Northwest Territories Environment and Natural Resources

June 25, 2015

Julian Morse
Regulatory Officer
Mackenzie Valley Land and Water Board
7th Floor – 4910 50th Avenue
P.O. Box 2130
Yellowknife, NT
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Dear Mr. Morse,

Re: **North American Tungsten Corp. Ltd.**
Water Licence - MV2015L2-0003
Information Request to GNWT
Flouride – Request to Provide MacDonald/Sinclair Paper

The Department of Environment and Natural Resources has reviewed the information request at reference based on its mandated responsibilities under the *Environmental Protection Act*, the *Forest Management Act*, the *Forest Protection Act, Waters Act* and the *Wildlife Act* and provides the requested document for the consideration of the Board. It should be noted by the proponent and the Board that this manuscript has been accepted for publication; however, it is still in final editing with the journal and therefore still appears in draft form.

Should you have any questions please contact Patrick Clancy, Environmental Regulatory Analyst, at (867) 920-6118 or email patrick_clancy@gov.nt.ca.

Sincerely,

Patrick Clancy
Environmental Regulatory Analyst
Environmental Impact Assessment Section
Conservation, Assessment and Monitoring Division
Department of Environment and Natural Resources
Government of the Northwest Territories

Att: MacDonald/Sinclair Paper

Running Head: Letter to the editor

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Letter to the editor

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To the editor:

McPherson et al. [1] have proposed a chronic effects benchmark for fluoride to protect aquatic life in freshwater. While the Canadian Council of Ministers of the Environment (CCME) have developed an interim water quality guideline (WQG) for the protection of aquatic life for fluoride [2], the WQG was developed by applying a safety factor to the most sensitive median lethal concentration (LC50) from the results of acute exposure tests compiled during the WQG derivation process [2]. Specifically, the reported 144-h LC50 estimate for the caddisfly, *Hydropsyche bronta*, from Camargo et al. [3] of 11.5 mg/L F^- was divided by a safety factor of 100, resulting in an interim WQG of 0.12 mg/L F^-. Given the uncertainty associated with the level of protection associated with the interim CCME WQG (i.e., derived using acute toxicity data), McPherson et al. [1] compiled and evaluated toxicological data generated on the effects of fluoride during chronic exposures with multiple aquatic species. Subsequently, the authors proposed a chronic effects benchmark of 1.94 mg/L F^-.

McPherson et al. [1] compiled a robust dataset for evaluating the effects of fluoride during chronic exposure. However, we have concerns with the approach used to treat the compiled data prior to developing the species sensitivity distribution (SSD) and with the selection of an appropriate model to describe the SSD. In the present study, we present an alternative chronic effects benchmark that was developed using the data compiled in McPherson et al. [1] and using methods consistent with the guidance provided by the CCME. The resultant benchmark offers a level of protection that is consistent with the narrative intent of the Canadian Water Quality Guidelines for the protection of aquatic life [4].

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The CCME has developed guidance for deriving WQGs in Canada using the SSD approach [4]. The guidance developed by CCME describes the process for determination of preferred statistical endpoints (e.g., 10% effective/inhibitory concentration; EC/IC10) for use in the SSD. Included in this guidance is the statement that "multiple comparable records for the same [statistical] endpoint are to be combined by the geometric mean of these records to represent the averaged species effects endpoint" [4]. While no guidance is provided by CCME for identifying comparable records (e.g., in terms of experimental conditions), the guidance is clear that the intent is to combine the same statistical endpoint [4]. In two cases, McPherson et al. [1] combined multiple statistical endpoints to derive species mean chronic values for use in the SSD (Table 1). For rainbow trout, an LC10 estimate of 4.8 mg/L F^- and an LC20 estimate of 2.0 mg/L F^- were combined to establish a species mean chronic value of 3.1 mg/L F^-. For the fathead minnow, an IC25 of 72 mg/L F^- and an IC10 of 14.6 mg/L F^- were combined to establish a species mean chronic value of 32.4 mg/L F^-. Following CCME guidance, the LC20 of 2.0 mg/L F^- for rainbow trout, and the IC10 of 14.6 mg/L F^- for the fathead minnow are appropriate endpoint estimates for use in the SSD. To evaluate the impact of combining the statistical endpoint estimates for the two species, the SSD was redeveloped using appropriate endpoints (i.e., the LC20 of 2.0 mg/L F^- for rainbow trout and the IC10 of 14.6 mg/L F^- for fathead minnow; Table 1). The resultant 5% hazardous concentration (HC5) estimates ranged from 0.35 mg/L F^- to 1.81 mg/L F^- , using the refined toxicological dataset, while the HC5 estimates using the dataset presented in McPherson et al. [1] ranged from 0.45 mg/L F^- to 1.94 mg/L F^- (Table 2).

