Submission to Nunavut Impact Review Board

Mary River Project – Early Revenue Phase

Response to Technical Meetings November 26-28, 2013

Commitment # 16

Discussion of albedo effects of dust fall at Milne Port and spring melt patterns in Milne Inlet.

December 20, 2013

From the Technical Review Meetings at the end of November 2013, Baffinland has committed "*to provide DFO with its prediction of the timing and extent of the albedo effects of dustfall at Milne Port and to incorporate a description of melt-out patterns in the Milne Inlet area by December 25, 2013".*

The following response has been prepared on behalf of Baffinland to address this commitment.

A. Predicted pattern and albedo effect of dust deposition

Albedo is the proportion of incident light that is reflected by a surface and ranges from 0 (material that wholly absorbs incident light) to 1 (material that wholly reflects the incident light). Sea ice can have a relatively high albedo, ranging from 0.7 to 0.9 in the visible light spectrum (e.g. Light et al., 1998) but can be lowered by the accumulation of particulates, which increase the absorptive properties of the ice.

Dust deposition as a result of the activities of the Early Revenue Phase of Baffinland's Mary River Project has the potential to reduce the albedo of sea ice in the vicinity of Milne Inlet. Annual dust deposition has been modeled for Milne Inlet for both the marine and terrestrial environments and presented in the FEIS addendum Volume 5, Figure 5-2.12. The total modeled area of deposition in the marine environment is $<6 \times 10^6$ m^2 (< 600 ha.) with deposition rates ranging from 1 to 500 g m^{-2} y^{-1}. Approximately 80% of this area of deposition is modeled to have a deposition rate of <10 g m^{-2} y^{-1}. The weighted average deposition rate for the marine environment at Milne Inlet has been calculated to be 13.07 g m^{-2} y^{-1}, giving an estimated mean annual dust layer thickness of 0.003 mm. Even at the highest modeled deposition rate, annual dust thickness would only be 0.115 mm (FEIS Addendum Volume 8, Table 8-3.17).

The dust layer thickness estimates are considered to be quite conservative since neither wind nor snowfall have been taken into account. For example, during the ice covered season snow cover is expected to be 5 to 25 cm (Table1). It is likely that dust thickness would never reach estimated values as it would be distributed throughout the snow layers.

Furthermore, several studies have found that particle size is important when discussing albedo effects of dust deposition. Light *et al.* (1998) conducted several studies to investigate the effect of particulates on the spectral albedo of sea ice and found that particles with radius (R) >30μm have little effect on bulk optical properties of sea ice. Volume 5, Section 2.6.3.2 of the FEIS states that over 99% of ore from the Mary River Project will consist of particles with radius (R) >37μm (>74μm in diameter). This suggests that, regardless of the thickness of the dust layer, such large particles will not measurably alter the albedo of the ice.

Table 1: Modeled mean rate of dust deposition, mean dust thickness and snow cover in the marine environment of Milne Inlet.

Mean Rate of Dust Deposition (g m^{-2} y^{-1})	Mean Annual Thickness of Dust (mm)	Snow Cover (cm)
13.07 [a]	0.003 [a,b]	5 – 25 [c]

a. SEE FEIS ADDENDUM ERRATUM VOLUME 8, TABLE 8-3.17.
b. CALCULATIONS ARE BASED ON AN ESTIMATED SPECIFIC GRAVITY OF 4.36 g/cm^3 FOR THE DUST PARTICLES.
c. SEE FEIS APPENDIX 3G: ICE AND MARINE SHIPPING ASSESSMENT.

B. The Natural Pattern of Ice Melt in Milne Inlet

The melt patterns for Milne Inlet were reviewed for the past 10 years (from 2004 to 2013) using the Canadian Ice Service weekly charts of ice concentration for Milne Inlet, Pond Inlet and Eclipse Sound. There is a consistent pattern of early melt at Milne Inlet compared to the rest of the region; each year, the area around the Milne Port location has melted out well before the rest of the fast ice in the area (Figure 1). This is due to the 20-day freshet experienced at Milne Inlet from Phillips Creek (described in the FEIS Addendum Vol. 8, 3.5.2.4).

