226) and gyrfalcon (Territory 311). Madrid-Boston road alignment is located on east side of this dyke/cliff. Hence, nest sites will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 7 years (2009-2015). Occupation could influence/be influenced by other species with nearby territories.
421	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	3	No	537, 549, 559	Quarry M	Territory on rocky dyke/cliff with nest sites facing southwest. Territory overlaps with rough-legged hawk (Territory 246) and golden eagle (Territory 119). Madrid-Boston infrastructure located on opposite side of cliff to the northwest. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 6 years (2009, 2011-2015). Occupation could influence/be influenced by other species with nearby territories.
425	Peregrine Falcon	2004, 2006, 2007, 2009-2015 (10 years)	2	No	155, 160	Quarry Z	Territory on rocky ledge/cliff along east shoreline of small lake with nest sites facing west. Territory overlaps with gyrfalcon (Territory 317) and rough-legged hawk (Territory 234). Nest sites are in line of sight of proposed Madrid-Boston activities to east with no topographic barriers to provide visual/auditory screening.	Occupied in 9 years (2004, 2006, 2007, 2009, 2011-2013). Occupation could influence/be influenced by other species with nearby territories.
429	Peregrine Falcon	2006, 2009 (2 years)	1	No	207	Boston Vent Raise	Territory on rocky ledge/cliff along east shoreline of small lake with nest sites facing east. Madrid-Boston infrastructure located on opposite side of cliff to the northwest. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 2 years (2006, 2009)
438	Peregrine Falcon	2011 (1 year)	1	No	484	Madrid-Boston Road	Territory on west side of rocky ledge/cliff. Madrid-Boston infrastructure located on opposite side of cliff to the east. Hence, nest site will have a topographic barrier to provide visual and auditory screening from Project activities.	Occupied in 1 year (2011)

97. ID #GN-25

97.1 DEPARTMENT

Environment

97.2 ORGANIZATION

Government of Nunavut

97.3 SUBJECT/TOPIC

Air Traffic

97.4 REFERENCES

- FEIS Vol.4, s.9.8.3.2 – Disturbance
- FEIS Vol.4, s.9.8.1.1 – Caribou Workshops with Elders and Land Users
- FEIS, Vol.3, s.4.6
- FEIS Vol.8, Annex V8-3, s.2.2.2 – Mitigation for Disturbance, Hope Bay Project Wildlife Mitigation and Monitoring Plan
- GN Technical Comment DEIS, TC#10

97.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent incorporated the effects of Project-related air traffic on wildlife, such as caribou, via noise modeling into a general disturbance assessment. This assessment considered all Project activities that could potentially contribute to a zone-of-influence (ZOI) around the Project. This approach resulted in the Proponent concluding that disturbance by the Project, including that from aircraft, would not have a significant residual impact on caribou (FEIS Vol. 4 s.9.8.3.2). The Proponent reached similar conclusions for other species.

97.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

Some of the GN concerns regarding the impacts of aircraft use on wildlife outlined in TC-GN- 10 during the DEIS review period remain outstanding, as follows:

Noise Modeling

The Proponent conducted noise modeling for aircraft using Health Canada standards for annoyance and disruption of sleep of humans in order to estimate the spatial extent of disturbance for wildlife. The use of these Health Canada standards—established with respect to human and not wildlife disturbance—is a weakness in the effects assessment for wildlife disturbance, as the consequent modeling may have underestimated the spatial extent of aircraft noise. Despite this limitation, the Proponent's modeling still indicates that:

- Noise from helicopters will reach Health Canada standards for annoyance and disruption of sleep for the base case of helicopters flying between Doris and Boston, and for the summer drilling support within one to two km of the Doris and Boston sites; and
- Noise levels due to (fixed-wing) aircraft will reach Health Canada standards for annoyance and disruption of sleep at approximately 600m from the ends of the runways and 300m from the sides of runways. These areas are well within the 4-km ZOI used for the assessment of disturbance on caribou.

Fix-wing Aircraft Rates.

While the Proponent fulfilled part of its commitment to provide information regarding fix-wing aircraft rates as requested by the GN during the DEIS review period (see FEIS, Vol.3, s.4.6), the Proponent has not provided estimates of flight frequency for aircraft transporting Nunavut residents to the Project.

Mitigation for Helicopter Operation

Wildlife such as caribou appear to be more sensitive to helicopters than to fixed winged aircraft (Wolfe et al 2000). During caribou workshops conducted by the Proponent, elders and land users identified disturbance from helicopters as a concern and recommended that helicopter use be limited during migration periods (FEIS Vol. 4, s9.8.1.1). This recommendation was not incorporated into the Project's Wildlife Mitigation and Monitoring Plan (WMMP).

The only measure applied to mitigate helicopter disturbance of wildlife is the application of an avoidance buffer for caribou, namely “[h]elicopter flights will avoid animals by as large a margin as possible, with a minimum of 300 m vertically and 600 m horizontally when safe to do so” (FEIS Vol 8, Annex V8-3, s2.2.2). The GN previously recommended revision of WMMP to clarify that this mitigation measure also apply to helicopters on the ground such that engine starts and takeoffs of helicopters will be suspended when caribou are observed within the buffer distance (TC-GN -10). The GN maintains this recommendation. Additionally, as discussed in GN technical comment 10, the ability to implement this buffer and its effectiveness are unknowns. Weather conditions, operation

constraints (i.e. type of helicopter use) and the ability to detect caribou in time to maintain the proposed buffers are limitations on effectiveness.

Air Traffic Monitoring.

During technical review, the GN recommended addition of an air traffic monitoring and reporting program to the Project's WMMP (see GN-TC-10). The revised WMMP, submitted as part of the FEIS, does not include this program. The GN maintains this recommendation.

97.7 REVIEWER'S RECOMMENDATIONS

Disturbance from aircraft can contribute to both indirect loss of wildlife habitat and disruption of movements, including caribou migration. Because gaps exist in the FEIS relating to disturbance from aircraft, the GN recommends the following:

- That the Project's WMMP be revised to include a program to monitor and report annually the air traffic levels (landings, take-off, dates, aircraft type) at the Doris and Boston airstrips;
- That the Project's WMMP be revised to include a program to monitor and report annually all helicopter traffic so that the spatial scale and intensity of this activity can be documented. This should include the collection and analysis of GPS flight tracks for all helicopter flights. This information should be used to: (1) verify the accuracy of EIS predictions and assumption about the level and distribution of helicopter traffic;
- (2) verify assumptions about helicopter traffic that were made in the noise modeling study; (3) assess compliance with minimum flight altitude restrictions designed to reduce disturbance of wildlife; and (4) facilitate other Project effects monitoring programs such as wildlife ZOI and movement studies;
- That the Project's WMMP be revised to include a program to monitor and report annually all caribou sightings by pilots, documenting the altitude and distance at which each group of caribou is first observed, the estimated group size, and behavior at time of observation;
- That the Project's WMMP be revised to clarify that the 600m horizontal avoidance buffer for operation of helicopters near caribou also applies to helicopters on the ground such that engine starts and takeoffs of helicopters will be suspended when caribou are observed within the buffer distance; and
- That the Project's WMMP be revised to avoid use of helicopters during caribou migratory seasons if evidence from monitoring programs suggests that pilots are unable to effectively implement avoidance buffers for helicopter operations.

97.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Conditions: The Proponent shall revise the WMMP to:

- include a program to monitor and report annually the air traffic levels (landings, take-off, dates, aircraft type) at the Doris and Boston airstrips;
- include a program to monitor and report annually all helicopter traffic so that the spatial scale and intensity of this activity can be documented. This should include the collection and analysis of GPS flight tracks for all helicopter flights. This information should be used to: (1) verify the accuracy of EIS predictions and assumption about the level and distribution of helicopter traffic; (2) verify assumptions about helicopter traffic that were made in the noise modeling study; (3) assess compliance with minimum flight altitude restrictions designed to reduce disturbance of wildlife; and (4) facilitate other Project effects monitoring programs such as wildlife ZOI and movement studies;
- include a program to monitor and report annually all caribou sightings by pilots; documenting the altitude and distance at which each group of caribou is first observed, the estimated group size and behavior at time of observation;
- clarify that the 600m horizontal avoidance buffer for operation of helicopters near caribou also applies to helicopters on the ground such that engine starts and takeoffs of helicopters will be suspended when caribou are observed within the buffer distance; and
- avoid use of helicopters during caribou migratory seasons if evidence from monitoring programs suggest that pilots unable to effectively implement avoidance buffers for helicopter operations.

97.9 TMAC RESPONSE FOR GN-25

TMAC acknowledges the information provided and data requests of GN in regards to aircraft traffic. Similar to the request to provide data on road traffic (GN-20) TMAC will revise the Wildlife Mitigation and Monitoring Plan (WMMP) to include the following:

- Helicopter flight logs will be collected. These data will be reported in the annual WMMP compliance report.
- Fixed-wing landings/take-offs at Project airstrips. These data will be reported in the annual WMMP compliance report.

These revisions to the WMMP do not require there to be a Project term or condition.

Discussion:

Pilot observations of caribou are recorded in the incidental wildlife sightings log. Although it sounds like a good idea to have pilots note caribou behaviour, a pilot's priorities are 1) the safety of the aircraft and crew, and 2) to ensure they are following the height and/or horizontal setbacks described in the WMMP; and therefore caribou will not respond to the overflight. TMAC does not have authority to change a pilot's job description and will not request pilot's to document caribou behaviour in addition to the task of ensuring safe operations.

TMAC has committed to conducting standard mitigation measures for both fixed-wing and helicopter flights, as proposed by the Government of Nunavut, Northwest Territories, Yukon, BC, Alberta and other locations for caribou. TMAC will maintain elevation and/or lateral distance buffers from wildlife, particularly caribou. These mitigation measures are well researched and are shown in multiple jurisdictions to be effective.

The 600 m horizontal avoidance buffer for operation of helicopters near caribou applies to all helicopter activities including landing and taking off.

TMAC notes that the management objective is to maintain buffers between helicopters and wildlife.

TMAC will continue to inform pilots to maintain appropriate buffers both vertically and laterally above observed wildlife.

98. ID #GN-26

98.1 DEPARTMENT

Environment

98.2 ORGANIZATION

Government of Nunavut

98.3 SUBJECT/TOPIC

Muskox Mitigation

98.4 REFERENCES

- FEIS Vol.4, s.9.12.4 – Significance of Project-Related Residual Effects for Muskox.
- FEIS Vol. 4, s.9.12.3.3 – Disruption of Movements
- GN Technical Comment DEIS, TC-GN-12
- Project Certificate AEM: 124683 / 16MN056
- Project Certificate Sabina: 124149 / 12MN036
- FEIS WMMP figure 2.2-1 Driver Mitigation for Caribou

98.5 SUMMARY OF PROPONENT'S CONCLUSIONS

The Proponent concluded that residual impacts of the Project on muskoxen due to disturbance and the disruption of movements will be negligible and not significant with medium confidence (FEIS Vol. 4., s.9.12.4).

The Proponent indicates that mitigation and management measures for muskoxen will “include enforcement of speed limits, reduction of speed or halt of trucks when muskox herds are observed near or on the road, and designed criteria to limit snow banks” (FEIS Vol. 4, s.9.12.3.3).

98.6 REVIEWER'S COMMENTS AND SUPPORTING RATIONALE

The GN's concerns regarding muskox and the assessment of Project impacts to this species detailed in TC-GN-12 during the technical review of the DEIS remain outstanding.

In comparison to barren-ground caribou, muskoxen live a relatively sedentary life-style, maintaining small home-ranges and making modest rather than long-range migrations between seasonal ranges (Reynolds 1998; Gunn and Fournier 2000). Individual herds may be resident near sites of human activity year-round or for entire seasons. Consequently, there is a greater likelihood that individual muskoxen or herds will be repeatedly disturbed by road activities over the course of a season or year. This vulnerability to repeated disturbance means that individuals within local herds may be subject to greater cumulative levels of disturbance (and associated energetic costs) than similar groups of caribou that are present on a more transitory basis. Repeated disturbance, especially during the winter when muskoxen may enter a negative nutritional state and rely to some degree on stored body fat and protein, may reduced body condition and reproductive performance (Adamaczeewski et al. 1997, 1998). Since muskoxen do not make long annual migrations, the potential barrier effects of roads are less likely to be a concern at a population level as compared to caribou. Roads may impede local movements of some muskox groups. More important is the potential for roads with high levels of traffic to disrupt long-term shifts in muskox population range or the type of range expansion currently occurring in some parts of Nunavut (Ford et al. 2012).

The GN and Proponent concur that empirical evidence for the impacts of human activities on muskox is very limited, which limits accurate assessment of the Project impacts on muskox. Anecdotal reports suggest some individuals habituate to human activities near communities and development sites. However, caution is advised in interpreting these observations as evidence of the specie's resilience because tolerance to humans may be specific to certain individuals in a population only. Avoidance of seismic operations by 800m has been documented. Behavioral observations have also found that muskox may react adversely within 1 km of snowmobiles and aircraft; with adult females being most reactive. Herd range shifts of 28 to 40 km have also been reported in response to repeated helicopter and snowmobile traffic (Lent 1971; McClaren and Green 1985; Miller et al. 1977; Miller and Gunn 1979, 1980; Riew 1973; Roseneau and Warbelow 1974)).

The GN concurs that the assessment of residual impacts on muskox should be assigned a confidence rating of medium. Given the very limited knowledge of human effects on muskoxen, caution is warranted in mitigating Project effects on this species. Although the GN acknowledges that the number of muskox exposed to Project effects is likely to be a small proportion of the regional population(s), at the present time, a basic standard of mitigation should be applied to reduce disturbance of individuals and groups in the vicinity of the Project. The welfare of these animals should not be disregarded, especially if exposure to the Project lowers body condition, survival and reproduction. This standard has not been met by the Project's Wildlife Mitigation and Monitoring Plan (WMMP).

A primary concern is road traffic. Traffic levels on some Project roads are within a range where effects on ungulates like caribou have been observed (see GN comment 20 – Traffic Monitoring and Management). While mitigation for muskoxen

“includes reduction of speed or halt of trucks when muskox herds are observed near or on the road” (FEIS Vol. 4, s9.12.3.3), these measures are not in the Project's WMMP and their application is not certain. Similar standards of mitigation for muskox have been applied to several Projects recently certified in Nunavut (AEM: 124683 / 16MN056 and Sabina: 124149 / 12MN036).

98.7 REVIEWER'S RECOMMENDATIONS

The following mitigation measures should be added to the Project's WMMP for muskox:

- Vehicles will slow to 30 km/hr and pass with caution when muskoxen are observed within 500 m of a road.
- On the road segment between Doris North and Madrid North (and other segments where traffic exceeds 4 vehicles per hour), driver-rules used for caribou (see flow chart in WMMP; figure 2.2-1 Driver Mitigation for Caribou) will be applied to muskoxen when muskoxen are within 250m of the road.

98.8 PROPOSED TERM AND CONDITION/COMMITMENT

The GN proposes the following Terms and Conditions:

- Vehicles shall slow to 30 km/hr and pass with caution when muskox are observed within 500 m of a road.
- On the road segment between Doris North and Madrid North (and other segments where traffic exceeds 4 vehicles per hour), driver-rules used for caribou (see flow chart in WMMP; figure 2.2-1 Driver Mitigation for Caribou) shall be applied to muskoxen when muskoxen are within 250m of the road.

98.9 TMAC RESPONSE FOR GN-26

The Wildlife Mitigation and Monitoring Plan (WMMP) has wildlife protection measures in place that includes driver response to caribou observed within 500 m of the road. To ensure simplicity and clear direction to operators, the same protection measures apply to muskox.

This existing protection measure does not require a new Project term or condition.

99. ID #HC-4.1.1

99.1 SUBJECT/TOPIC

Air Quality Criteria Air Contaminants

99.2 REFERENCES

- Volume 4, Section 2.4.2.1 – Air Quality
- Page 2-23
- Table 2.4-3

99.3 SUMMARY

The air quality assessment incorrectly states that non-threshold contaminants are only harmful at high concentrations. Health Canada does not agree with this statement.

99.4 DISCUSSION

99.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

99.4.2 Detailed Review Comment

Table 2.4-3 lists air contaminants that were included in the air assessment. The final sentence under each of these contaminants is: "...can be harmful to humans at high concentrations." or "...may be harmful at high concentration.", with exception of TSP and dust deposition.

The assessment is understating the potential risks of some air contaminants by stating they can/may be harmful at high concentrations. The FEIS does not indicate that some of these contaminants such as NO₂, PM_{2.5}, PM₁₀, and O₃ are also non-threshold contaminants and as such, health risks exist below the guidelines. Scientific analysis has found no evidence of a threshold for population-level health effects associated with non-threshold contaminants meaning that health effects may occur at any level of exposure, and guideline values should not be construed as limits to which polluting up to is allowed. It should be acknowledged that health risks exist below the guidelines. In addition, the principles of keeping clean areas clean and continuous improvement are operative, thus proposed mitigation measures should not be confined to meeting the standards, but

should also be targeted towards reducing population exposure to PM_{2.5}, PM₁₀, and NO₂ associated with the proposed project¹.

99.5 RECOMMENDATION/REQUEST

Health Canada suggests that the proponent's analysis acknowledge that NO₂, PM_{2.5}, PM₁₀, and O₃ are non-threshold contaminants, and that health effects may occur at any level of exposure not just at high concentrations.

99.6 TMAC RESPONSE FOR HC-4.1.1

It is acknowledged that NO₂, PM_{2.5}, PM₁₀, and O₃ are non-threshold air contaminants and health risks exist below the ambient air quality guidelines, at any level of exposure. Health risks from exposure to air contaminants from the Project were assessed in Section 5.4, Chapter 5, Volume 6 of the FEIS.

It is also acknowledged that ambient air quality guidelines should not be construed as pollution limits. Proposed mitigation measures will aim to reduce population exposure to PM_{2.5}, PM₁₀, and NO₂ associated with the proposed Project and are further described in responses to comments HC-4.1.2 and HC-4.1.4.