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In addition, McPherson et al. [1] do not provide a transparent approach to selection of an appropriate model to describe the SSD. While McPherson et al. [1] used the CCME SSD Master software (Version 3.0) [5], a summary of the model results for the 4 valid distribution functions (i.e., normal, logistic, extreme value, and Gumbel models) was not provided. To evaluate the model selection procedure, the original and refined toxicological datasets were run through SSD Master Version 3.0 [5]. A comparison of the model results for both datasets is provided in Table 2. McPherson et al. [1] state that the best fit from the valid models was selected based on the Anderson-Darling goodness-of-fit test. However, all valid models passed the Anderson-Darling goodness-of-fit test. Furthermore, the Anderson-Darling statistic for the Gumbel model selected by McPherson et al. [1] was higher than that for the other three models, inferring a worse fit in the tails relative to the other models (Table 2) [4]. Finally, the mean squared error (MSE) in the lower tail of the distribution was lower in both the normal (0.0151) and logistic models (0.0171) relative to the Gumbel model (0.0180). Given these results, a more appropriate model for describing the SSD would be the normal model, resulting in an HC_5 estimate of 1.03 (0.72 - 1.49) mg/L F^- (Table 2).

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The results of the present evaluation demonstrate that the authors' selection of species mean chronic values for use in the SSD is not consistent with the intent of the CCME guidance [4]. By combining statistical endpoints for different effects levels (i.e., combining an LC10 with an LC20 estimate and an IC10 with an IC25 estimate), the authors have calculated no-effects thresholds for fluoride that may not be protective of the tested receptors. This is inappropriate because relevant thresholds were available in the literature. In addition, information on the model results for all valid SSD models were not provided in McPherson et al. [1]. The results of the present review suggest that the normal model (Figure 1) is a more appropriate model to describe the fluoride SSD based on both the MSE in the lower tail and the Anderson-Darling statistic (Table 2). An alternative chronic effects benchmark of 1.03 mg/L F^- is proposed. The HC5 derived using the refined dataset and appropriate model offers a level of protection for aquatic life that is equivalent to that of a CCME water quality guideline.

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LIST OF FIGURES

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Table 1. Comparison of endpoint estimates used in McPherson et al. [1] and the refined toxicological dataset used to develop an alternative chronic effects benchmark using the species sensitivity distribution (SSD) approach.

