APPENDIX L

Development of a Molybdenum Screening Value for the Impact Assessment

TECHNICAL MEMORANDUM

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TO Dale Reimer, General Manager
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DEVELOPMENT OF A MOLYBDENUM SCREENING VALUE FOR THE IMPACT ASSESSMENT

Golder Associates Ltd. is pleased to provide Mount Polley Mining Corporation with the following technical memorandum describing the approach adopted to develop a screening value for molybdenum as a component of the impact assessment in support of the permit amendment application for a long-term water discharge system under the *Environmental Management Act* for Permit 11678 for the Mount Polley Mine (the Mine). The following analysis is intended to support Operations and Closure planning for the Mine.

1.0 INTRODUCTION

Molybdenum is an essential trace metal required for adequate mammalian nutrition; however, high concentrations in diet or drinking water can result in molybdenosis (Eisler 1989). Molybdenosis is a copper-deficiency disease, which is caused by the depressing effect of molybdenum on the physiological availability of copper (Erdmen et al. 1978). Ruminants, in particular cattle, have been shown to be the most sensitive mammals to molybdenosis (Erdman et al. 1978; Ward 1978; Swain 1986; Eisler 1989). Symptoms of molybdenosis in cattle are diarrhea, weight loss, depigmentation, reproductive impairment, alteration of endocrine and pituitary systems, impaired immune function, fragile bones, and occasionally death (Anke et al. 2010; Swain 1986; Telfer et al. 2004). Molybdenum related toxicity is more frequently observed in animals when the copper to molybdenum ratio in their diet is low (Swain 1986).

The BC water quality criteria for molybdenum protective of livestock and wildlife water supply derived according to rationale provided in Swain (1986) is not based on toxicological effects. Therefore, it is not a useful screening value for evaluating the potential for effects on these receptors due to predicted changes in water quality. To support the impact assessment, a screening value was developed based on a literature review of the toxicity of molybdenum to livestock and wildlife focusing on exposure from drinking water. A summary of the results is presented below.

2.0 TOXICITY OF MOLYBDENUM IN DRINKING WATER TO LIVESTOCK AND MAMMALIAN WILDLIFE

Available molybdenum toxicity data have been summarized by the US Fish and Wildlife Service (Eisler 1989). The majority of the studies on effects of molybdenum to mammals have been conducted on livestock (primarily cattle and sheep), and only one livestock study (Kincaid 1980) exposed the study animals to molybdenum via drinking water. Kincaid (1980) exposed calves to 0, 1, 10, and 50 mg/L ammonium molybdenum (less than 1, 1, 8, and 53 mg/L molybdenum) in drinking water for 21 days. Calves were fed a diet containing 0.29% sulfur, 13 mg/L copper, and less than 1 mg/L molybdenum. The study showed no effect on liver and plasma copper levels, growth, or food and water consumption up to 10 mg/L ammonium molybdenum (Kincaid 1980). Calves exposed to the highest dose (50 mg/L ammonium molybdenum) showed a shift in the copper distribution in blood and copper bioavailability. The study concluded that toxic effects of molybdenum to calves exposed via drinking water was at a concentration between 10 and 50 mg/L ammonium molybdenum (Kincaid 1980). The US Fish and Wildlife Service proposed a molybdenum criteria for the protection of cattle (the most sensitive mammal) exposed via drinking water of less than 10 mg/L based on the minimum toxic concentration between 10 and 50 mg/L for calves from the Kincaid (1980) study (Eisler 1989).

Toxicity data on molybdenum effects to mammalian wildlife is limited, although the available data suggest that domestic livestock are at greater risk (Swain 1986; Eisler 1989). In addition, Swain (1986) suggested that wildlife would be less susceptible to molybdenosis than livestock because wildlife are not confined to one area and will forage from a variety of food sources. The most relevant exposure route for molybdenum uptake by wildlife ruminants, such as deer and moose, is through their plant-based diet rather than directly via drinking water (Swain 1986).

A mule deer (*Odocoileus hemionus*) study showed that this species was at least 10 times more tolerant to high levels of dietary molybdenum than domestic ruminants (Nagy et al. 1975). Female mule deer showed no apparent effects after 33 days on diets containing up to 200 mg Mo/day, or after 8 days at 1,000 mg Mo/day. Only slight effects such as a reduction in food intake and some animals with diarrhea were observed at diets of 2,500 mg Mo/day for 25 days (Nagy et al. 1975). Dietary concentrations of 5,000 and 7,500 mg Mo/day resulted in a reduction in food intake; however, recovery began almost immediately once the animals were switched back to an uncontaminated diet (Nagy et al. 1975).

3.0 PROPOSED SCREENING VALUE FOR MOLYBDENUM

Based on the available toxicity data for molybdenum discussed above, effects to livestock occur between 10 and 50 mg/L and effects to wildlife are at even higher molybdenum concentrations. As a result of this literature review, the aquatic life 30-day guideline of 1 mg/L was compared to predicted concentrations at the initial dilution zone of Quesnel and Bootjack Lakes. Based on the available information, this guideline was considered protective of other receiving environment uses including potential effects on livestock and wildlife.

4.0 CLOSURE

We trust that the information provided in this technical memorandum is sufficient for your present needs. If you have any questions, please do not hesitate to contact the undersigned at (604) 296-4200.

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Attachment: Study Limitations

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