¹ CCME. 2007. Guidance Document on Continuous Improvement and Keeping-Clean-Areas-Clean. Canada-wide Standards for Particulate Matter and Ozone. Winnipeg.
http://www.ccme.ca/files/Resources/air/pm_ozone/1389_ci_kcac_e.pdf

100. ID #HC-4.1.2

100.1 SUBJECT/TOPIC

Air Quality Mitigation Measures

100.2 REFERENCES

- Volume 4, Section 2.6.3 – Air Quality
- Pages 2-42, 2-43

100.3 SUMMARY

Health Canada suggests that the proponent implements additional mitigation measures to reduce air pollutant emissions from the project.

100.4 DISCUSSION

100.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

100.4.2 Detailed Review Comment

After reviewing the suggested mitigation measures on the referenced pages, Health Canada recommends the inclusion of additional mitigation measures that can help reduce the air pollutant emissions from the project.

100.5 RECOMMENDATION/REQUEST

Health Canada recommends the inclusion of the additional mitigation measures that can help reduce the air pollutant emissions from the project.

- i. Covered transport trucks and conveyors to reduce dust generation.
- ii. Dust collectors and other pollution control devices at the crushing and processing plants.
- iii. Stringent (Tier III/IV) vehicle and fuel standards for on-road and off-road equipment

100.6 TMAC RESPONSE FOR HC-4.1.2

Additional mitigation measures are described in Section 2.2 of the Hope Bay Project Air Quality Management Plan (Volume 8, Annex V8-2) included in the FEIS. These measures will include minimizing discharge heights from the crushers onto conveyers and conveyors onto stockpiles, as well as enclosing the discharge from crushers onto conveyors or into other equipment where practicable. These measures all aid in reduction of dust emissions.

Crushing and ore processing will be conducted in enclosed buildings – enclosure of emissions sources is a proven method to minimize particulate emissions to the environment. Dust collectors or other pollution control devices may be utilized where required.

All new on and off-road equipment will meet the applicable standards in effect at the time of their purchase and/or manufacture.

101. ID #HC-4.1.3

101.1 SUBJECT/TOPIC

Monitoring and Dust Suppression

101.2 REFERENCES

- Volume 4, Section 2.6.3.3 – Air Quality
- Pages 2-43, 2-44

101.3 SUMMARY

The criteria and thresholds for determining when continuous monitoring and additional dust suppression activities will be implemented are not provided in the FEIS.

101.4 DISCUSSION

101.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

101.4.2 Detailed Review Comment

The assessment states:

“TSP, PM₁₀ and PM_{2.5} monitoring will be conducted using the methods described in Section 2.3.4.2 and may be upgraded to include continuous monitoring if deemed necessary.”

The criteria for upgrading to continuous monitoring should be provided for review. PM₁₀ and PM_{2.5} are non-threshold contaminants, meaning there is no level where health effects may not occur. Health Canada is concerned that these contaminants should be monitored over the life of the project.

The assessment also states:

“The results of the airborne particulate matter monitoring will be used to inform the effectiveness of dust suppression activities and the amount of suppression will be adjusted as needed.”

However, the thresholds that will trigger the need for improved dust suppression activities are not provided in this section.

101.5 RECOMMENDATION/REQUEST

- a) Provide the criteria for upgrading to continuous monitoring of criteria air contaminants.
- b) Provide the criteria or thresholds that will determine when increased dust suppression activities will be implemented.

101.6 TMAC RESPONSE FOR HC-4.1.3

Continuous monitoring of TSP, PM₁₀ or PM_{2.5} would be considered if frequent exceedances of their relevant air quality guidelines or standards are measured by the non-continuous monitors.

Section B.2.2 of the Hope Bay Project Air Quality Management Plan (Volume 8, Annex V8-2) presented in the FEIS includes dustfall monitoring locations intended to quantify dust fall levels with distance from the Doris-Windy All Weather Road. The results of this study will be used to confirm/refine the adequacy of the road dust control measures through the adaptive management methodology described in the Air Quality Management Plan. The adaptive management methodology specifies that, in the event that an evaluation of the data generated by the monitoring program indicates an exceedance of dustfall guidelines or predictions, an investigation will be conducted and the mitigation/management measures will be reviewed or revised.

102. ID #HC-4.1.4

102.1 SUBJECT/TOPIC

Exceedances of Criteria Air Contaminants

102.2 REFERENCES

- Volume 4, Section 2.6.5.3 – Air Quality
- Pages 2-61, 2-66
- Table 2.6-6, Table 2.6-7

102.3 SUMMARY

The project is causing exceedances of NO₂ and PM₁₀, which are both non-threshold contaminants. There is the potential for health effects from any increase in concentration from non-threshold contaminants, thus specific mitigation to reduce non-threshold contaminants should be provided and implemented.

102.4 DISCUSSION

102.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

102.4.2 Detailed Review Comment

Table 2.6-6 provides predicted maximum values from the construction of the Madrid-Boston (Hope Bay Phase 2) project.

During construction, NO₂ 1-hour max values are predicted to exceed the CAAQS guideline up to 194 days per year. This is an increase from 90 days per year under existing conditions. Additionally, the max concentration of 24-hour PM₁₀ is increased over the existing conditions, approaching the 50 µg m⁻³ guideline.

Table 2.6-7 provides predicted maximum values during operation of the Madrid-Boston (Hope Bay Phase 2) project. During operation, NO₂ 1-hour max values are predicted to exceed the CAAQS guideline up to 190 days per year. This is an increase of 61 days per year under existing conditions. Additionally the max concentration of 24-hour PM₁₀ is significantly increased over the existing conditions, exceeding the 50 µg m⁻³ guideline 1 day per year.

Overall, the project predicts to exceed the CAAQS 1-hour NO₂ guideline more than every 2 days per year during both the construction and operations phases of the project.

NO₂ and PM₁₀ are non-threshold contaminants and can be harmful to humans at lower concentrations. The existing standards and objectives are not fully protective of human health and therefore, the proponent should demonstrate a commitment to the CAAQS principles of Keeping Clean Areas Clean and Continuous Improvement to ensure that the project, during all phases, contributes minimally to the degradation of air quality, in turn contributing minimally to adverse effects on human health.

It is important to keep in mind that NO₂ and PM has the potential for harmful health effects from short-term exposure, so the rationale that there is infrequent human occupancy in the LSA/RSA is not adequate.

Furthermore, with up to 194 days/year of NO₂ 1-hour CAAQS exceedances, special attention should be put on reducing NO₂ levels during the construction and operation phases of the project. It is not clear what specific mitigation measures are going to be put in place to address these issues.

102.5 RECOMMENDATION/REQUEST

- c) Provide additional specific mitigation measures to reduce the 1-hour NO₂ concentrations below CAAQS guidelines.
- d) Provide additional specific mitigation measures to reduce PM₁₀.
- e) Provide a commitment from the proponent to the principle of continuous improvement.
- f) Provide rationale for the differences found under the Existing Conditions (includes Baseline Conditions) column between Table 2.6-6 and Table 2.6-7.

102.6 TMAC RESPONSE FOR HC-4.1.4

- a) TMAC's actions with respect to NO₂ mitigation measures will be dependent on how the CAAQS criteria are applied by the Government of Nunavut (GN) and the results of refined NO₂ modelling currently being conducted. Mitigation measures that may be considered by TMAC to address this issue may include:
 - Wind power generation may be pursued, which would be expected to reduce NO_x emissions due to reduced power plant operation.
 - Consideration of taller stacks at the Madrid North and Boston power plants to promote greater dispersion.

- Consideration for additional NO_x emissions reductions during detailed Project design. These may include energy efficiency methodologies, allowances in design for inclusion of future control technologies in power plant design, etc.

Please refer to the response to the response to GN-9 for additional discussion.

- b) Maximum 24-hour average PM₁₀ concentrations are predicted to exceed the relevant criteria only in a limited area to the south-east of Madrid South for Project Operations by no more than 19% above the criteria and exceedances were predicted to occur infrequently (1 day in 365). Ambient monitoring for PM₁₀ along the project boundary in the area of the predicted exceedance is included in the Hope Bay Air Quality Management Plan to validate this prediction. If measured PM₁₀ concentrations are found to exceed the PM₁₀ criteria, than evaluation and mitigation measures will be implemented following the Adaptive Management Plan included in the Hope Bay Air Quality Management Plan.
- c) The ambient monitoring program outlined in the Hope Bay Air Quality Management Plan (Volume 8, Annex V8-2) includes routine review of the measurement data with respect to air quality guidelines and objectives and FEIS predictions and investigation to determine the possible source(s) and potential impacts of measured exceedances. A review of the implementation of mitigation and management measures will be conducted as a part of this investigation and will form the basis for continuous improvement of TMACs operations and mitigation measures with respect to air quality.
- d) Existing Conditions refers to the operations at the existing Doris Site during construction and operations, for which calendar years 2019 and 2030 were modelled. The differences in the Existing Condition predictions in Tables 2.6.6 and 2.6.7 reflect the expected changes in the Doris Site operations between these two years.

103. ID #HC-4.2.1

103.1 SUBJECT/TOPIC

Human Health Risk Assessment - Receptor Characteristics

103.2 REFERENCES

- Volume 6, Section 5.3.2.1
- Page 5-21

103.3 SUMMARY

The human health risk assessment (HHRA) did not assess off-duty workers that may hunt/consume country foods within the LSA/RSA.

103.4 DISCUSSION

103.4.1 Importance of Issue to the Impact Assessment Process

Potential gap in the assessment of risk to human health.

103.4.2 Detailed Review Comment

The HHRA assumed that off-duty workers will not hunt or consume country foods and therefore did not consider the country food pathway for the off-duty workers who stay at the project site. However, the workers hired from the local population, as well as those hired externally (i.e. those that are brought in to work that are not part of the local community), may become involved in traditional hunting/fishing or harvesting activities during their off-duty time and consume country foods from the study area even though commercial foods will be provided at the camp kitchens. Accordingly, consideration should be given to this exposure pathway in the HHRA.

103.5 RECOMMENDATION/REQUEST

Include an additional receptor in the HHRA of an off-duty worker that hunts/consumes country foods within the LSA/RSA or provide additional rationale why this receptor is not included in the assessment.

103.6 TMAC RESPONSE FOR HC-4.2.1

There is a country food kitchen on site, that workers can use to store, prepare, and consume personally harvested wildlife, should they choose to do so (with country food items brought with them from their home communities several hundred kilometers away).

Harvesting food while off-duty is not permitted for off duty workers. Therefore, Health Canada's request is not warranted. Work shifts are 12 hours, workers cannot bring firearms to site (there is a no firearms policy for all Project staff and contractors while on site), and access to areas for harvesting/fishing around the Project footprint is not permitted for safety reasons. People are not free to walk around the mine site or Project infrastructure when not working. Workers arrive at site by airplane and therefore have no access to snow machines or ATV's.

Workers will not be able to remain on site during their 2-weeks off and are flown back to their home community. Therefore, ingestion of country foods harvested near the Project site is not a complete exposure pathway for off-duty workers.

104. ID #HC-4.2.2

104.1 SUBJECT/TOPIC

Human Health Risk Assessment - Short-term/intermittent Exposures

104.2 REFERENCES

- Volume 6, Section 5.3.2.1
- Page 5-21

104.3 SUMMARY

The HHRA may underestimate risk to off-duty workers as a result of dose-averaging and intermittent exposures. The proponent is being asked to consider the potential of dose-averaging on the risk to human health.

104.4 DISCUSSION

104.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

104.4.2 Detailed Review Comment

The HHRA appears to have assessed the chronic health effects alone by dose-averaging the intermittent exposures of the off-duty workers (i.e. 2 weeks / 4 weeks, 26 weeks/year for 14 years). The following issues should be considered with regards to dose averaging (or dose amortization) practice².

- i. There is a potential for underestimating chronic health risks for both cancer and non-cancer risk assessments.
- ii. The possibilities of acute/subchronic non-cancer effects due to elevated exposures that exceed chronic TRVs have not been considered.
- iii. Considerations should be given to assessing the potential acute/subchronic/chronic health effects noted above. To this end, Health

² Health Canada. 2013. Federal Contaminated Site Risk Assessment in Canada, Interim Guidance on Human Health Risk Assessment for Short-Term Exposure to Carcinogens at Contaminated Sites. Contaminated Sites Division, Safe Environments Directorate, Ottawa.

Canada has developed specific guidance³ that can be employed to assess risks associated with short- and/or intermittent duration exposure scenarios. Alternatively, an uncertainty analysis can be conducted in order to determine how representative the risk assessment is of actual site conditions, and how sensitive the risk estimates are to changes in any or all of the assumptions used in this risk assessment. Such analysis would allow for mitigative measures to be designed accordingly.

104.5 RECOMMENDATION/REQUEST

- a) Provide rationale for dose-averaging the intermittent exposures off-duty workers.
- b) Assess risks associated with short- and/or intermittent duration exposure scenarios or alternatively an uncertainty analysis can be conducted in order to determine how representative the risk assessment is of actual site conditions, and how sensitive the risk estimates are to changes in any or all of the assumptions used in this risk assessment.

104.6 TMAC RESPONSE FOR HC-4.2.2

- a) The carcinogenic and non-carcinogenic risk to off duty-workers calculated in the DEIS followed Health Canada guidance (Health Canada 2010a, 2010b, 2010c, 2010d, 2010e, 2010f, 2011). During the DEIS review period, no comments from regulatory agencies were received on the dose-averaging methodology used to estimate health risks for off-duty workers from Health Canada or any other reviewing agencies. The Health Canada guidance documents referenced in the DEIS were subsequently used in the FEIS.
- b) TMAC was unable to locate the Health Canada (2016) guidance document referenced in comment HC-4.2.2 in publicly-accessible data bases and requests that this document be provided for review.

References:

Health Canada. 2010a. *Draft Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFoods)*. Version 1.2 (Draft). Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

³ Health Canada. 2016. Memorandum: A primer for evaluating human health risk at contaminated sites for chronic and less-than chronic exposures to chemicals.

Health Canada. 2010b. *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA)*. Version 2.0. Revised 2012. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Health Canada. 2010c. *Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors*. Version 2.0. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Health Canada. 2010d. *Federal Contaminated Site Risk Assessment in Canada, Part V: Guidance on Human Health Detailed Quantitative Risk Assessment for Chemicals (DQRACHEM)*. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Health Canada. 2010e. *Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFoods)*. Contaminated Sites Division, Safe Environments Directorate: Ottawa, ON.

Health Canada. 2010f. *Useful Information for Environmental Assessments*. 978-1-001-15153-3. Health Canada, Environmental Assessment Division: Ottawa, ON.

Health Canada. 2011. *Toxicological Reference Values, Estimated Daily Intakes or Dietary Reference Values for Trace Elements. Obtained from Chemical Health Hazard* Revised March 2011, unpublished: Ottawa, ON.

Health Canada. 2016. Memorandum: A primer for evaluating human health risk at contaminated sites for chronic and less-than chronic exposures to chemicals.

105. ID #HC-4.2.3

105.1 SUBJECT/TOPIC

Human Health Risk Assessment – Soil Ingestion Rates

105.2 REFERENCES

- Volume 6, Section 5.3.3.3
- Page 5-50
- Table 5.3-13

105.3 SUMMARY

The proponent may have used soil ingestion rates that are not applicable to the chosen receptors in the HHRA. The proponent is being asked to provide rationale to support the use of less conservative soil ingestion rates over ones recommended by Health Canada.

105.4 DISCUSSION

105.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

105.4.2 Detailed Review Comment

It is important that ingestion rates be used appropriately, based on site-specific activities and characteristics. The chosen ingestion rates may not apply at sites where there is traditional land use, significant outdoor activity (i.e. camping) or where time on site is different than assumptions used in derivation of the published ingestion rates. Whichever soil and dust ingestion rates are used in an HHRA, the rates need to be sufficiently documented and described in order to evaluate the scientific approaches used for their derivation. An uncertainty analysis can also be conducted in order to determine how sensitive the risk estimates are to changes in soil and dust ingestion rates.

The assessment uses a soil ingestion rate of 20 mg d⁻¹ and 1.6 mg d⁻¹ for toddlers and adults, respectively (Wilson et al. 2013)⁴. Health Canada typically suggests using the CCME soil ingestion rates of 80 mg d⁻¹ and 20 mg d⁻¹ for toddlers and adults, respectively.

⁴ Ross Wilson, Heather Jones-Otazo, Sanya Petrovic, Ian Mitchell, Yvette Bonvalot, David Williams & G. Mark Richardson (2012) Revisiting Dust and Soil Ingestion Rates Based on Hand-to-Mouth Transfer, Human and Ecological Risk Assessment: An International Journal, 19:1, 158-188, DOI: 10.1080/10807039.2012.685807

However, if a lower value for soil ingestion is used, such as in this HHRA, then the assessment should include an analysis of time indoors (e.g. via settled dust that may be tracked in). If the site is remote and unlikely to impact indoor dust, the lower soil ingestion rates from Wilson et al. (2013) may not apply (as they are based on time-dependent hand to mouth activity).

105.5 RECOMMENDATIONS/REQUEST

Provide additional rationale and an uncertainty analysis for the justification of using the soil ingestion rates from Wilson et al. (2013), or as an alternative use the CCME soil ingestion rates of 20 mg d⁻¹ and 80 mg d⁻¹ for adults and toddlers respectively.

105.6 TMAC RESPONSE FOR HC-4.2.3

Please see the response to comment # KIA-FEIS-04 and the associated memo 'TMAC Resources Inc. – Technical Comments KIA-FEIS-01 and KIA-FEIS-04 received from the Kitikmeot Inuit Association (KIA) regarding the Madrid-Boston Final Environmental Impact Statement', dated March 28, 2018.