		McPherson *et al.* [1]		Refined dataset	
Test species	Reference	Endpoint	Endpoint estimate (mg/L F^-)	Endpoint	Endpoint estimate (mg/L F^-)
Hyalella azteca	Pearcy[a]	IC10	1.8	IC10	1.8
Musculium transversum	[6]	MATC	2.25	MATC	2.25
Oncorhynchus mykiss	[7/8]	LC20/LC10	3.1[b]	LC20	2.0
Potamopyrgus antipodarum	[9]	MATC	6.6	MATC	6.6
Acipenser baerii	[10]	IC10	7.7	IC10	7.7
Chironomus dilutus	Pearcy[a]	IC20	8.2	IC20	8.2
Ceriodaphnia dubia	Pearcy[a]	IC10	10.6	IC10	10.6
Cyprinus carpio	[7]	LC20	25	LC20	25
Daphnia magna	[11]	IC10	27.7	IC10	27.7
Pimephales promelas	[7/ Pearcy[a]]	IC25/IC10	32.4[c]	IC10	14.6
Synechococcus leopoliensis	[12]	EC13	50	EC13	50
Alasmidonta raveneliana	[13]	IC10	91	IC10	91
Chlorella vulgaris	[14]	IC11	95	IC11	95
Lemna minor	Pearcy[a]	IC10	125	IC10	125
Salvelinus namaycush	Pearcy[a]	IC10	> 134	IC10	> 134
Pseudokirchneriella subcapitata	Pearcy[a]	IC10	195	IC10	195

[a] K.L. Pearcy, Nautilus Environmental, Burnaby, British Columbia, Canada, unpublished manuscript.

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[b] Calculated as the geometric mean of the LC20 of 2.0 mg/L F^- [7] and the LC10 of 4.8 mg/L F^- [8].

[c] Calculated as the geometric mean of the IC25 of 72 mg/L F^- [7] and the IC10 of 14.6 mg/L F^- [5].

IC*x* = *x*% inhibitory concentration; MATC = maximum allowable toxicant concentration; LC*x* = x% lethal concentration; EC*x* = *x*% effective concentration.

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Table 2. Species sensitivity distribution (SSD) model results using the endpoint estimates provided in McPherson *et al.* [1] and the refined toxicological dataset presented in Table 1.

	McPherson et al. [1]			Refined dataset		
Model	HC5 (conf. interval)	MSE lower tail	Anderson-Darling statistic	HC5 (conf. interval)	MSE lower tail	Anderson-Darling statistic
Normal	1.19 (0.83-1.70)	0.0151	0.298	1.03 (0.72-1.49)[b]	0.0131	0.311
Logistic	0.93 (0.46-1.91)	0.0171	0.332	0.81 (0.39-1.69)	0.0142	0.337
Extreme Value	0.45 (0.18-1.17)	0.0212	0.313	0.35 (0.12-1.04)	0.0243	0.357
Gumbel	1.94 (0.89-4.24)[a]	0.0180	0.389	1.81 (0.86-3.77)	0.0147	0.405

[a] Chronic effects benchmark proposed in McPherson et al. [1].

[b] Alternative chronic effects benchmark based on the refined toxicological dataset and best-fitting model reported by SSD Master Version 3.0 [5].

HC5 = 5% hazardous concentration; MSE = mean squared error.

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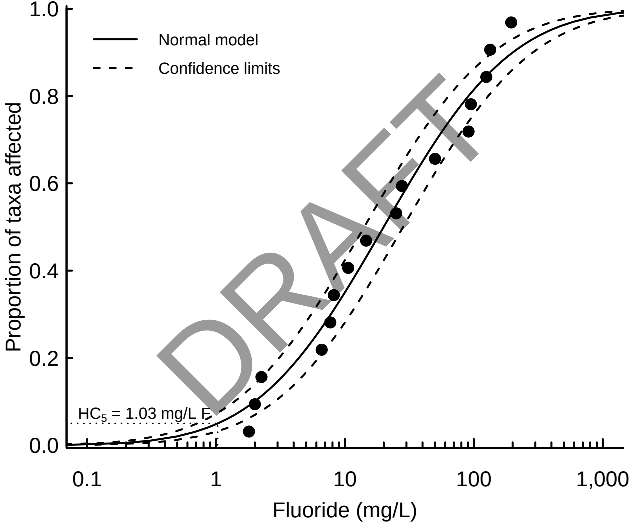

Normal model
Confidence limits
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HC$_5$ = 1.03 mg/L F
Proportion of taxa affected
1.0
0.8
0.6
0.4
0.2
0.0
0.1
1
10
100
1,000
Fluoride (mg/L)