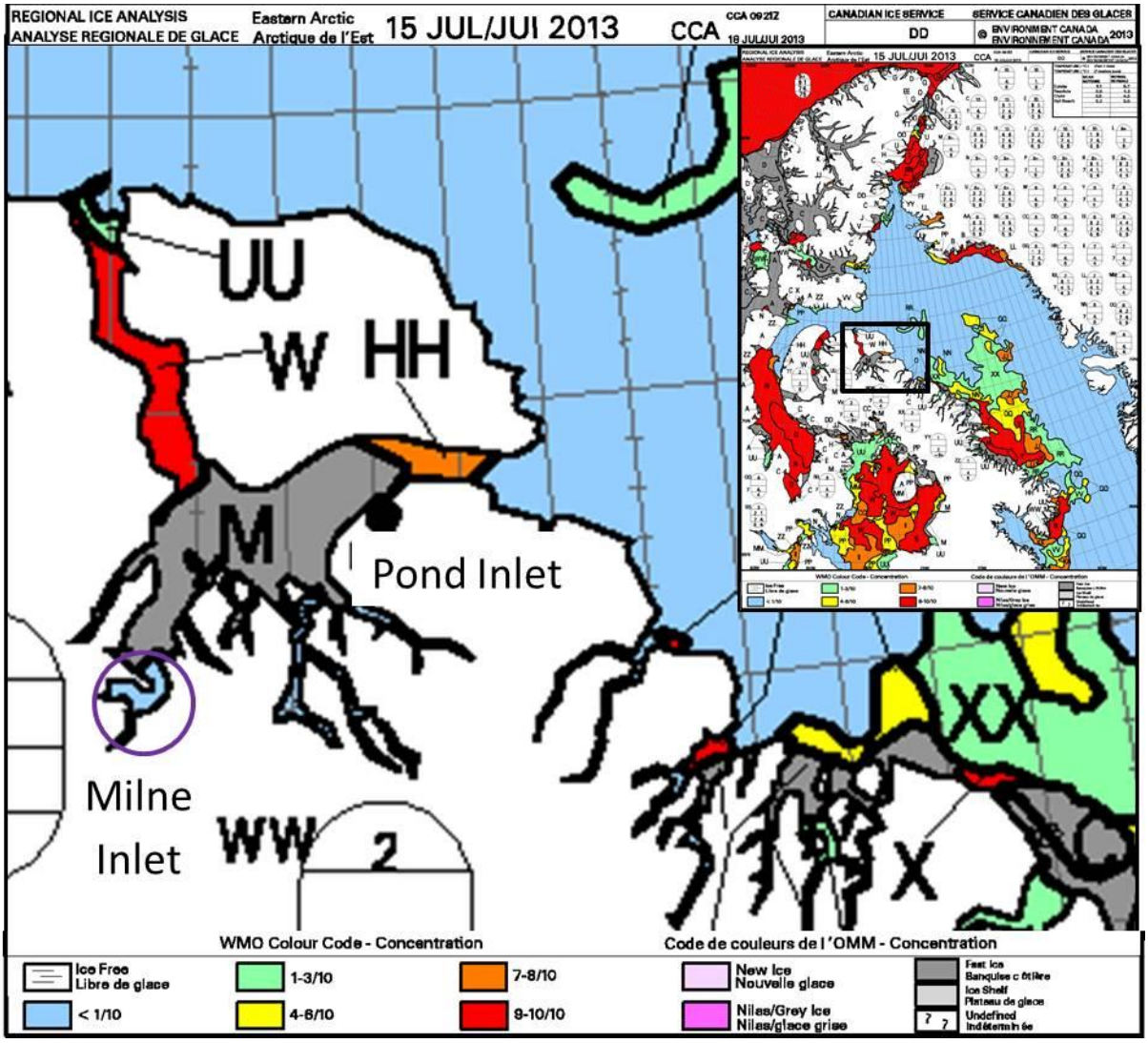

Figure 1. Weekly Regional Ice Chart (Canadian Ice Service, Eastern Arctic Region) for the week of July 15, 2013 – a representative chart of the last 10 years of ice concentration data showing early melting in Milne Inlet.

This melting pattern at Milne Inlet, relative to the rest of the Regional Study Area (RSA) occurs over the course of a week, usually beginning mid-July but ranging anywhere from July 9 to July 26. This melt is induced by the heat from Phillips Brook freshwater discharge. As a result, in-situ melting that might be affected by dust deposition is not a factor.

Conclusions

Dust Deposition is unlikely to affect albedo due to the low estimate of dust layer thickness, the large particle size, and the expected snowfall and wind conditions. In any case, spring melt at Milne Inlet results from Phillips Brook freshet, and not from the in-place melting of ice.

References

Light, B., Eicken, H., Maykut, G. A., Grenfell, T. C., 1998. The effect of included particulates on the spectral albedo of sea ice. Journal of Geophysical Research, 103(C12): 27,739-27,752.