Please note that the Project area is in the arctic and experiences long periods of snow accumulation: "On average, there are 263 days per annum when there is greater than 1 cm of snow on the ground" (Section 1.2.2.3 of Volume 4 of the FEIS). Since the soil is covered by snow on average 72% of the year at the Project site, there is limited potential for land users to be exposed to soil. That limited exposure is likely much less than the soil exposure the general Canadian population experiences, and the use of lower soil ingestion rates for people in this location is justified.

106. ID #HC-4.2.4

106.1 SUBJECT/TOPIC

Human Health Risk Assessment – Arsenic in Fish ILCR

106.2 REFERENCES

- Volume 6, Section 5.4.4.4
- Page 5-132, 5-135
- Table 5.3-22, Table 5.4-25

106.3 SUMMARY

It is unclear if the Madrid-Boston Project-Related HHRA is a project-alone or existing conditions plus project scenario. The proponent is being asked to clarify or correctly characterize the risk from the project.

106.4 DISCUSSION

106.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

106.4.2 Detailed Review Comment

The assessment states:

"The percent change between the existing conditions arsenic ILCR (4.1×10^{-5}) and the summed Project phases arsenic ILCR (4.2×10^{-5}) for adult land users is 3.4%. It is unlikely that a change in the ILCR of less than 10% is measurable, and a change in cancer risk from arsenic exposure due to the Project is unlikely to occur."

However, it is unclear if the incremental lifetime cancer risk (ILCR) from the project shown in Table 5.4-25 is in addition to the ILCR from existing conditions. It appears that the ILCR from arsenic to the adult land user receptor has an ILCR of $1.2\text{E-}05$ during the construction phase and $3.0\text{E-}05$ from the operations phase from **projects-related effects**. This would mean there was a greater than 100% increase in ILCR as a result of the project. The HHRA needs to clearly state if the ILCR is from existing conditions plus project-related effects.

106.5 RECOMMENDATIONS/REQUEST

- a) Clarify if the ILCR shown in Table 5.3-22 is from a project-alone scenario or from project plus existing conditions scenario.
- b) If the ILCR shown in Table 5.3-22 is from a project-alone scenario, provide mitigation measures to decrease the risk of human health from arsenic as a result of the project.
- c) Provide the monitoring and mitigation measures that will be put in place to ensure the project does not increase the ILCR to land user receptors.

106.6 TMAC RESPONSE FOR HC-4.2.4

- a) The ingestion ILCR for arsenic for an adult land user shown in Table 5.3-22 of the FEIS (4.1×10^{-5}) is for the existing conditions scenario, with no influence from the Project. It was calculated assuming an exposure duration of 14 years at the Project site, assuming the Project wasn't constructed and that existing conditions were maintained for those 14 years. This allowed direct comparison with the ILCRs calculated in the Project-related HHRA that had an exposure duration of four years during the Construction phase and 10 years during the Operational phase, which were then summed (Table 5.4-25 of Volume 6 of the FEIS). The ingestion exposures calculated for the Project-related scenario (Table 5.4-25 of Volume 6 of the FEIS) took into account baseline concentrations of COPCs in environmental media plus the incremental increase in COPC concentrations due to the Project. Thus, the Project-related ILCRs shown in Table 5.4-25 are not simply the incremental increase due to the Project, as they also include the baseline ILCR. If Project-related ILCR calculations had been conducted only on the incremental change in COPC concentrations due to the Project, then summing with the existing conditions ILCR would have been required. However, that was not the methodology used and instead the Project-related risk has the existing-conditions risk built in.
- b) The ingestion ILCR for an adult land user shown in Table 5.3-22 of Volume 6 of the FEIS (4.1×10^{-5}) is for the existing conditions scenario. The ingestion ILCR for an adult land user shown in Table 5.4-25 of Volume 6 of the FEIS (4.2×10^{-5}) is for the Project-related scenario with existing conditions built in (see response a). Additional mitigation measures are not required as the change in the ILCR from existing conditions to Project conditions is only 3.4%, which is likely not measurable. Furthermore, worst-case emissions were assumed in the Project-related scenario, which is a conservative assumption and likely overestimates the cancer risk due to ingestion of arsenic.
- c) For the reasons described above, additional monitoring and mitigation measures are not necessary.

107. ID #HC-4.2.5

107.1 SUBJECT/TOPIC

Human Health Risk Assessment – NO₂ Guideline

107.2 REFERENCES

- Volume 6, Section 5.3.2.3
- Page 5-34
- Table 5.3-4

107.3 SUMMARY

The NO₂ ambient air quality criteria in the HHRA are outdated, the proponent is being asked to update it to Canadian Ambient Air Quality Standards (CAAQS), which is consistent with the air quality assessment.

107.4 DISCUSSION

107.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

107.4.2 Detailed Review Comment

The NO₂ ambient air quality criteria ($\mu\text{g m}^{-3}$) presented in the HHRA is outdated and does not match the criteria that are used in the air quality assessment. The criteria should be updated in this table to the CAAQS values.

107.5 RECOMMENDATIONS/REQUEST

Revise the NO₂ ambient air quality criteria in Table 5.3-4 of the HHRA to the CAAQS for NO₂.

107.6 TMAC RESPONSE FOR HC-4.2.5

Please see Table 5.3-4 of the HHRA presented in Volume 6 of the FEIS below with the updated CAAQS for NO₂. Note that all baseline concentrations of criteria air contaminants are below the updated CAAQS. Therefore, the outcome of the assessment will not change.

Table 5.3-4. Ambient Air Quality Criteria and Baseline Concentrations of Criteria Air Contaminants

Criteria Air Contaminant	Averaging Period	Ambient Air Quality Criteria ($\mu\text{g}/\text{m}^3$)			2009 - 2014 Baseline Air Quality Monitoring Data ($\mu\text{g}/\text{m}^3$)		
		Canada ^a	Nunavut ^b	BC ^c	Minimum	Mean ^d	Maximum
SO ₂	1-hour	183 (effective in 2020) ^{e, f}	450	183 ^k	-	-	-
	24-hour	-	150	-	-	-	-
	Annual	13 (effective in 2020) ^{f, g}	30	13 ^l	0.1 ^p	0.4 ^p	5.0 ^p
NO ₂	1-hour	113 (effective in 2020) ^{h, i}	400	188 ^m	-	-	-
	24-hour	-	200	-	-	-	-
	Annual	32 (effective in 2020) ^{i, j}	60	60	0.1 ^p	1.9 ^p	9.6 ^p
CO	1-hour	-	-	14,300	-	1,250 ^q	-
	8-hour	-	-	5,500	-	143 ^q	-
PM ₁₀	24-hour	-	-	50	0.5	6.3	46.0
PM _{2.5}	24-hour	28 and 27 (effective in 2020) ⁱ	30	25 ⁿ	0.1	-	20.0
	Annual	10 and 8.8 (effective in 2020) ^j	-	8 ^o	-	3.0	-

Notes:

SO₂ = sulphur dioxide; NO₂ = nitrogen dioxide ; CO = carbon monoxide; PM_{2.5} = particulate matter $\leq 2.5 \mu\text{m}$ in diameter; PM₁₀ = particulate matter $\leq 10 \mu\text{m}$ in diameter.

(-) = not available or applicable

Bold and italicized values indicate the air quality criteria used in the assessment.

^a CCME (2018); ^b Government of Nunavut (2011); ^c BC MOE (2017).

^d Mean value of all stations and measurements.

^e The 3-year average of the annual 99th percentile of the SO₂ daily maximum 1-hour average concentrations.

^f The Canadian Ambient Air Quality Standard for SO₂ is presented in units of parts per billion (ppb), thus a conversion factor of 2.62 (assuming an ambient pressure of 1 atmosphere and temperature of 25°C) was applied to the standard in units of ppb to obtain units of $\mu\text{g}/\text{m}^3$.

^g The average over a single calendar year of all 1-hour average SO₂ concentrations.

^h The 3-year average of the annual 98th percentile of the daily maximum 1-hour average concentrations.

ⁱ The Canadian Ambient Air Quality Standard for NO₂ is presented in units of parts per billion (ppb), thus a conversion factor of 1.88 (assuming an ambient pressure of 1 atmosphere and temperature of 25°C) was applied to the standard in units of ppb to obtain units of $\mu\text{g}/\text{m}^3$.

^j The average over a single calendar year of all 1-hour average concentrations.

^k Based on annual 99th percentile of daily 1-hour maximum, averaged over three consecutive years.

^l Based on annual average of 1-hour concentrations over one year.

^m Based on annual 98th percentile of daily 1-hour maximum, over one year.

ⁿ Based on annual 98th percentile of daily average over one year.

^o Based on annual average over one year.

^p Each sample was normally exposed for a period of 30 days. There are no 30-day guidelines for NO₂ or SO₂. These values can be conservatively compared with the annual Nunavut guideline values.

^q CO baseline concentrations are the annual averages used for the Bathurst Inlet and Road Project (BIPR; located northwest of the study area), which is representative of background levels typical in Nunavut.

References:

CCME. 2018. CAAQS (Canadian Ambient Air Quality Standards). Canadian Council of Ministers of the Environment. <http://airquality-qualitedelair.ccme.ca/en/> (accessed March 2018).

Government of Nunavut. 2011. Environmental Guideline for Ambient Air Quality. http://env.gov.nu.ca/sites/default/files/guideline_-_ambient_air_quality_2011.pdf (accessed May 1, 2013).

BC MOE. 2017. Provincial Air Quality Objective Information Sheet: British Columbia Ambient Air Quality Objectives - Updated November 8, 2016. <http://www.bcairquality.ca/reports/pdfs/aqotable.pdf> (accessed November 2017).

108. ID #HC-4.2.6

108.1 SUBJECT/TOPIC

Human Health Risk Assessment - Criteria Air Contaminants

108.2 REFERENCES

- Volume 6, Section 5.4.4.2
- Page 5-121, 5-122

108.3 SUMMARY

The proponent did not provide sufficient rationale to exclude inhalation from criteria air contaminants in the HHRA. Health Canada recommends that this pathway be included in the HHRA or provide sufficient rationale for its exclusion.

108.4 DISCUSSION

108.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

108.4.2 Detailed Review Comment

In the HHRA, hunting and fishing camps were not considered in the inhalation assessment from the project because land users would be at a site for less than 24 hours. Health Canada does not agree that this is sufficient rationale to exclude inhalation of these contaminants from the HHRA. Many of these substances (SO₂, NO₂, CO, PM₁₀, and PM_{2.5}) may lead to adverse health effects from very short-term exposures (less than 24 hours). Therefore, Health Canada believes that inhalation should be part of the assessment and mitigation measures such as vehicles emissions requirements (Tier standards) should be put in place.

108.5 RECOMMENDATIONS/REQUEST

- a) Include inhalation of criteria air contaminants in the HHRA or provide additional rationale to support the exclusion of these contaminants.
- b) Provide the mitigation measures that will reduce exposure from these contaminants. Health Canada recommends using Tier III/IV emission standards for vehicles used for the project.

108.6 TMAC RESPONSE FOR HC-4.2.6

- a) As described in Section 5.3.2.3 of Volume 6 of the FEIS, none of the baseline criteria air contaminant (CAC) concentrations exceeded the Nunavut Air Quality Standards (Government of Nunavut 2011), the federal CAAQs (CCME 2017b, 2017c), or BC MOE Air Quality Objectives (BC MOE 2017). Therefore, none of the CACs were classified as contaminants of potential concern (COPCs). The only route of exposure to CACs is via inhalation. Since none of the CACs were considered to be COPCs, and there are no other routes of exposure to CACs, CACs were not carried forward for further consideration in the existing conditions HHRA. Even when the updated Canadian Ambient Air Quality Standards are considered (CCME 2018), none of the CACs would be screened in as COPCs (see response to comment HC-4.2.5). Therefore, there is no need to carry CACs forward in the existing conditions HHRA as they are not COPCs.

As described in Section 5.4.1.3 of Volume 6 of the FEIS, some CACs exceeded the ambient air quality objectives during the Construction and Operational phases and were identified as COPCs (Table 5.4-1 of Volume 6 of the FEIS). Therefore, these CACs were carried forward in the Project-related HHRA. Since CACs are not present in environmental media other than air, there is no summing of pathways required. Furthermore, hazard quotients (HQs) for CACs are calculated as the predicted air contaminant concentration divided by the ambient air quality criteria, thus EDI calculations are not required. Therefore, the HQs for the CAC exceedances are provided in Section 5.4.4.2 and Table 5.4-18 of Volume 6 of the FEIS.

- b) Mitigation measures for air quality are described in the Project's Air Quality Management Plan (Annex V8-2 of the FEIS). The mitigation measures described in the Project's Air Quality Management Plan will reduce exposure to CACs.

Please see the response to HC-4.1.2 and HC-4.1.4.

References:

CCME. 2017b. Resources: Particulate Matter and Ground-level Ozone. http://www.ccme.ca/en/resources/air/pm_ozone.html (accessed November 2017).

CCME. 2017c. Resources: Sulphur Dioxide. <http://www.ccme.ca/en/resources/air/air/sulphur-dioxide.html> (accessed November 2017).

CCME. 2018. CAAQS (Canadian Ambient Air Quality Standards). Canadian Council of Ministers of the Environment. <http://airquality-qualitedelair.ccme.ca/en/> (accessed March 2018).

Government of Nunavut. 2011. Environmental Guideline for Ambient Air Quality.
http://env.gov.nu.ca/sites/default/files/guideline_-_ambient_air_quality_2011.pdf
(accessed May 1, 2013).

BC MOE. 2017. Provincial Air Quality Objective Information Sheet: British Columbia
Ambient Air Quality Objectives - Updated November 8, 2016.
<http://www.bcairquality.ca/reports/pdfs/aqotable.pdf> (accessed November 2017).

109. ID #HC-4.2.7

109.1 SUBJECT/TOPIC

Human Health Risk Assessment - Manganese in Drinking Water

109.2 REFERENCES

- Volume 6, Section 5.3.2.3
- Page 5-40
- Table 5.3-8

109.3 SUMMARY

The HHRA used the aesthetic objective for manganese and conservatively included it as a COPC. However, Health Canada currently has a health based objective for manganese of 0.1 mg L⁻¹ in drinking water. The proponent is being asked to assess manganese in light of the health based objective.

109.4 DISCUSSION

109.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

109.4.2 Detailed Review Comment

While manganese was brought forward in the assessment for existing conditions, there was no mention of the proposed health-based⁵ manganese objective of 0.1 mg L⁻¹. Health Canada recommends that manganese levels in drinking water be compared to the proposed health-based value as identified in the current public consultation document prepared by the Federal-Provincial-Territorial Committee on Drinking Water.

⁵ Health Canada (HC). 2016. Manganese in Drinking Water. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water. Available at: <https://www.canada.ca/en/health-canada/programs/consultation-manganese-drinking-water/manganese-drinking-water.html>

109.5 RECOMMENDATIONS/REQUEST

Health Canada suggests including manganese in the existing conditions and Madrid-Boston scenarios as a COPC and assess the risks to human health from drinking water using the manganese drinking water health based objective of 0.1 mg L⁻¹.

109.6 TMAC RESPONSE FOR HC-4.2.7

Please note that the Health Canada website: *Guidelines for Canadian Drinking Water Quality – Summary Table*, last updated February 2017 (and available online here: <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html>) was used to compile the Canadian drinking water quality guidelines (DWQGs) for use in the HHRA. On the Health Canada (2017) website, which is still current, it states that there is no maximum acceptable concentration (MAC) for manganese and that the aesthetic objective (AO) is ≤ 0.05 mg/L. The new health-based DWQG for manganese was not noted. If the MAC for manganese proposed in the Health Canada (2016) Document for Public Consultation was indeed adopted, we kindly request that Health Canada update their summary table of DWQGs online (i.e., Health Canada 2017) with the contents of the Canadian DWQG reports.

As described in Sections 5.3.2.3 and 5.4.1.3 in Volume 6 of the FEIS, maximum manganese concentrations in surface water existing conditions (0.957 mg/L; Table 5.3-8 in Volume 6 of the FEIS), and predicted during the Construction and Operational phases (provided in Section 4.5.4.2 of Volume 5 of the FEIS) exceeded the AO for manganese of 0.05 mg/L (Health Canada 2017). Normally an exceedance of an aesthetic objective would not result in a parameter being classified as a COPC and it would not be carried forward in the assessment. However, because there are other exposure pathways for manganese and because it can cause adverse health effects at high enough concentrations, manganese was conservatively considered to be a COPC in drinking water and was carried forward in both the existing conditions HHRA and the Project-related HHRA.

The risks from exposure to manganese were quantified for existing conditions (Section 5.3.5.2 and Tables 5.3-19 and 5.3-20 of Volume 6 of the FEIS) and Project-related conditions (Section 5.4.4.3 and Tables 5.4-19 and 5.4-20 of Volume 6 of the FEIS). Even if the proposed health-based MAC for manganese of 0.1 mg/L (Health Canada 2016) was used, the COPC screening outcome would be unchanged, as manganese would still be selected as a COPC in drinking water (because the maximum concentration under existing conditions exceeds the MAC) and manganese would be carried through the existing conditions and Project-related HHRAs, as was done in the FEIS.

References:

Health Canada. 2016. Manganese in Drinking Water. Document for Public Consultation. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water. <https://www.canada.ca/en/health-canada/programs/consultation-manganese-drinking-water/manganese-drinking-water.html> (accessed online March 2018).

Health Canada. 2017. *Guidelines for Canadian Drinking Water Quality – Summary Table*. February 2017. Prepared by the Federal-Provincial-Territorial Committee on Health and the Environment. <https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table.html> (accessed online March 2018)

110. ID #HC-4.3.1

110.1 SUBJECT/TOPIC

Crown Pillar Recovery Noise

110.2 REFERENCES

- Volume 4, Section 3.8.2 – Noise and Vibration
- Page 3-29

110.3 SUMMARY

Crown pillar recovery was not included in the noise assessment. Health Canada believes excluding this activity from the assessment may underestimate the human health impacts from noise and requests additional rationale for its exclusion.

110.4 DISCUSSION

110.4.1 Importance of Issue to the Impact Assessment Process

Possible gap in the assessment of noise.

110.4.2 Detailed Review Comment

Crown pillar recovery, an activity that is of similar magnitude to blasting and that lasts over several months was excluded from the assessment of noise. Crown pillar recovery may cause significant increases in noise levels and the exclusion of this activity in the assessment may underestimate the potential for noise to adversely impact human health.

Health Canada disagrees that several months is a short duration. The activity is similar in magnitude to blasting of the mine portal entrance, and therefore should be included in the assessment of noise.

110.5 RECOMMENDATIONS/REQUEST

Include crown pillar recovery in the assessment of noise or alternatively provide additional justification for the exclusion of crown pillar recovery from the noise assessment.

110.6 TMAC RESPONSE FOR HC-4.3.1

Section 3.8.2 of the FEIS (Volume 4, Section 3) notes that crown pillar recovery is expected at the surface and describes where it may occur. Noise and vibration effects are expected to be similar or less in magnitude than the blasting for the portal entrance and for quarries and these blasting activities would not occur concurrently.

For the purposes of this assessment, the results of the blasting assessment is applicable to crown pillar recovery. Results figures 7.4.2 through 7.4.5, and 7.4.7 through 7.4.10 in Section 3.7 of Appendix V4-3A have been created by creating a zone of influence around each of the portal locations. Crown pillar recovery activities are expected to be within the same zone of influence based on available data.

111. ID #HC-4.3.2

111.1 SUBJECT/TOPIC

Noise - % change in Highly Annoyed

111.2 REFERENCES

- Volume 4, Section 3.8.3.1 – Noise and Vibration
- Page 3-32
- Table 3.7-2, Table 3.8-3, Table 3.8-5

111.3 SUMMARY

The noise assessment incorrectly used the 62 dBA Ldn as a threshold for daytime noise when the assessment should be assessing annoyance based on a 6.5% change in % highly annoyed (HA).

111.4 DISCUSSION

111.4.1 Importance of Issue to the Impact Assessment Process

Incorrect application of criterion for %HA.

111.4.2 Detailed Review Comment

The noise assessment incorrectly uses 62 dBA Ldn as a threshold for annoyance for daytime noise. The 62 dBA Ldn is a complaint based limit for short-term construction noise (for construction lasting less than 12 months).

Mitigation against annoyance should be based on a 6.5% change in calculated %HA from project noise. Construction noise should be assessed as operational noise when the construction is long-term.

It is also unclear to Health Canada how the %HA was derived in Table 3.8-3 as additional information on the source, time or applicable adjustments applied were not provided.

111.5 RECOMMENDATIONS/REQUEST

- a) Provide %HA results for Human Daytime Use Receptors Construction Noise Assessment Results with Comparison to Health Canada Thresholds for Annoyance in Table 3.8-5.

- b) Describe all adjustments made in estimating the change in %HA, including source, time and other applicable adjustments.

111.6 TMAC RESPONSE FOR HC-4.3.2

- a) The 62 dbA Ldn threshold was put forward for the unique circumstances of this project, where there are many areas that are not residential but considered potential areas where people may participate in recreational activities. There were 8 receptors included in the assessment of noise effects: two of these receptors had the potential to contain sleeping quarters, while the remaining 6 receptors were identified as "non-habitation" human receptors (e.g., trails or other passive recreational areas). For the two receptors with potential sleeping quarters, the % Highly Annoyed (%HA) criteria proposed by Health Canada was used as it is a useful metric to "...estimate community response to noise levels." (Health Canada, 2017, Pg. 9). However, since the other 6 receptors were not considered inhabited areas or areas that would have night time use, the %HA criterion was not considered appropriate to quantify an adverse environmental effect. Instead, criteria for widespread complaints based on the 62 dBA Ldn was selected as an appropriate criterion. According to Health Canada's latest guidance document, the 62 dBA Ldn has been used as a threshold for "widespread complaints" (Health Canada, 2017, pg. 8).
- b) The methods for calculating %HA was provided in Section 2.1.1.1 of the Environmental Noise and Vibration Study Report (Appendix V4-3A of the FEIS).

References:

Health Canada, 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. www.iso.org/iso/catalogue_detail?csnumber=28633

112. ID #HC-4.3.3

112.1 SUBJECT/TOPIC

Noise - Baseline

112.2 REFERENCES

- Volume 4, Section 3.6.3, 3.8.3.1 – Noise and Vibration
- Pages 3-20, 3-32
- Table 3.6-2, Table 3.8-3

112.3 SUMMARY

There is the potential that baseline data has been contaminated by wind. Clarification is needed to determine if wind was the primary source that made up the baseline data.

112.4 DISCUSSION

112.4.1 Importance of Issue to the Impact Assessment Process

The baseline data may underestimate the potential risk to human health.

112.4.2 Detailed Review Comment

The baseline data mean Leq ranges from 22.9 to 53.3 dBA, however there is a correlation of mean dBA and wind speed. Health Canada has questions about the appropriateness of the baseline data measurements as it appears the baseline data may be contaminated by wind. There is no additional information provided what makes up the baseline noise other than: “...baseline noise environment consisting primarily of natural noise sources.”

112.5 RECOMMENDATIONS/REQUEST

- a) Provide additional information of the noise sources making up the baseline.
- b) Explain if wind contamination was controlled for in the baseline measurements of noise, or is wind the primary factor influencing the baseline noise environment?
- c) Provide rationale for using 50 dBA as the baseline to assess %HA.

112.6 TMAC RESPONSE FOR HC-4.3.3

- a) Wind is a legitimate source of naturally occurring noise due to friction between wind and objects and is not a "contaminant" of the baseline conditions. As wind speed increases, friction increases which produces more noise. The baseline noise was measured using a sound level meter with a microphone protected by a wind screen (see V4-S3, Section 3.6.1.2) to help reduce the affects of the wind hitting the microphone and generating noise from the microphone itself. This windscreen reduces wind noise by approximately 15 dB for wind speeds up to 120 km/h and fulfils IEC 61672 class 1 and ANSI S1.4 Type2 standards (<https://www.bksv.com/media/doc/Bp1696.pdf>).
- b) Sources of baseline noise are summarized in V4-S3, Section 3.6.3, and detailed in the baseline reports in Appendix V4-3A's Appendix C. Sources of natural baseline noise included animals, waves and frequent winds. Anthropogenic noise included occasional helicopter traffic and machinery. Noise associated with the baseline study itself (e.g., helicopter noise during deployment of noise monitoring equipment) was removed from the data set. In the absence of discrete short duration noise events such as machinery, helicopters and animals, wind was the primary source of noise and was proportional to the wind speed.

Future project noise monitoring (Annex V8-8) will continue to incorporate noise generated from the wind and therefore has the potential to exaggerate the overall noise (background and project-related noise). Any future monitoring reports will include a discussion of how wind is a component of background noise vs. project-related noise.

- c) Stantec used 50 dBA Ldn as the baseline noise level for assessing %HA. This value was based on the available interpretations of existing baseline data that indicated that appropriate measures were taken to control for anthropogenic sources and meteorological conditions.

113. ID #HC-4.3.4

113.1 SUBJECT/TOPIC

Aircraft Noise

113.2 REFERENCES

- Volume 4, Section 3.8.3.4 – Noise and Vibration
- Page 3-63
- Figure 3.9-10

113.3 SUMMARY

The noise assessment incorrectly uses 57 dBA as a threshold of annoyance for aircraft. However, recent literature does not support that receptors outside the NEF25 (Noise Exposure Forecast) will not be annoyed.

113.4 DISCUSSION

113.4.1 Importance of Issue to the Impact Assessment Process

Underestimation of annoyance from aircrafts leading to more complaints.

113.4.2 Detailed Review Comment

Health Canada does not agree that 57 dBA is the threshold of annoyance as it appears to be suggested from the following statement:

"NEF Contours for the Doris and Boston Airstrips are shown in Figure 3.8-10. The NEF 25 contour corresponds to 57 dBA and anything above this level is likely to produce some level of annoyance. The Doris site does not include any human PORs within this boundary to experience annoyance and the Boston site includes only R-H-H1 which is not predicted to be greater than NEF25 (i.e., not NEF26). The NEF25 level is considered in compliance with the thresholds. No PORs are within the NEF30 contour."

A recent study⁶ provides additional information:

⁶ Ragetti et al., (2016) Annoyance from road traffic, trains, airplanes and from total environmental noise levels, Int. J. Environ. Res Public Health 13(1):90

"We observed that a considerable proportion of the population was disturbed by aircraft noise, even outside of the NEF25 zone."

113.5 RECOMMENDATIONS/REQUEST

Health Canada accepts that it is difficult to estimate annoyance, complaints, and sleep disturbance from aircraft noise and suggests that the proponent include a strong commitment to resolving any project-related noise complaints as a result of aircrafts (and other project related noise effects).

113.6 TMAC RESPONSE FOR HC-4.3.4

In order to assess the potential effect from aircraft traffic, the assessment included a conservative itinerary of daily traffic at each airstrip. The NEF contour of 25 was included as a criteria as it is noted by Transport Canada as being the contour for which an exceedance would likely produce some level of annoyance. Transport Canada further recommends against residential development within the NEF25 contour band. On this basis, the NEF 25 contour was used as the threshold limit. However, meeting this threshold limit does not suggest that there will be no annoyance or complaints beyond the NEF25 contour.

114. ID #HC-4.3.5

114.1 SUBJECT/TOPIC

Noise Monitoring/Mitigation

114.2 REFERENCES

- Volume 4, Section 3.8.5, 3.8.5.5 – Noise and Vibration
- Pages 3-73, 3-74

114.3 SUMMARY

It is unclear what determinants the proponent will use to implement corrective actions to mitigate/reduce on-site noise and vibrations.

114.4 DISCUSSION

114.4.1 Importance of Issue to the Impact Assessment Process

Potential risk to human health.

114.4.2 Detailed Review Comment

The assessment states:

114.5 RECOMMENDATIONS/REQUEST

- a) Provide what determinants will be used to decide if there was a need for corrective action (such as noise complaints) and what corrective actions would be used.
- b) Indicate how noise complaints will be addressed.

114.6 TMAC RESPONSE FOR HC-4.3.5

- a) Based on the activities proposed by the proponent and the mitigation included within the assessment in the FEIS, it is not anticipated that corrective actions will be required. Conservative assumptions were applied throughout the assessment including the type and number of vehicles as well as project facilities operating were used in the assessment of potential adverse effects.

- b) TMAC has presented a community complaints procedure within the Community Involvement Plan (FEIS Volume 8, Appendix V8-7) that could be used to address noise complaints from nearby community members.

115. ID #HC-4.3.6

115.1 SUBJECT/TOPIC

Blasting Noise

115.2 REFERENCES

- Volume 4, Section 3.7.3 – Noise and Vibration
- Page 3-23
- Table 3.7-2

115.3 SUMMARY

The noise assessment incorrectly used the 120 dBZ peak limit as the blasting noise standard instead of the 70 dBZ that should be used as the threshold to cause annoyance.

115.4 DISCUSSION

115.4.1 Importance of Issue to the Impact Assessment Process

Incorrect standards used to assess blasting noise may underestimate the potential risk.

115.4.2 Detailed Review Comment

When low-frequency noise is emitted, information describing the impacts of any anticipated effects, such as rattling and its related mitigation measures should be included. Aircrafts are known to cause rattling, but the FEIS does not identify noise induced rattling as a potential outcome.

The 120 dBZ peak limit refers to a hearing loss limit to protect children from blasting noise. The dBZ recommendation for sounds with strong low-frequency content that can cause annoyance is 70 dBZ. Health Canada suggests the use of the United States Environmental Protection Agency (US EPA)'s sonic boom criterion⁷ as a blasting mitigation noise level for blasting that lasts less than one year. For blasting exposures more than one year, Health Canada recommends following the recommendations in ISO 1996-1:2003⁸

⁷ United States Environmental Protection Agency (US EPA). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (Report No. 550/9-74-004).

⁸ . International Organization for Standardization (ISO). 2003. ISO 1996-1:2003 Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures. www.iso.org/iso/catalogue_detail?csnumber=28633

115.5 RECOMMENDATIONS/REQUEST

- a) Reassess the blasting noise using the recommendations listed in ISO 1996-1:2003 or provide rationale why this is not needed.
- b) Assess noise induced rattling from sources such as aircraft or provide rationale for its exclusion.

115.6 TMAC RESPONSE FOR HC-4.3.6

- a) The utilized limit of 120 dBZ is the established criteria for noise induced hearing loss in children (criteria for adults is 140 dBZ) (HC, 2017). In addition, 120 dBZ is also a standard criteria for determining potential for building damage as a result of the activity. It is also the same limit for blasting impacts on hearing damage (as per HC). For the purposes of this assessment, the use of these criteria is considered the valid metric for protecting human hearing and nearby structures.

The referenced standard of 70 dBZ (HC, 2017) is a recommended limit to prevent the risk of noise induced rattle which can cause annoyance. The compliance with this limit is determined by adding the sum of the predicted sound levels in only the 16 Hz, 31.5 Hz and 63 Hz octave bands.

- b) The assessment of potential noise induced rattle from both blasting and aircraft flyovers was not included in this assessment. The criteria based on hearing loss and building damage was considered appropriate for the type of project under assessment. In addition, NEF contours were used for the assessment of aircraft traffic which also includes a consideration for annoyance and is therefore considered reasonable.

References:

Health Canada, 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. www.iso.org/iso/catalogue_detail?csnumber=28633

116. ID #HC-4.3.7

116.1 SUBJECT/TOPIC

Assessment of noise

116.2 REFERENCES

- Volume 4, Sections 3.8.2.3 to 3.8.2.5 – Noise and Vibration

116.3 SUMMARY

The noise assessment did not combine noise from the operations phase, blasting, aircraft, and helicopter together to evaluate the total effect on the noise environment from the project.

116.4 DISCUSSION

116.4.1 Importance of Issue to the Impact Assessment Process

The overall noise impacts from operation cannot be determined due to the methodology used.

116.4.2 Detailed Review Comment

The FEIS assesses the operational noise values for aircraft, helicopter and blasting separately. Health Canada recommends that these operational noise contributions be assessed together to determine the overall noise impacts.

116.5 RECOMMENDATIONS/REQUEST

Provide an assessment of noise that combines operational noise, blasting, aircraft and helicopter noise together so that the total effect from the project on the noise environment can be evaluated or provide a rationale as to why this is not necessary.

116.6 TMAC RESPONSE FOR HC-4.3.7

- The criteria that were used for the assessment on the acoustic environment are considered appropriate for the various activities associated with the project. Different activities (e.g., aircraft use, blasting, vehicle traffic) have different noise characteristics (e.g., tonal, impulsive, continuous) and so they are typically assessed using different criteria that suit the particular activity. For example, Health Canada guidelines include separate criteria for project construction, project operations, and blasting activities (HC, 2017). As another example, the Ontario

Ministry of Environment and Climate Change's acoustics guideline NPC-300 states that blasting should be assessed separately to other project activities (MOECC, 2013).

- The existing regulatory guidance in Canada suggests that one overall criterion is insufficient to address the different types of noise sources that can occur. In the absence of one overall criterion, several criteria have been used to match the various activities present for this project. In addition, the assessment is structured such that an exceedance of one of these criteria constitutes a significant adverse effect on the acoustic environment. Having assessed all of these activities based on their applicable criteria, the effects of the project on the acoustic environment were predicted to be not significant.

References:

Health Canada, 2017. Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise. www.iso.org/iso/catalogue_detail?csnumber=28633

Ministry of the Environment and Climate Change (MOECC). 2013. Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning (NPC-300). <https://www.ontario.ca/page/environmental-noise-guideline-stationary-and-transportation-sources-approval-and-planning>

117. ID #TC-4.1.1

117.1 SUBJECT/TOPIC

Aviation Safety

117.2 REFERENCES

- Volume 1 Annex V1-7 Type A Water Licence Applications,
- Package P5-29, Hope Bay Project: Boston Airstrip
- Preliminary Design
- Volume 1, 3.3.1.7
- Volume 3, 3.9

117.3 SUMMARY

The design of the Boston airstrip is described in Hope Bay Project – Boston Airstrip Preliminary Design (Package P5- 29). The airstrip will be a new facility constructed for the Project and, therefore, its construction is attributable to the Project. The Project construction activities include:

- development and use of quarries to produce construction bulk rock fill and aggregate; and
- construction of the airstrip, access road, de-icing facility and other associated facilities per design.

The Boston mine site requires reliable year-round air access that cannot be achieved with the existing 500 m STOL airstrip. A new 1,524 m (5,000') long gravel airstrip has been designed for Dash 8 sized and Boeing 737-200 aircraft as well as an optional 450 m extension, which would allow for larger aircraft such as Hercules C-130 aircraft. The EIS considers the longer airstrip in all assessments.

The airstrip is intended for private use to support year round operations of the Boston mining area. Normal use includes; routine crew changes and cargo transfers. The airstrip is also used for emergency medical evacuation. The airstrip will be a non-precision approach runway in accordance with the Aerodrome Standards and Recommended Practices (Transport Canada 2015).

117.4 DISCUSSION

117.4.1 Importance of Issue to the Impact Assessment Process

Requirements under Subpart 7 (307.01) of the Canadian Aviation Regulations (CARs)

117.4.2 Detailed Review Comment

Private airstrips do not require TC approvals or oversight, however the proponent will be required to meet the regulations under Subpart 7 (307.01) of the Canadian Aviation Regulations (CARs) which outlines the requirements to consult.

117.5 RECOMMENDATION/REQUEST

TMAC will be required to meet the regulations under Subpart 7 (307.01) of the Canadian Aviation Regulations (CARs) which outlines the requirements to consult for aerodrome works other than work necessary to comply with a new requirement imposed by or under the Act, carried out for any new or existing aerodrome.

117.6 TMAC RESPONSE FOR TC-4.1.1

Noted. TMAC will comply with the regulations under Subpart 7 (307.01) of the Canadian Aviation Regulations (CARs).

118. ID #TC-4.2.1

118.1 SUBJECT/TOPIC

Transportation of Dangerous Goods

118.2 REFERENCES

Volume 1 Executive Summary, Utilities, Storage, and Auxiliary Services

118.3 SUMMARY

Hazardous materials (including reagents) will be transported, handled at stored in accordance with the requirements of the Transportation of Dangerous Goods Act; the primary reagent storage facilities are at the Doris Site and Boston Site. Hazardous waste will be removed from the site for authorized disposal.

118.4 DISCUSSION

118.4.1 Importance of Issue to the Impact Assessment Process

Transportation of Dangerous Goods - Wording is inaccurate

118.4.2 Detailed Review Comment

The Transportation of Dangerous Goods Act and Regulations is not involved with the onsite storage of reagents.

118.5 RECOMMENDATION/REQUEST

It is recommended that TMAC amend the wording to read "*Hazardous materials (including reagents) will be handled, offered for transport or transported in accordance with the requirements of the Transportation of Dangerous Goods Act and Regulations.*"

118.6 TMAC RESPONSE FOR TC-4.2.1

TMAC notes Transport Canada's revised wording. The Executive Summary will not be re-written as part of NIRB's process, however, TMAC will ensure that correct wording is used in future documentation.

Attachment 1

Memo Response to KIA-FEIS-02



Memorandum



Date: March 28, 2018
To: Oliver Curran, TMAC Resources Inc.
From: ERM Consultants Canada
CC: Nicole Bishop, ERM and Marc Wen, ERM

Subject: **TMAC Resources Inc. – Technical Comment KIA-FEIS-02 received from the Kitikmeot Inuit Association (KIA) regarding the Madrid-Boston Final Environmental Impact Statement**

INTRODUCTION

This memorandum responds to Technical Comment KIA-FEIS-02 by the Kitikmeot Inuit Association (KIA) in March 2018 with respect to TMAC Resources Inc.'s (TMAC) Final Environmental Impact Statement (FEIS). Provided below is the KIA technical comment KIA-FEIS-02 (Section 2) followed by TMAC's response (Section 3).

TECHNICAL COMMENT KIA-FEIS-02

SUBJECT/TOPIC

Missing fish sampling data for Arctic Char, Whitefish and Lake Trout.

REFERENCES

- FEIS, Volume 6, Section 5.3.3.6, Page 55.

TMAC states:

"Lake Trout were sampled in 2009 and 2010 and Arctic Char were sampled in 2017 for the Project.

In total, 38 Lake Trout and 17 Arctic Char collected from within the human health LSA ... had tissue metals analysed, and were included in the assessment."

- FEIS, Volume 6, Section 5.3.3.6, Page 56, Table 5.3-16.
- FEIS, Appendix V6-5C Concentrations of Contaminants of Potential Concern in Fish Tissue Samples

SUMMARY

This issue was first discussed in KIA-IR63 (Fish sampling methodology Arctic Char) and KIA-IR64 (Fish sampling methodology for Whitefish and Lake trout). KIA-DEIS-12 and KIA-DEIS-13 are also relevant to this issue. The response to our IRs clarified what the issue was, that data were omitted from the appendix V6-5, and TMAC agreed to correct the Appendix in the FEIS. However, TMAC has not followed through and missing data is still not provided.

Importance of Issue

It is essential to provide the raw data for fish sampling, in order for it to be reviewed for completeness, and accuracy. This is a crucial part of the human health risk assessment as fish can have a significant effect on contaminant exposure. Baseline levels of COPCs in all fish samples must be presented.

Detailed Review Comment

Gap/Issue

As discussed in several related IRs and technical comments submitted for the DEIS, the FEIS is missing significant portions of data for fish sampling that was allegedly completed but has not been provided for review.

Disagreement with DEIS Conclusion

In the case of Arctic char, the original issue was that there were only 5 samples from a previous study, and only 3 of these were adults that would have used marine habitat (Arctic Char were used as a marine indicator species). In 2017, an additional 17 samples were taken to improve the baseline program in response to the KIA's concern about the very low sample size. However, in Appendix V6-5C, no Arctic Char data are provided for this current program. Instead, the previous dataset with the 5 samples (3 adults) was retained, even though this data has effectively been removed from the rest of the HHRA and is no longer discussed in the FEIS. Hence, Appendix V6-5C needs to be updated.

For Lake Trout, there was a discrepancy in the DEIS between whether there were 69 samples or 38. The FEIS continues to say 38 even though TMAC indicated in their response to our KIA- IR#64 that 69 was the correct number. They also stated that "2010 samples are missing from the Appendix V6-5C. We will update the appendix for FEIS." which they have not done. Instead, now there are only 25 Lake Trout samples shown in the Appendix.

Reasons for Disagreement with Conclusion

As described above, the FEIS is still missing substantial fish sampling data including all the raw data related to Arctic Char. TMAC has not revised the Appendix as they have committed to.

RECOMMENDATION/REQUEST

- Provide the dataset for 2010 freshwater fish sampling for Lake trout; and
- Provide the dataset for 2017 fish sampling for Arctic char in the appendix.

TMAC RESPONSE TO KIA-FEIS-02

Thank you for identifying the inadvertent omission of Lake trout samples from Appendix V6-5C in the FEIS. The complete set of Lake trout data (N = 69) have been included in an updated Appendix V6-5C in this memorandum. However, please note the original Appendix V6-5C included the complete set of Arctic Char samples (N = 17) that were incorporated into the human health and ecological risk assessment (HHERA).

The complete set of fish data used in the HHERA is provided in an updated Appendix V6-5C below. These data are comprised of the following fish samples:

- Arctic Char sampled in 2017 (N = 17);
- Lake trout sampled in 2009 and 2010 (N = 69);
- Whitefish sampled in 2009 and 2010 (N = 7); and
- Ninespine stickleback sampled in 2010 (N = 134)

The text in Volume 6, Section 5.3.3.6 (Page 55) states that 38 Lake trout and 17 Arctic Char tissue samples were used in the HHERA. As shown in the updated Appendix V6-5C provided herein, the correct number of Lake trout samples is 69, and the correct number of Arctic Char samples is 17. Concentrations for the correct number of fish were used in the HHERA calculations.

Appendix V6-5C (Updated)

**Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during
the Baseline Monitoring Program**

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Arctic Char (<i>Salvelinus alpinus</i>)																		Lake Trout (<i>Salvelinus namaycush</i>)				
Sample ID	AC 22	AC 23	AC 24	AC 52	AC 74	AC 73	AC 109	AC 26	AC 30	AC 31	AC 35	AC 36	AC 37	AC 38	AC 39	AC 41	AC 42	LITTLE	LITTLE	LITTLE	LITTLE	LITTLE	
	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	MUSCLE/ TISSUE	ROBERTS LAKE- MUSCLE-1	ROBERTS LAKE- MUSCLE-2	ROBERTS LAKE- MUSCLE-3	ROBERTS LAKE- MUSCLE-4	ROBERTS LAKE- MUSCLE-5	
Date Sampled	3-Aug-17	3-Aug-17	3-Aug-17	4-Aug-17	4-Aug-17	4-Aug-17	8-Aug-17	23-Aug-17	25-Aug-17	25-Aug-17	27-Aug-17	27-Aug-17	27-Aug-17	27-Aug-17	27-Aug-17	27-Aug-17	27-Aug-17	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	
ALS Sample ID	L1984147-58	L1984147-59	L1984147-60	L1984147-61	L1984147-62	L1984147-63	L1984147-64	L1984147-65	L1984147-66	L1984147-67	L1984147-68	L1984147-69	L1984147-70	L1984147-71	L1984147-72	L1984147-73	L1984147-74	L806060-70	L806060-71	L806060-72	L806060-73	L806060-74	
% Moisture	72.6	74.8	76.5	73.6	76.0	71.2	70.2	72.9	62.3	74.6	71.3	70.9	74.5	75.0	75.6	75.4	70.7	74.5	79.9	75.4	77.6	76.6	
Metals (mg/kg ww)																							
Aluminum	0.46	2.12	0.85	2.11	0.42	0.69	1.68	0.48	0.77	0.79	<0.40	<0.40	0.97	<0.40	<0.40	1.41	3.52	2.2	2.4	2.2	2.7	3.2	
Antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.002	<0.0020	<0.0020	0.0087	<0.010	<0.010	<0.010	<0.010	<0.010	
Arsenic	0.58	1.29	0.57	0.57	0.71	1.22	1.96	1.56	2.23	0.57	0.70	1.32	1.17	1.07	0.57	0.860	1.41	0.928	0.035	0.031	0.025	0.027	
Barium	0.03600	0.06500	0.03900	0.10800	0.05400	0.07300	0.09500	0.03000	0.01100	0.03400	0.04700	0.02700	0.02500	0.07300	0.06400	0.04500	0.023	0.017	0.214	0.034	0.018	0.029	
Beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.10	<0.10	<0.10	<0.10	<0.10	
Bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.030	<0.030	<0.030	<0.030	<0.030	
Boron	<0.20	0.27	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.42	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-	
Cadmium	0.0016	0.0019	0.0011	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	
Calcium	57.4	82.6	55.5	86.3	54.7	63.4	69.6	60.8	69.5	91.2	85.1	122	71.6	99	155	68.9	93.1	269	567	206	333	426	
Cesium	0.0272	0.026	0.0112	0.0286	0.0135	0.0254	0.0267	0.0253	0.0394	0.0108	0.0224	0.022	0.0179	0.0165	0.0093	0.0133	0.0251	-	-	-	-	-	
Chromium	<0.010	<0.010	<0.010	0.024	0.013	0.011	<0.010	0.012	<0.010	<0.010	<0.010	0.018	<0.010	<0.010	<0.010	<0.010	0.016	<0.10	<0.10	<0.10	<0.10	<0.10	
Cobalt	<0.0040	<0.0040	0.0042	0.0046	<0.0040	<0.0040	0.0056	0.0054	<0.0040	0.005	<0.0040	0.0049	0.0063	0.0045	0.0045	0.0061	0.0049	<0.020	<0.020	<0.020	<0.020	<0.020	
Copper	0.333	0.351	0.233	0.435	0.452	0.468	1.71	1.06	0.379	1.74	0.583	0.539	0.576	1.47	0.611	0.697	0.635	0.256	0.328	0.282	0.261	0.181	
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Iron	4.14	7.7	4.9	14.4	4.99	4.72	7.79	7.8	3.62	6.84	4.46	3.78	4.91	4.36	4.07	6.04	9.68	-	-	-	-	-	
Lead	0.0057	0.0082	0.0064	<0.0040	<0.0040	<0.0040	0.0086	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.020	<0.020	0.033	<0.020	<0.020	
Lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Magnesium	360	392	353	344	302	324	303	347	341	345	344	363	359	362	387	356	411	305	284	334	284	311	
Manganese	0.061	0.117	0.091	0.475	0.058	0.07	0.12	0.114	0.057	0.108	0.08	0.096	0.099	0.093	0.112	0.0980	0.135	0.126	0.251	0.173	0.194	0.205	
Mercury	0.0311	0.0276	0.0434	0.0292	0.0492	0.018	0.0184	0.0144	0.0378	0.0377	0.0224	0.0172	0.0297	0.0204	0.0259	0.0165	0.0253	0.0836	0.147	0.11	0.143	0.0766	
Molybdenum	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.010	<0.010	<0.010	<0.010	<0.010	
Nickel	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.1060	<0.040	<0.040	0.1410	<0.040	<0.040	<0.040	0.0890	<0.040	<0.040	<0.040	<0.10	<0.10	<0.10	<0.10	<0.10	
Phosphorus	3150	2790	3000	3020	2860	2820	3040	3260	2970	3310	3050	3170	3130	3340	3430	3200	3480	-	-	-	-	-	
Potassium	5040	4450	4990	4970	4690	4470	4290	5070	4820	4890	4940	5250	5170	4990	5670	5190	5500	-	-	-	-	-	
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rubidium	1.380	1.20	1.21	1.08	1.07	0.93	1.02	1.45	1.16	1.35	1.15	1.30	1.34	1.55	1.63	1.41	1.33	-	-	-	-	-	
Selenium	0.455	0.505	0.292	0.516	0.392	0.445	0.504	0.554	0.616	0.307	0.468	0.434	0.427	0.372	0.278	0.324	0.536	0.56	<0.20	0.2	<0.20	<0.20	
Silver	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	-	-	-	-	-	
Sodium	305	819	377	359	494	440	385	362	322	424	441	421	461	462	599	422	735	-	-	-	-	-	
Strontium	0.092	0.415	0.126	0.146	0.118	0.122	0.190	0.148	0.128	0.306	0.257	0.389	0.247	0.425	0.477	0.200	0.4220	0.562	0.975	0.269	0.421	0.61	
Tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	-	-	-	-	-	
Thallium	0.00144	0.00086	0.001260	0.000610	0.000970	0.000640	0.000970	0.001650	0.000930	0.001170	0.001000	0.001340	0.001730	0.002020	0.002120	0.00154	0.00097	<0.010	<0.010	<0.010	<0.010	<0.010	
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Tin	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.021	<0.050	<0.050	<0.050	<0.050	<0.050	
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Uranium	<0.00040	0.00136	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.00040	<0.0020</					

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Lake Trout (<i>Salvelinus namaycush</i>)																			
	LITTLE ROBERTS LAKE-MUSCLE-6	LITTLE ROBERTS LAKE-MUSCLE-7	LITTLE ROBERTS LAKE-MUSCLE-8	LITTLE ROBERTS LAKE-MUSCLE-9	P.O. LAKE-MUSCLE-LKTR-1	P.O. LAKE-MUSCLE-LKTR-2	P.O. LAKE-MUSCLE-LKTR-6	P.O. LAKE-MUSCLE-LKTR-7	P.O. LAKE-MUSCLE-LKTR-8	P.O. LAKE-MUSCLE-LKTR-9	WINDY LAKE-MUSCLE-1	WINDY LAKE-MUSCLE-2	WINDY LAKE-MUSCLE-3	WINDY LAKE-MUSCLE-4	WINDY LAKE-MUSCLE-5 'FISH 78'	WINDY LAKE-MUSCLE-5 'FISH 49'	WINDY LAKE-MUSCLE-6	WINDY LAKE-MUSCLE-7	WINDY LAKE-MUSCLE-9	WINDY LAKE-MUSCLE-10
Sample ID	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09
Date Sampled	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09
ALS Sample ID	L806060-75	L806060-76	L806060-77	L806060-78	L806060-89	L806060-90	L806060-91	L806060-92	L806060-93	L806060-94	L806060-51	L806060-52	L806060-53	L806060-54	L806060-55	L806060-56	L806060-57	L806060-58	L806060-59	L806060-60
% Moisture	76.2	78.3	77.5	74.9	77.2	72.7	79.2	78.8	77	77.5	75.8	77.2	78.7	75.8	74.8	78.1	77.1	75.5	75.5	74.4
Metals (mg/kg ww)																				
Aluminum	13.1	2.1	2.2	<2.0	2.4	<2.0	14.9	<2.0	2.4	<2.0	<2.0	2.3	2.7	2.4	2.2	<2.0	2.7	2.4	<2.0	4
Antimony	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	0.065	0.036	0.038	0.026	0.031	0.034	0.031	0.025	0.018	0.022	0.106	0.11	0.118	0.199	0.088	0.107	0.116	0.249	0.096	0.135
Barium	0.115	<0.010	<0.010	0.012	0.037	0.034	0.158	0.024	0.031	0.022	0.03	0.032	0.262	0.036	0.023	0.028	0.065	0.025	0.024	0.031
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium	1080	123	111	246	94.5	96.6	85.1	102	190	168	217	160	126	139	278	205	318	150	119	400
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.10	<0.10	<0.10	<0.10	0.35	<0.10	0.14	0.15	<0.10	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	<0.10	<0.10	<0.10
Cobalt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper	0.243	0.222	0.222	0.265	0.268	0.307	0.26	0.252	0.31	0.271	0.302	0.286	0.303	0.33	0.242	0.223	0.284	0.366	0.302	0.327
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	0.104	<0.020	<0.020	<0.020	0.032	0.031	0.115	<0.020	<0.020	<0.020	<0.020	0.025	<0.020	0.021	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium	337	320	302	333	304	315	293	307	314	320	310	313	307	326	298	329	321	314	307	314
Manganese	0.407	0.176	0.169	0.181	0.234	0.156	0.365	0.193	0.17	0.168	0.132	0.113	0.139	0.146	0.142	0.161	0.148	0.093	0.148	0.136
Mercury	0.0481	0.079	0.115	0.0654	0.134	0.144	0.13	0.143	0.159	0.163	0.0276	0.0206	0.0149	0.0117	0.0288	0.0167	0.0067	0.0425	0.0177	0.0049
Molybdenum	0.044	<0.010	0.011	<0.010	0.044	<0.010	0.014	0.018	<0.010	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	<0.010
Nickel	<0.10	<0.10	<0.10	<0.10	0.21	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.20	<0.20	0.23	<0.20	0.25	0.3	0.22	0.23	0.28	0.3	0.64	0.59	0.45	0.62	0.6	0.53	0.55	0.63	0.6	0.58
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	1.73	0.106	0.098	0.383	0.068	0.075	0.199	0.089	0.237	0.183	0.239	0.156	0.152	0.141	0.301	0.241	0.372	0.111	0.102	0.456
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.01	<0.010	<0.010
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.054	<0.050	<0.050	<0.050	<0.050
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	4.63	3.79	3.38	4.7	4.06	4.42	3.59	4.04	4.18	3.71	4.89	3.89	5.52	5.1	3.92	4.08	3.65	4.46	4.25	4.14
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Lake Trout (<i>Salvelinus namaycush</i>)																			
	Reference LAKE A- MUSCLE-1	Reference Lake A- MUSCLE-2	Reference Lake A- MUSCLE-3	Reference Lake A- MUSCLE-4	Reference Lake A- MUSCLE-5	Reference Lake A- MUSCLE-6	Reference Lake A- MUSCLE-7	Reference Lake A- MUSCLE-8	Reference Lake A- MUSCLE-9	Reference Lake A- MUSCLE-10	Reference Lake B- MUSCLE-1	Reference Lake B- MUSCLE-2	Reference Lake B- MUSCLE-3	Reference Lake B- MUSCLE-4	Reference Lake B- MUSCLE-5	Reference Lake B- MUSCLE-6	Reference Lake B- MUSCLE-7	Reference Lake B- MUSCLE-8	Reference Lake B- MUSCLE-9	Reference Lake B- MUSCLE-10
Sample ID																				
Date Sampled	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09
ALS Sample ID	L806060-11	L806060-12	L806060-13	L806060-14	L806060-15	L806060-16	L806060-17	L806060-18	L806060-19	L806060-20	L806060-31	L806060-32	L806060-33	L806060-34	L806060-35	L806060-36	L806060-37	L806060-38	L806060-39	L806060-40
% Moisture	80.2	79.5	78.8	80.6	80.0	80.1	79.3	80.7	81.7	80.8	79.8	78.2	79.5	79.1	79.1	78.9	78.8	78.4	78.3	79.1
Metals (mg/kg ww)																				
Aluminum	2.2	<2.0	<2.0	5.7	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.3	2.1	<2.0	2.0	2.4	2.8	<2.0	2.1	<2.0	<2.0
Antimony	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	0.053	0.088	0.071	0.074	0.084	0.081	0.062	0.038	0.054	0.098	0.046	0.049	0.041	0.043	0.050	0.046	0.048	0.112	0.057	0.045
Barium	0.027	0.018	0.022	0.030	0.030	0.011	0.017	0.018	0.013	0.021	0.040	0.020	0.026	0.025	0.028	0.040	0.023	0.030	0.025	0.024
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Calcium	254	126	219	92.6	75.7	75.0	115	122	229	179	147	211	81.7	79.6	94.0	93.2	97.7	106	109	158
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.14	0.11	0.10	0.12	0.13	0.13	0.12	0.18	0.12	0.13
Cobalt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper	0.244	0.306	0.291	0.199	0.247	0.221	0.202	0.193	0.169	0.148	0.261	0.201	0.287	0.333	0.315	0.264	0.266	0.252	0.302	0.264
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	0.084	0.020	0.043	0.062	0.030	0.108	0.034	<0.020	<0.020	<0.020	0.026	0.033	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium	290	299	303	291	308	306	323	297	284	291	256	259	246	252	267	245	253	264	274	266
Manganese	0.172	0.149	0.139	0.130	0.124	0.127	0.145	0.119	0.116	0.149	0.123	0.092	0.121	0.174	0.116	0.108	0.109	0.128	0.138	0.126
Mercury	0.0746	0.0832	0.162	0.0776	0.119	0.147	0.0697	0.194	0.207	0.341	0.270	0.114	0.178	0.179	0.160	0.111	0.141	0.361	0.107	0.117
Molybdenum	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	<0.010	<0.010
Nickel	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	0.34	0.34	0.36	0.36	0.37	0.39	0.35	0.26	0.29	0.30	0.48	0.43	0.43	0.53	0.53	0.49	0.49	0.47	0.47	0.52
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	0.333	0.125	0.238	0.088	0.047	0.034	0.114	0.111	0.317	0.260	0.166	0.241	0.059	0.066	0.059	0.078	0.087	0.083	0.096	0.161
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.010	0.011	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	0.011	<0.010	<0.010	<0.010	0.013	0.011	0.010	0.014	<0.010
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	3.27	3.73	3.47	3.58	3.52	3.01	3.40	3.26	2.93	3.28	3.53	3.29	3.48	3.16	3.52	4.54	3.46	4.19	4.16	3.67
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Lake Trout (<i>Salvelinus namaycush</i>)																			
	AIMAOKAT ALOK 117 MUSCLE	AIMAOKAT ALOK 118 MUSCLE	AIMAOKAT ALOK 119 MUSCLE	AIMAOKAT ALOK 120 MUSCLE	AIMAOKAT ALOK 121 MUSCLE	AIMAOKAT ALOK 122 MUSCLE	AIMAOKAT ALOK 123 MUSCLE	AIMAOKAT ALOK 139 MUSCLE	AIMAOKAT ALOK 140 MUSCLE	AIMAOKAT ALOK 141 MUSCLE	AIMAOKAT ALOK 142 MUSCLE	AIMAOKAT ALOK 143 MUSCLE	AIMAOKAT ALOK 144 MUSCLE	REFD 1 MUSCLE	REFD 2 MUSCLE	REFD 3 MUSCLE	REFD 8 MUSCLE	REFD 9 MUSCLE	REFD 10 MUSCLE	REFD 11 MUSCLE
Sample ID																				
Date Sampled	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	20-AUG-10	24-AUG-10	24-AUG-10	24-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10	25-AUG-10
ALS Sample ID	L941447-97	L941447-98	L941447-99	L941447-100	L941447-101	L941447-102	L941447-103	L941447-104	L941447-105	L941447-106	L941447-107	L941447-108	L941447-109	L941447-113	L941447-114	L941447-115	L941447-116	L941447-117	L941447-118	L941447-119
% Moisture	82	79.8	78.9	81.4	80.7	79.5	78.8	82.5	81.4	80.9	81.1	81.2	79.8	79.6	76.9	77.8	77.1	77.3	80.3	77.4
Metals (mg/kg ww)																				
Aluminum	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.4	<2.0	<2.0	<2.0	3	<2.0	<2.0	3.7	<2.0	2
Antimony	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	0.074	0.12	0.033	0.073	0.045	0.089	0.15	0.04	0.069	0.067	0.127	0.078	0.122	0.014	0.119	0.031	0.01	0.013	0.027	0.028
Barium	0.02	0.015	<0.010	<0.010	<0.010	0.029	<0.010	<0.010	<0.010	<0.010	0.067	<0.010	0.037	0.012	0.048	0.026	0.012	0.02	0.016	0.042
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Bismuth	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.007
Calcium	59	57.9	62	78.9	81.7	40.7	44.2	108	50.8	40.3	159	44.1	51.8	59.4	68.1	53.7	50.7	55.4	76.2	67.5
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	0.32	<0.10	0.24	0.26	0.7	0.17	<0.10	0.24	0.16	0.19	0.24	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.33	0.44	0.14
Cobalt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Copper	0.172	0.417	0.259	0.288	0.198	0.202	0.216	0.15	0.273	0.3	0.219	0.167	0.186	0.22	0.333	0.357	0.305	0.316	0.233	0.259
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.048	<0.020	<0.020
Lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Magnesium	209	224	220	234	210	233	206	228	230	227	191	216	228	201	240	218	234	224	259	195
Manganese	0.14	0.153	0.169	0.161	0.141	0.072	0.108	0.12	0.118	0.118	0.239	0.101	0.234	0.12	0.27	0.134	0.118	0.346	0.224	0.189
Mercury	1.07	0.956	0.393	1.05	0.938	1.8	0.728	0.953	1.3	1.09	1.62	0.874	0.768	0.201	0.232	0.116	0.089	0.135	0.142	0.116
Molybdenum	0.018	<0.010	0.013	0.013	0.031	0.011	<0.010	0.014	<0.010	0.014	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.012	<0.010
Nickel	0.2	<0.10	0.15	0.16	0.38	0.11	<0.10	0.14	0.1	0.11	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.19	0.22	<0.10
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.20	<0.20	<0.20	<0.20	<0.20	0.2	0.21	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.21	<0.20	<0.20	0.24	<0.20
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	0.056	0.05	0.058	0.057	0.107	0.019	0.044	0.102	0.052	0.039	0.215	0.023	0.024	0.052	0.167	0.075	0.047	0.046	0.066	0.066
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.010	<0.010	0.01	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.062	0.087	0.087	0.206	0.155	0.244	0.175	0.18	0.108
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	2.52	3.34	2.88	2.87	2.68	2.88	2.67	2.92	2.81	3.04	3.37	2.52	2.61	3.11	3.88	3.69	3.19	4.02	3.56	3.45
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Lake Trout (<i>Salvelinus namaycush</i>)				Whitefish (<i>Coregonus spp</i> .)							Ninespine Stickleback (<i>Pungitius pungitius</i>)							
	REFD 1 MUSCLE	REFD 9 MUSCLE	REFD 10 MUSCLE	REFD 11 MUSCLE	P.O. LAKE-MUSCLE-WHITEFISH-1	P.O. LAKE-MUSCLE-WHITEFISH-2	P.O. LAKE-MUSCLE-WHITEFISH-3	P.O. LAKE-MUSCLE-WHITEFISH-4	SPYDER 145 MUSCLE	SPYDER 146 MUSCLE	SPYDER 147 MUSCLE	BOSTON1 NORTH STREAM 1	BOSTON1 NORTH STREAM 2	BOSTON1 NORTH STREAM 3	BOSTON1 NORTH STREAM 4	BOSTON1 NORTH STREAM 5	BOSTON1 NORTH STREAM 6	BOSTON1 NORTH STREAM 7	BOSTON1 NORTH STREAM 8
Sample ID																			
Date Sampled	11-SEP-10	12-SEP-10	12-SEP-10	12-SEP-10	05-AUG-09	05-AUG-09	05-AUG-09	05-AUG-09	20-AUG-10	20-AUG-10	20-AUG-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10
ALS Sample ID	L941447-120	L941447-121	L941447-122	L941447-123	L806060-95	L806060-96	L806060-97	L806060-98	L941447-110	L941447-111	L941447-112	L941447-1	L941447-2	L941447-3	L941447-4	L941447-5	L941447-6	L941447-7	L941447-8
% Moisture	77.7	76.6	77	76	80.1	78.9	78.1	78.2	74.7	78.7	82	72.2	70.6	67.0	75.8	76.4	68.2	67.2	69.0
Metals (mg/kg ww)																			
Aluminum	<2.0	<2.0	<2.0	<2.0	2.7	<2.0	<2.0	<2.0	3.2	<2.0	<2.0	30.6	56.6	66.1	8.30	9.8	37.0	31.0	18.3
Antimony	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020
Arsenic	0.015	0.015	0.016	0.014	0.031	0.023	0.065	0.02	0.222	0.051	0.055	0.0360	0.0700	0.0520	<0.020	0.0300	0.0420	0.0610	0.0470
Barium	0.011	0.031	0.011	0.045	0.024	0.032	0.056	0.035	0.026	0.017	<0.010	3.07	2.58	2.32	3.37	5.62	2.77	2.35	2.45
Beryllium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20
Bismuth	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.060	<0.060	<0.060	<0.060	<0.090	<0.060	<0.060	<0.060
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0200	0.0250	0.0100	0.0210	0.0340	0.0210	0.0210	0.0120
Calcium	142	212	152	285	203	296	527	309	90.2	89.6	109	12100	10600	11600	11800	17000	12400	11000	9180
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.10	0.27	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.11	<0.10	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20
Cobalt	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.029	<0.020	<0.020	<0.040	0.0500	<0.040	<0.040	<0.060	<0.040	<0.040	<0.040
Copper	0.242	0.241	0.252	0.3	0.202	0.14	0.199	0.167	0.335	0.221	0.176	1.74	1.56	1.23	1.31	1.64	1.09	0.941	1.08
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	<0.020	<0.020	<0.020	<0.020	<0.020	0.161	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.040	<0.040	<0.040	<0.060	<0.040	<0.040	<0.040
Lithium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20
Magnesium	243	268	261	253	301	288	304	317	253	225	224	375	367	373	549	434	404	354	409
Manganese	0.14	0.229	0.148	0.252	0.257	0.234	0.338	0.327	0.953	0.201	0.149	9.29	9.80	8.68	6.45	11.2	8.58	8.62	6.15
Mercury	0.192	0.118	0.093	0.13	0.068	0.247	0.0422	0.13	0.222	0.176	0.338	0.0880	0.0806	0.0441	0.0891	0.109	0.0439	0.0381	0.0549
Molybdenum	<0.010	0.014	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.0310	0.0370	0.0290	0.0230	0.0320	0.0310	0.0260	0.0240
Nickel	<0.10	0.16	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.37	<0.10	<0.10	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.20	<0.20	<0.20	<0.20	0.27	0.25	0.28	0.27	0.24	0.2	<0.2	0.420	0.420	<0.40	<0.40	<0.60	<0.40	<0.40	0.420
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	0.201	0.356	0.22	0.412	0.363	0.556	1.37	0.569	0.102	0.131	0.149	17.0	13.6	17.3	14.9	20.7	17.9	17.6	13.0
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.020	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.11	0.053	0.086	<0.10	<0.10	<0.10	<0.10	<0.15	<0.10	<0.10	<0.10
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0259	0.0308	0.0168	0.0218	0.0239	0.0175	0.0116	0.0106
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.20	0.21	0.23	<0.20	<0.30	<0.20	<0.20	<0.20
Zinc	3.9	3.62	4.16	4.13	3.72	3.24	3.97	3.22	3.5	2.77	2.8	58.4	58.8	40.7	55.8	82.8	50.9	44.3	38.6
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																			
	BOSTON1 NORTH STREAM 9	BOSTON1 NORTH STREAM 10	BOSTON1 NORTH STREAM 11	BOSTON1 NORTH STREAM 12	BOSTON1 NORTH STREAM 13	BOSTON1 NORTH STREAM 14	BOSTON1 NORTH STREAM 15	BOSTON1 NORTH STREAM 16	BOSTON1 NORTH STREAM 17	BOSTON1 NORTH STREAM 18	BOSTON1 NORTH STREAM 19	BOSTON1 NORTH STREAM 20	BOSTON1 EAST STREAM 1	BOSTON1 EAST STREAM 2	BOSTON1 EAST STREAM 3	BOSTON1 EAST STREAM 4	BOSTON1 EAST STREAM 5	BOSTON1 EAST STREAM 6	BOSTON1 EAST STREAM 7	BOSTON1 EAST STREAM 8
Sample ID																				
Date Sampled	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10
ALS Sample ID	L941447-9	L941447-10	L941447-11	L941447-12	L941447-13	L941447-14	L941447-15	L941447-16	L941447-17	L941447-18	L941447-19	L941447-20	L941447-21	L941447-22	L941447-23	L941447-24	L941447-25	L941447-26	L941447-27	L941447-28
% Moisture	74.1	70.1	68.5	64.8	65.5	71.1	69.2	67.6	65.7	66.3	67.6	68.6	72.3	69.0	66.9	73.5	67.5	67.5	65.3	72.3
Metals (mg/kg ww)																				
Aluminum	6.30	13.4	34.7	52.8	63.3	32.3	31.9	20.8	18.4	78.1	68.3	126	<4.0	<4.0	7.60	<8.0	7.10	<4.0	37.1	24.7
Antimony	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.020	<0.020	<0.020	<0.020
Arsenic	0.0480	0.0400	0.0520	0.0510	0.0560	0.0350	0.0650	0.0430	0.0320	0.0610	0.0410	0.0650	<0.020	<0.020	0.0340	<0.040	0.0380	0.0220	0.0490	0.0370
Barium	3.07	1.56	2.43	1.96	3.54	2.45	5.33	2.42	2.25	6.92	2.44	5.15	2.46	1.92	1.96	5.61	2.70	2.02	2.83	2.76
Beryllium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20
Bismuth	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.12	<0.060	<0.060	<0.060	<0.060
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.0130	0.0110	0.0210	<0.010	0.0190	0.0170	0.0350	0.0110	0.0100	0.0220	0.0140	0.0280	0.0140	0.0140	0.0160	0.0700	0.0260	<0.010	0.0190	0.0260
Calcium	12400	10200	10700	10900	15400	11100	11800	13100	14200	16000	13500	14100	9700	11200	10600	25700	15800	11800	15400	13700
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.220	0.220	3.32	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20
Cobalt	<0.040	<0.040	<0.040	<0.040	0.0490	<0.040	0.0740	<0.040	<0.040	0.0660	<0.040	0.0630	<0.040	<0.040	<0.040	<0.080	<0.040	<0.040	0.0590	<0.040
Copper	1.78	1.10	1.24	0.986	1.30	1.27	1.19	0.836	1.32	1.60	1.51	1.61	1.04	0.866	0.969	1.62	1.63	1.20	1.28	3.06
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.155	39.7	0.110	<0.040	<0.040	<0.040	<0.080	<0.040	0.0490	<0.040	<0.040
Lithium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20
Magnesium	562	342	339	375	435	462	397	382	423	555	422	496	309	348	321	752	447	361	470	375
Manganese	7.20	8.32	7.15	6.50	8.25	6.93	8.88	10.8	5.57	9.43	5.98	16.5	5.90	6.00	7.16	15.6	12.1	7.02	12.9	9.88
Mercury	0.0464	0.0537	0.0446	0.0358	0.0314	0.0392	0.0285	0.0379	0.0269	0.0372	0.0195	0.0193	0.0560	0.0400	0.0790	0.164	0.0727	0.0227	0.0683	0.104
Molybdenum	0.0250	0.0240	0.0290	0.0330	0.0270	0.0350	0.0340	0.0250	0.0250	0.0380	0.0310	0.0490	0.0230	0.0270	0.0300	0.0430	0.0310	0.0230	0.0350	0.0370
Nickel	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20	<0.20
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.40	<0.40	0.420	<0.40	<0.40	0.490	<0.40	<0.40	<0.40	0.430	<0.40	<0.40	<0.40	<0.40	<0.40	<0.80	<0.40	<0.40	0.400	<0.40
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	15.1	14.2	15.9	15.2	26.4	15.8	19.0	18.4	24.2	24.8	23.9	23.0	16.5	15.6	15.7	40.0	25.1	21.5	25.2	19.5
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.040	<0.020	<0.020	<0.020	<0.020
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.0114	0.0149	0.0149	0.0156	0.0279	0.0169	0.0138	0.0117	0.0142	0.0291	0.0187	0.0293	0.00420	0.00430	0.00660	0.0198	0.0152	0.0130	0.0314	0.0326
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.20	<0.20	<0.20	<0.20	0.53	<0.20	<0.20	<0.20	<0.20	0.30	0.37	0.32	0.37	<0.20	<0.20	<0.20	<0.40	<0.20	<0.20	<0.20
Zinc	51.6	43.1	42.6	44.3	52.6	39.6	48.9	40.4	45.4	53.9	42.1	49.1	43.5	44.3	49.8	146	73.7	44.0	56.7	60.4
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																			
	BOSTON1 EAST STREAM 9	BOSTON1 EAST STREAM 10	BOSTON1 EAST STREAM 11	BOSTON1 EAST STREAM 12	BOSTON1 EAST STREAM 13	BOSTON1 EAST STREAM 14	BOSTON1 EAST STREAM 15	BOSTON1 EAST STREAM 16	BOSTON1 EAST STREAM 17	BOSTON1 EAST STREAM 18	BOSTON1 EAST STREAM 19	BOSTON1 EAST STREAM 20	BOSTON1 TAILINGS STREAM 1	BOSTON1 TAILINGS STREAM 2	BOSTON1 TAILINGS STREAM 3	BOSTON1 TAILINGS STREAM 4	BOSTON1 TAILINGS STREAM 5	BOSTON1 TAILINGS STREAM 6	BOSTON1 TAILINGS STREAM 7	BOSTON1 TAILINGS STREAM 8
Sample ID																				
Date Sampled	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10
ALS Sample ID	L941447-29	L941447-30	L941447-31	L941447-32	L941447-33	L941447-34	L941447-35	L941447-36	L941447-37	L941447-38	L941447-39	L941447-40	L941447-41	L941447-42	L941447-43	L941447-44	L941447-45	L941447-46	L941447-47	L941447-48
% Moisture	67.5	72.4	62.1	67.4	68.8	72.7	68.6	68.7	68.1	66.6	64.0	69.0	77.1	65.3	70.0	68.3	69.8	68.1	67.3	68.0
Metals (mg/kg ww)																				
Aluminum	38.7	7.30	9.10	34.3	30.5	20.8	7.30	13.3	24.5	<4.0	12.4	9.40	17.6	39.5	8.20	41.0	27.0	34.7	16.1	29.1
Antimony	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020	<0.030	<0.020
Arsenic	0.0330	0.0310	0.0230	0.0360	0.0480	0.0370	0.0380	0.0270	0.0280	0.0230	0.0320	0.0260	0.0240	0.0380	<0.030	0.0270	0.0430	0.0290	<0.030	0.0270
Barium	2.41	2.18	2.61	3.27	3.55	3.80	2.71	2.98	3.93	1.75	3.87	2.42	3.80	3.00	1.56	2.70	3.42	2.17	3.46	3.34
Beryllium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20
Bismuth	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.090	<0.060	<0.060	<0.060	<0.090	<0.060
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.0160	0.0160	0.0250	0.0440	0.0400	0.0460	0.0300	0.0330	0.0280	0.0190	0.0250	0.0430	0.0400	0.105	0.0390	0.0310	0.0210	0.0320	0.0710	0.0300
Calcium	12000	11100	17300	12600	10900	15000	13900	11700	11100	10000	12800	13200	12300	14000	9970	17900	14700	11500	10500	9640
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.20	<0.20	0.520	<0.20	<0.20	<0.20	<0.20	<0.20	0.380	<0.20	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20
Cobalt	<0.040	<0.040	0.0480	0.0450	<0.040	<0.040	<0.040	<0.040	0.231	<0.040	<0.040	<0.040	<0.040	0.0520	<0.060	<0.040	<0.040	<0.040	<0.060	<0.040
Copper	1.11	1.43	1.46	1.51	1.28	1.30	1.10	1.18	1.89	2.10	1.71	0.990	1.14	1.36	1.29	2.16	1.69	2.59	1.44	0.950
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	0.0430	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.0410	<0.060	0.0430	<0.040	<0.040	<0.060	<0.040
Lithium	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20
Magnesium	358	377	509	432	354	490	445	361	391	344	421	421	314	468	361	443	401	358	395	348
Manganese	8.10	8.36	19.0	8.76	8.78	10.6	10.9	7.65	8.23	12.0	6.80	7.70	9.33	8.30	5.56	9.59	8.37	7.35	5.68	6.35
Mercury	0.0640	0.112	0.0982	0.121	0.0820	0.124	0.0515	0.0920	0.110	0.0720	0.0900	0.0900	0.178	0.116	0.0452	0.126	0.0887	0.0857	0.0596	0.0547
Molybdenum	0.0270	0.0350	0.0320	0.0410	0.0290	0.0340	0.0260	0.0270	0.0350	0.0270	0.0290	0.0250	0.0300	0.0520	<0.030	0.0490	0.0520	0.0580	0.0320	0.0300
Nickel	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	7.03	<0.20	<0.20	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	0.330	<0.20
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.40	0.450	0.470	0.460	0.410	0.450	<0.40	<0.40	0.490	<0.40	<0.40	<0.40	<0.40	<0.40	<0.60	<0.40	<0.40	0.420	<0.60	<0.40
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	17.1	15.9	24.3	21.2	16.0	19.3	20.2	16.1	16.5	14.9	18.4	17.5	11.3	15.4	8.05	18.6	14.3	10.3	11.4	13.9
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020	<0.030	<0.020
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.15	<0.10	<0.10	<0.10	<0.15	<0.10
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.0139	0.00940	0.0242	0.0274	0.0185	0.0384	0.0158	0.0115	0.0175	0.00780	0.0147	0.00850	0.0838	0.113	0.0429	0.121	0.111	0.117	0.0389	0.0627
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.30	0.22	<0.20	<0.20	<0.30	<0.20
Zinc	43.2	58.7	57.4	55.0	55.8	70.1	55.6	51.6	60.5	46.5	61.3	59.1	68.3	63.4	44.3	63.7	56.1	48.6	57.3	50.6
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																			
	BOSTON1 TAILINGS STREAM 9	BOSTON1 TAILINGS STREAM 10	BOSTON1 TAILINGS STREAM 11	BOSTON1 TAILINGS STREAM 12	BOSTON1 TAILINGS STREAM 13	BOSTON1 TAILINGS STREAM 14	BOSTON1 TAILINGS STREAM 15	BOSTON1 TAILINGS STREAM 16	BOSTON1 TAILINGS STREAM 17	BOSTON1 TAILINGS STREAM 18	BOSTON1 TAILINGS STREAM 19	BOSTON1 TAILINGS STREAM 20	BOSTON 2 STREAM 1	BOSTON 2 STREAM 2	BOSTON 2 STREAM 3	BOSTON 2 STREAM 4	BOSTON 2 STREAM 5	BOSTON 2 STREAM 6	BOSTON 2 STREAM 7	BOSTON 2 STREAM 8
Sample ID																				
Date Sampled	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	06-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10	04-SEP-10
ALS Sample ID	L941447-49	L941447-50	L941447-51	L941447-52	L941447-53	L941447-54	L941447-55	L941447-56	L941447-57	L941447-58	L941447-59	L941447-60	L941447-61	L941447-62	L941447-63	L941447-64	L941447-65	L941447-66	L941447-67	L941447-68
% Moisture	65.8	65.3	64.7	67.4	70.0	66.3	66.7	68.6	66.8	71.5	66.8	66.5	76.1	64.7	72.5	69.0	72.5	72.3	70.9	74.0
Metals (mg/kg ww)																				
Aluminum	17.5	59.4	27.0	29.9	21.9	28.6	33.7	16.1	16.8	58.5	25.5	43.0	<4.0	<4.0	<4.0	11.9	<4.0	<4.0	<2.0	4.00
Antimony	<0.020	<0.020	<0.030	<0.030	<0.030	<0.030	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.010
Arsenic	0.0280	0.0550	0.0500	0.171	0.0480	0.137	0.0340	0.0300	0.0570	0.0400	0.0230	0.0430	<0.020	0.0450	<0.020	0.0300	0.0280	<0.020	0.0130	0.0250
Barium	1.44	3.59	2.63	3.98	5.96	2.94	2.05	3.07	2.08	2.92	1.65	2.66	2.13	2.64	1.90	3.63	1.14	1.86	1.54	1.44
Beryllium	<0.20	<0.20	<0.30	<0.30	<0.30	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10
Bismuth	<0.060	<0.060	<0.090	<0.090	<0.090	<0.090	<0.060	<0.060	<0.060	<0.090	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.030	<0.030
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.0320	0.0380	0.0330	0.0270	0.0420	0.0490	0.0190	0.0210	0.0190	0.0630	0.0530	0.0360	0.0190	0.0180	0.0120	<0.010	0.0170	<0.010	<0.0050	0.00870
Calcium	9920	10200	9100	13900	16000	15000	11800	11000	12300	14600	14200	14500	17000	14800	15500	12500	11100	11200	10100	7750
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.20	0.230	<0.30	<0.30	<0.30	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	0.210	<0.20	<0.20	<0.20	<0.10	<0.10
Cobalt	<0.040	<0.040	<0.060	<0.060	<0.060	<0.060	<0.040	<0.040	<0.040	<0.060	<0.040	0.0430	<0.040	<0.040	<0.040	<0.040	<0.040	0.0580	0.0480	0.0760
Copper	1.82	1.92	1.29	2.02	4.06	2.01	1.56	1.06	1.05	2.41	1.67	1.97	1.52	1.25	2.28	0.942	1.10	0.693	0.776	0.950
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	<0.040	0.0610	<0.060	0.0940	<0.060	0.0980	<0.040	<0.040	0.0700	<0.060	<0.040	0.0530	0.0670	<0.040	<0.040	<0.040	<0.040	<0.040	<0.020	<0.020
Lithium	<0.20	<0.20	<0.30	<0.30	<0.30	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10
Magnesium	324	417	371	507	548	506	342	337	411	500	478	473	458	491	448	465	560	386	357	327
Manganese	8.87	8.68	6.25	8.85	9.01	9.24	5.75	3.32	6.09	8.78	9.76	11.2	8.24	3.27	6.19	5.26	3.80	4.60	4.50	4.78
Mercury	0.136	0.0691	0.0544	0.0797	0.0979	0.0763	0.0949	0.0958	0.0829	0.0809	0.155	0.0960	0.0404	0.0692	0.0310	0.0512	0.0473	0.0443	0.0445	0.0532
Molybdenum	0.0500	0.0500	0.0350	0.0430	0.0410	0.0310	0.0380	0.0320	0.0320	0.0510	0.0510	0.0510	0.0250	0.0250	0.0310	0.0260	0.0230	<0.020	0.0150	0.0240
Nickel	<0.20	<0.20	<0.30	<0.30	0.470	<0.30	<0.20	<0.20	<0.20	<0.30	0.240	<0.20	<0.20	0.310	<0.20	<0.20	<0.20	<0.20	0.120	<0.10
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	<0.40	<0.40	<0.60	<0.60	<0.60	<0.60	<0.40	<0.40	<0.40	<0.60	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.390	0.410
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	8.68	13.5	9.06	12.8	18.5	13.2	10.9	17.1	11.3	12.4	13.6	13.4	6.54	14.0	5.47	14.2	27.4	25.4	22.0	20.3
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.020	<0.020	<0.030	<0.030	<0.030	<0.030	<0.020	<0.020	<0.020	<0.030	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.010
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.10	<0.10	<0.15	<0.15	<0.15	<0.15	<0.10	<0.10	<0.10	<0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	0.123	0.167	0.0553	0.0600	0.0627	0.0914	0.101	0.0300	0.0495	0.165	0.0685	0.169	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0020	<0.0020
Yttrium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.20	<0.20	<0.20	<0.10	<0.10
Vanadium	<0.20	0.34	<0.30	<0.30	<0.30	<0.30	<0.20	<0.20	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	-	-	-	-	-
Zinc	44.2	59.2	54.6	61.9	56.3	60.9	46.7	43.8	49.8	62.3	60.1	59.6	56.6	58.8	58.8	63.4	50.7	31.2	35.9	39.5
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																			
	BOSTON 2 STREAM 9	BOSTON 2 STREAM 10	BOSTON 2 STREAM 11	BOSTON 2 STREAM 1	BOSTON 2 STREAM 2	BOSTON 2 STREAM 3	BOSTON 2 STREAM 4	BOSTON 2 STREAM 5	BOSTON 3 FT 1	BOSTON 3 FT 2	BOSTON 3 FT 3	BOSTON 3 FT 4	BOSTON 3 FT 5	BOSTON 3 FT 6	BOSTON 3 FT 7	BOSTON 3 FT 8	BOSTON 3 FT 9	BOSTON 3 FT 10	BOSTON 3 FT 11	BOSTON 3 FT 12
Sample ID																				
Date Sampled	04-SEP-10	04-SEP-10	04-SEP-10	05-SEP-10	05-SEP-10	05-SEP-10	05-SEP-10	05-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10
ALS Sample ID	L941447-69	L941447-70	L941447-71	L941447-72	L941447-73	L941447-74	L941447-75	L941447-76	L941447-77	L941447-78	L941447-79	L941447-80	L941447-81	L941447-82	L941447-83	L941447-84	L941447-85	L941447-86	L941447-87	L941447-88
% Moisture	78.2	76.5	75.2	67.3	67.5	70.4	73.3	73.5	63.5	66.4	71.6	65.9	65.9	70.3	66.5	71.5	70.5	60.5	66.8	66.9
Metals (mg/kg ww)																				
Aluminum	<2.0	7.50	<2.0	<6.0	23.0	10.4	5.10	4.20	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<2.0	<4.0	<4.0	<4.0	<4.0	<4.0
Antimony	<0.010	<0.020	<0.010	<0.030	<0.020	<0.020	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020
Arsenic	0.0510	0.0340	0.0280	0.0310	0.0530	0.0210	0.0370	0.0280	0.0300	0.0430	0.0320	0.0270	0.0230	0.0430	0.0200	0.0380	0.0270	0.0210	0.0250	0.0280
Barium	1.08	1.77	1.73	2.54	2.31	3.97	1.11	1.38	3.37	3.19	2.52	2.32	1.59	2.47	1.99	2.89	2.97	2.34	1.95	1.98
Beryllium	<0.10	<0.20	<0.10	<0.30	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20
Bismuth	<0.030	<0.060	<0.030	<0.090	<0.060	<0.060	<0.030	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.030	<0.060	<0.060	<0.060	<0.060	<0.060
Boron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.0110	<0.010	0.0104	<0.015	0.0210	0.0210	0.0195	0.0160	0.0170	0.0270	0.0140	<0.010	0.0110	<0.010	0.00560	0.0160	0.0160	0.0100	<0.010	0.0110
Calcium	6630	13000	9050	16000	17000	16600	8830	12700	16600	16500	16000	15300	14800	16200	10600	15500	21100	18600	13700	14700
Cesium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	<0.10	<0.20	<0.10	<0.30	0.230	0.240	0.130	<0.20	<0.20	0.500	<0.20	<0.20	<0.20	0.220	0.110	<0.20	<0.20	<0.20	<0.20	<0.20
Cobalt	0.100	<0.040	<0.020	<0.060	0.0450	<0.040	0.0580	0.0820	<0.040	<0.040	0.0420	<0.040	<0.040	<0.040	<0.020	<0.040	<0.040	<0.040	<0.040	<0.040
Copper	0.828	0.589	0.914	1.14	1.11	1.28	0.765	1.04	1.02	1.06	0.913	1.05	0.873	0.939	0.756	1.59	0.799	0.866	1.11	0.806
Gallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	<0.020	<0.040	<0.020	<0.060	<0.040	<0.040	<0.020	<0.040	0.101	0.0510	0.0500	<0.040	0.0810	<0.040	<0.020	<0.040	<0.040	<0.040	<0.040	<0.040
Lithium	<0.10	<0.20	<0.10	<0.30	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20
Magnesium	321	296	536	666	574	623	466	539	476	414	411	424	440	423	380	398	458	513	378	444
Manganese	3.68	6.52	3.69	6.16	10.0	7.75	3.99	4.07	13.1	18.1	10.2	10.8	8.73	7.83	6.03	15.2	13.8	11.0	8.32	11.9
Mercury	0.0330	0.0732	0.0252	0.0413	0.0339	0.0409	0.0540	0.0408	0.0655	0.109	0.0548	0.0747	0.0656	0.0601	0.0550	0.0564	0.0583	0.0458	0.0809	0.0325
Molybdenum	0.0190	<0.020	0.0270	0.0370	0.0320	0.0280	0.0260	0.0270	0.0280	0.0340	0.0310	0.0300	0.0240	0.0250	0.0250	<0.020	0.0230	0.0240	0.0220	0.0260
Nickel	<0.10	<0.20	<0.10	<0.30	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20
Phosphorus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	0.320	<0.40	0.360	0.610	<0.40	0.520	0.520	0.460	0.430	<0.40	<0.40	<0.40	<0.40	<0.40	0.220	<0.40	<0.40	<0.40	<0.40	<0.40
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	15.9	20.8	19.5	39.6	33.3	36.3	19.1	22.4	19.0	20.3	19.0	15.7	11.3	18.9	9.45	18.0	21.2	11.4	14.0	9.49
Tellurium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	<0.010	<0.020	<0.010	<0.030	<0.020	<0.020	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.010	<0.020	<0.020	<0.020	<0.020	<0.020
Thorium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	<0.050	<0.10	<0.050	<0.15	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10
Titanium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	<0.0020	0.004500	<0.0020	<0.0060	<0.0040	<0.0040	<0.0020	<0.0040	0.00430	0.00670	0.00500	<0.0040	<0.0040	<0.0040	<0.0020	0.00510	0.00930	<0.0040	<0.0040	<0.0040
Yttrium	<0.10	0.230	<0.10	<0.30	<0.20	<0.20	<0.10	<0.20	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	<0.20	<0.20	0.24	<0.20	<0.20	<0.20	<0.10	<0.20	<0.20	<0.20	<0.20	<0.20
Zinc	36.1	39.6	46.8	85.6	75.0	69.0	50.4	66.6	57.0	82.6	61.1	47.0	57.3	61.5	41.9	80.4	70.8	63.1	52.8	54.8
Zirconium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																				
	BOSTON 3 FT 13	BOSTON 3 FT 14	BOSTON 3 FT 15	BOSTON 3 FT 16	BOSTON 3 FT 17	BOSTON 3 FT 18	BOSTON 3 FT 19	BOSTON 3 FT 20	Doris North # 1	Doris North # 3	Doris North # 4	Doris North # 5	Doris North # 6	Doris North # 7	Doris North # 8	Doris North # 1	Doris South # 2	Doris South # 3	Doris South # 4	Doris South # 5	Doris South # 6
Sample ID																					
Date Sampled	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	03-SEP-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10
ALS Sample ID	L941447-89	L941447-90	L941447-91	L941447-92	L941447-93	L941447-94	L941447-95	L941447-96	L930021-1	L930021-3	L930021-4	L930021-5	L930021-6	L930021-7	L930021-8	L930021-9	L930021-10	L930021-11	L930021-12	L930021-13	L930021-14
% Moisture	65.9	67.4	65.4	68.0	67.3	67.4	69.9	64.3	76.2	77.9	78.7	74.6	76.6	75.8	76.8	77.1	75.2	74.7	77.4	75.7	77.1
Metals (mg/kg ww)																					
Aluminum	<4.0	<6.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	16.8	5.80	1.02	4.00	1.82	0.920	2.30	0.870	32.0	34.8	19.0	7.59	14.6
Antimony	<0.020	<0.030	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.00570	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic	0.0400	0.0310	0.0270	0.0330	0.0370	0.0380	0.0250	0.0270	0.0915	0.0554	0.131	0.140	0.0603	0.101	0.0913	0.104	0.103	0.135	0.0910	0.132	0.101
Barium	2.98	6.07	2.50	1.79	2.15	2.37	2.64	1.77	1.04	0.658	1.36	1.20	0.978	1.14	1.64	0.810	1.16	1.24	1.14	0.971	1.08
Beryllium	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth	<0.060	<0.090	<0.060	<0.060	<0.060	<0.060	<0.060	<0.060	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Boron	-	-	-	-	-	-	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium	0.0100	<0.015	<0.010	<0.010	0.0130	<0.010	<0.010	<0.010	0.00370	<0.0020	<0.0020	0.00300	0.00390	0.00310	0.00300	<0.0020	0.00540	0.00660	0.00740	0.00470	0.00280
Calcium	18300	25000	19000	13900	13700	14700	14200	15600	6840	6110	11700	10400	10300	10700	9530	8330	8220	9530	8760	9560	9440
Cesium	-	-	-	-	-	-	-	-	0.00390	0.00200	0.00410	0.00500	0.00250	0.00340	0.00330	0.00380	0.00660	0.00410	0.00340	0.00420	0.00460
Chromium	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	3.23	0.864	0.952	0.042	0.308	0.0330	0.0190	0.0260	0.120	0.0960	0.0560	0.0450	0.0790
Cobalt	<0.040	<0.060	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.0568	0.0233	0.0232	0.0235	0.0154	0.0191	0.0175	0.0139	0.0356	0.0431	0.0343	0.0200	0.0189
Copper	0.944	1.13	0.732	0.842	0.762	0.563	0.836	0.907	0.914	0.566	0.751	0.870	0.660	0.813	0.700	0.678	0.814	0.942	0.878	0.817	0.907
Gallium	-	-	-	-	-	-	-	-	0.00550	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.0104	0.0123	0.00620	<0.0040	0.00460
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-	97.8	27.4	23.6	23.8	18.6	22.6	24.1	17.4	61.8	68.6	49.7	25.3	35.1
Lead	<0.040	<0.060	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	0.0114	0.00520	0.00520	0.00690	0.00850	0.00580	0.0107	0.00470	0.0178	0.0157	0.0123	0.00950	0.0107
Lithium	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.0220	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.0480	0.0470	0.0310	<0.020	0.0210
Magnesium	474	521	526	369	382	397	398	390	339	238	412	409	416	431	399	373	396	512	444	418	411
Manganese	13.6	15.2	15.4	7.61	8.90	7.51	14.8	13.4	16.7	9.54	24.7	18.2	26.1	20.5	17.7	13.5	19.2	20.2	16.3	17.0	20.3
Mercury	0.0642	0.0744	0.0550	0.0429	0.0663	0.0561	0.0448	0.0619	0.0663	0.0417	0.0636	0.0930	0.0595	0.0968	0.0637	0.0388	0.0247	0.0442	0.0262	0.0250	0.0266
Molybdenum	<0.020	0.0320	0.0320	0.0250	0.0300	<0.020	0.0270	0.0220	0.140	0.0536	0.0522	0.0423	0.0395	0.0341	0.0314	0.0234	0.0312	0.0294	0.0308	0.0294	0.0289
Nickel	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	1.79	0.488	0.515	0.0260	0.175	0.0170	0.0160	0.0140	0.0600	0.0630	0.0480	0.0280	0.0380
Phosphorus	-	-	-	-	-	-	-	-	5720	4290	7970	7450	7360	7930	7190	6600	6670	7090	6710	7330	7190
Potassium	-	-	-	-	-	-	-	-	3380	1860	3350	3460	3420	3640	3550	3540	3490	3310	3440	3510	3640
Rhenium	-	-	-	-	-	-	-	-	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium	-	-	-	-	-	-	-	-	1.68	0.798	1.43	1.66	1.43	1.88	1.78	1.77	2.09	1.97	1.62	1.73	1.91
Selenium	<0.40	<0.60	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	0.236	0.144	0.240	0.259	0.183	0.244	0.234	0.207	0.197	0.243	0.210	0.269	0.222
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	1290	840	1450	1550	1370	1330	1350	1400	1330	1250	1390	1320	1320
Strontium	21.9	34.7	17.7	9.10	10.2	10.9	10.9	13.5	7.40	6.41	13.6	11.6	12.4	11.2	9.64	9.22	10.0	10.5	9.82	10.6	9.92
Tellurium	-	-	-	-	-	-	-	-	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium	<0.020	<0.030	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.00183	0.00121	0.00173	0.00131	0.00200	0.00155	0.00178	0.00219	0.00316	0.00218	0.00228	0.00202	0.00207
Thorium	-	-	-	-	-	-	-	-	0.00540	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0125	0.0148	0.00700	<0.0020	0.00540
Tin	<0.10	<0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.00850	<0.0040	0.00470	0.00620	0.00820	<0.0040	0.00500	0.00800	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Titanium	-	-	-	-	-	-	-	-	0.829	0.259	0.0320	0.318	0.0660	0.0270	0.0910	0.0230	1.91	2.08	1.07	0.345	0.721
Uranium	0.00530	0.00680	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.00339	0.00229	0.00239	0.00244	0.00465	0.00348	0.00246	0.00310	0.00463	0.00543	0.00495	0.00357	0.00348
Yttrium	-	-	-	-	-	-	-	-	0.0637	0.0272	0.0315	0.0322	0.0500	0.0199	0.0301	0.0369	0.0999	0.0963	0.0633	0.0403	0.0554
Vanadium	<0.20	<0.30	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.00550	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.0117	0.0127	0.00750	0.00290	0.00470
Zinc	85.5	89.7	69.1	45.0	47.2	55.1	68.2	62.4	36.7	27.9	59.6	45.4	44.3	51.3	43.9	30.0	34.6	43.4	43.8	41.2	41.6
Zirconium	-	-	-	-	-	-	-	-	<0.040	<0.040	<0.040	<0.040	<0.040	0.0410	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (continued)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)																					
	Doris South # 7	Doris South # 8	Little Roberts # 1	Little Roberts # 2	Little Roberts # 3	Little Roberts # 4	Little Roberts # 5	Little Roberts # 7	Little Roberts # 8	Reference B # 1	Reference B # 2	Reference B # 3	Reference B # 4	Reference B # 5	Reference B # 6	Reference B # 7	Reference B # 8	Reference D # 1	Reference D # 2	Reference D # 3	Reference D # 4	Reference D # 5
Sample ID	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10	Sep-10
ALS Sample ID	L930021-15	L930021-16	L930021-17	L930021-18	L930021-19	L930021-20	L930021-21	L930021-23	L930021-24	L930021-25	L930021-26	L930021-27	L930021-28	L930021-29	L930021-30	L930021-31	L930021-32	L930021-33	L930021-34	L930021-35	L930021-36	L930021-37
% Moisture	77.5	75.7	78.4	75.9	74.7	75.6	75.9	74.6	77.2	76.2	78.1	76.1	76.9	75.7	76.4	77.2	77.8	76.2	76.9	75.9	78.4	76.0
Metals (mg/kg ww)																						
Aluminum	8.57	16.5	2.72	9.17	35.8	2.63	14.7	29.0	7.54	1.29	1.29	2.68	7.77	15.4	12.1	14.3	1.24	5.70	1.81	5.40	23.5	10.4
Antimony	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Arsenic	0.0745	0.0805	0.0696	0.0901	0.107	0.100	0.0768	0.0930	0.0645	0.0459	0.0626	0.0720	0.0712	0.0390	0.0514	0.0693	0.0743	0.0456	0.0576	0.0497	0.0409	0.0486
Barium	1.38	1.28	0.902	1.10	1.37	1.04	1.06	1.09	1.30	1.78	2.10	2.12	2.57	2.35	2.83	2.94	3.31	1.62	1.22	1.82	1.29	1.07
Beryllium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Bismuth	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.00250	0.00270	0.00220	<0.0020	<0.0020	<0.0020	<0.0020	0.00210	<0.0020
Boron	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium	0.00290	0.00630	0.00820	0.0150	0.0152	0.00900	0.00830	0.0134	0.00920	0.0172	0.0211	0.0179	0.0346	0.0273	0.0222	0.0317	0.0123	0.00780	0.00960	0.00750	0.0112	0.0124
Calcium	10600	9720	9340	10600	9810	10100	8860	10900	11900	9650	10900	9230	11700	9580	10900	9630	11300	10700	9350	10200	5830	7230
Cesium	0.00250	0.00280	0.00210	0.00230	0.00410	0.00350	0.00280	0.00350	0.00180	0.0134	0.00780	0.00800	0.0102	0.00870	0.00940	0.00640	0.00700	0.00210	0.00170	0.00150	0.00300	0.00200
Chromium	0.0350	0.0440	0.0230	0.0280	0.108	0.0230	0.0530	0.0910	0.0450	0.0210	0.0130	0.0160	0.0310	0.0450	0.0330	0.0610	0.0110	0.0400	0.0170	0.0230	0.0520	0.0310
Cobalt	0.0192	0.0274	0.0247	0.0209	0.0399	0.0265	0.0303	0.0356	0.0221	0.0218	0.0197	0.0273	0.0490	0.0438	0.0292	0.0607	0.0163	0.0245	0.0179	0.0227	0.0425	0.0197
Copper	0.737	0.832	0.680	0.719	0.919	1.05	0.751	0.920	0.794	0.880	1.07	0.936	1.21	1.01	0.871	1.37	1.00	0.872	0.814	0.992	0.884	1.07
Gallium	<0.0040	0.00550	<0.0040	<0.0040	0.0131	<0.0040	0.00690	0.0102	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.00540	0.00410	0.00430	<0.0040	<0.0040	<0.0040	<0.0040	0.00810	<0.0040
Gold	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	34.1	43.2	27.5	35.6	111	29.2	55.9	91.3	32.3	27.9	20.7	38.6	38.0	52.4	49.3	54.1	43.6	35.3	29.3	40.8	79.8	45.3
Lead	0.00810	0.0301	0.00710	0.0238	0.0198	0.00620	0.0134	0.0307	0.0163	0.00890	0.0111	0.00750	0.00930	0.0178	0.0235	0.0123	0.0150	0.00760	0.0406	0.0269	0.0207	0.0141
Lithium	<0.020	0.0260	<0.020	<0.020	0.0550	<0.020	0.0260	0.0350	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.0280	<0.020
Magnesium	414	442	427	431	462	553	486	462	427	471	440	419	485	409	447	488	448	446	437	451	350	408
Manganese	19.6	15.2	11.6	13.9	22.3	16.1	15.0	21.1	21.5	7.01	9.23	7.95	11.3	6.92	8.18	7.00	8.46	13.2	9.85	11.2	6.17	7.77
Mercury	0.0413	0.0490	0.0515	0.0421	0.0290	0.0391	0.0334	0.0405	0.0506	0.0575	0.0377	0.0592	0.0560	0.0522	0.0482	0.0452	0.0700	0.0361	0.0443	0.0337	0.0347	0.0331
Molybdenum	0.0260	0.0267	0.0343	0.0394	0.0390	0.0354	0.0312	0.0364	0.0302	0.0235	0.0243	0.0277	0.0255	0.0303	0.0272	0.0274	0.0303	0.0306	0.0350	0.0271	0.0296	0.0261
Nickel	0.0240	0.0540	0.0220	0.0370	0.0700	0.0190	0.0380	0.0570	0.0320	0.0190	0.0190	0.0270	0.0360	0.0590	0.0290	0.0420	0.0180	0.0290	0.0300	0.0330	0.0520	0.0370
Phosphorus	7710	7230	6890	7610	7080	7060	6620	7940	8210	7120	7810	6980	8240	7210	8190	6900	8150	7840	7200	7370	5220	5840
Potassium	3450	3470	3470	3280	3280	3290	3230	3480	3210	3100	3130	3230	3270	3340	3520	3300	3320	3680	3350	3230	3290	3370
Rhenium	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Rubidium	1.59	1.46	1.37	1.35	1.52	1.68	1.47	1.56	1.44	3.84	3.45	4.11	3.13	3.29	3.30	3.10	4.09	2.39	2.66	2.20	2.26	2.37
Selenium	0.215	0.246	0.205	0.194	0.213	0.276	0.199	0.206	0.201	0.314	0.395	0.445	0.459	0.322	0.335	0.299	0.389	0.261	0.267	0.255	0.237	0.237
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	1440	1440	1380	1420	1240	1250	1200	1370	1250	1240	1240	1370	1470	1430	1440	1380	1500	1350	1220	1170	1300	1310
Strontium	11.7	9.14	11.0	13.2	12.8	11.8	10.2	12.4	14.3	9.97	12.0	9.72	12.0	10.8	12.5	10.0	11.3	15.1	13.2	15.1	9.01	9.62
Tellurium	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
Thallium	0.00175	0.00209	0.00193	0.00256	0.00308	0.00230	0.00235	0.00276	0.00242	0.00433	0.00426	0.00462	0.00693	0.00498	0.00567	0.00452	0.00542	0.00358	0.00281	0.00235	0.00300	0.00244
Thorium	0.00300	0.00660	<0.0020	0.00360	0.0191	<0.0020	0.00630	0.0119	0.00240	<0.0020	<0.0020	<0.0020	0.00240	0.00640	0.00550	0.00590	<0.0020	0.00250	<0.0020	0.00230	<0.0020	<0.0020
Tin	<0.0040	<0.0040	<0.0040																			

Notes:
ww = wet weight
(-) = not available

Appendix V6-5C. Concentrations of Contaminants of Potential Concern in Fish Tissue Samples Collected during the Baseline Monitoring Program (completed)

Species Name	Ninespine Stickleback (<i>Pungitius pungitius</i>)		
	Reference D # 6	Reference D # 7	Reference D # 8
Sample ID			
Date Sampled	Sep-10	Sep-10	Sep-10
ALS Sample ID	L930021-38	L930021-39	L930021-40
% Moisture	74.5	76.6	74.1
Metals (mg/kg ww)			
Aluminum	2.68	1.52	1.54
Antimony	<0.0020	<0.0020	<0.0020
Arsenic	0.0369	0.0328	0.0443
Barium	1.32	1.09	1.04
Beryllium	<0.0020	<0.0020	<0.0020
Bismuth	<0.0020	<0.0020	0.0020
Boron	<0.20	<0.20	<0.20
Cadmium	0.00960	0.00600	0.00780
Calcium	9150	9120	8710
Cesium	0.00200	0.00220	0.00150
Chromium	0.0160	0.0130	0.0160
Cobalt	0.0174	0.0176	0.0176
Copper	0.768	0.918	0.843
Gallium	<0.0040	<0.0040	<0.0040
Gold	-	-	-
Iron	30.5	31.0	27.9
Lead	0.00640	0.00620	0.0243
Lithium	<0.020	<0.020	<0.020
Magnesium	418	442	375
Manganese	11.4	9.21	9.10
Mercury	0.0458	0.0452	0.0496
Molybdenum	0.0280	0.0268	0.0336
Nickel	0.0260	0.0210	0.0330
Phosphorus	7070	6800	6730
Potassium	3570	3420	3510
Rhenium	<0.0020	<0.0020	<0.0020
Rubidium	2.03	2.54	2.06
Selenium	0.226	0.196	0.252
Silver	-	-	-
Sodium	1470	1360	1310
Strontium	12.0	13.0	12.6
Tellurium	<0.0040	<0.0040	<0.0040
Thallium	0.00268	0.00235	0.00291
Thorium	<0.0020	<0.0020	<0.0020
Tin	<0.0040	0.0055	<0.0040
Titanium	0.129	0.0490	0.0500
Uranium	0.00560	0.00513	0.00544
Yttrium	0.0466	0.0527	0.0423
Vanadium	<0.0020	<0.0020	<0.0020
Zinc	39.4	37.4	37.6
Zirconium	-	-	-

Notes:
ww = wet weight
(-) = not available