CEAA 41

Initial Reviewer Question (HC-IR-5 Round 1 Part 2)

In Table 2.4, the toxicity reference value (TRV) presented for chromium is a total chromium value and not representative of the most toxic form of chromium to humans (i.e. hexavalent chromium or [Cr VI] which is a carcinogen via inhalation). The assumption that any increases in chromium are "total Cr" instead of Cr VI may underestimate potential health risks associated with exposure to Cr VI (if present).

In addition, the mercury value presented is for inorganic mercury and not representative of the most toxic form of mercury to humans (i.e. methyl mercury).

If a specific contaminant species is not known, the most conservative approach is to assume that the substance is in its most toxic form and to evaluate the potential health risks associated with the most toxic form.

CEAA Follow-up

In reviewing the response to CEAA 41 (Round 1 – Part 2), it is not clear that the full range of potential human health risks posed by chromium arising from the Project have been adequately assessed. This information is needed to assess the effects to the health of Indigenous peoples.

Health Canada has advised the Agency that with respect to chromium (Cr), the proponent's statement that the toxicity reference value (TRV) for total Cr that it is based on 1/7th of total Cr being Cr VI is correct. The ratio used in deriving the guideline value was based on a specific industrial source where chromium was analysed and speciated and 1/7 of that chromium was Cr VI, thus for that particular industrial release, 1/7 was the ratio. This is not necessarily the case for other sources/releases of chromium given the different ways chromium is released and transformed in different environments. Health Canada is currently in the process of updating the guidance document which will provide a summary of recommended TRVs to be used for federal contaminated sites in the near future.

In order to be conservative in the evaluation of chromium with respect to human health, Cr should be assumed to be 100% Cr VI in the HHRA (unless it can be justified otherwise, such as by speciating Cr or providing literature references to indicate the likelihood of the Cr present to be Cr VI).

Specific Request to Address Comment

Provide a revised human health risk analysis for chromium where Cr is assumed to be 100% Cr VI in the assessment, or provide a rationale that the form of Cr expected to be present is one or more less toxic forms of Cr (e.g. Cr III).

AECOM Response

As previously communicated, Health Canada's TRV assumes 1/7th of the total Chromium to exist as hexavalent chromium, and the TDI is based on hexavalent chromium exposure to occupationally exposed individuals. Similarly, the inhalation cancer slope factor published by Health Canada (Health Canada 2010). Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0) is based on hexavalent chromium and assumes 1/7th of total Cr is hexavalent (i.e., the slope factor potency numerically reflects that Cr+6 is present as 1/7th). Use of the total Cr cancer slope factor therefore inherently assess a cancer risk from hexavalent chromium assuming 1/7th of the total chromium is present as the hexavalent form.

Health Canada has requested that AECOM consider the use of 100% hexavalent chromium composition in the absence of specific information. This request is in opposition to Health Canada's written guidance policies, as well as being contradictory to the environmental chemistry of chromium. AECOM respectfully declines the request to assume anything greater than 1/7th Cr6+ on the following grounds:

1. **Site-Specific Empirical Data:** Site-specific soils collected from adjacent to the haul road, and therefore influenced by local and mineral extraction activities, were submitted to Maxxam Analytical on January 21 2017 for analysis of strong acid extractable chromium (EPA Method EPA 6020B m) and hexavalent chromium by ion chromatography (EPA Method 3060/7199 m). Concentration of strong acid extractable Cr in soils tested ranged from 16 to 47 mg/kg. Maximum values exceed the assumed concentration of Cr used for assessing particulate inhalation risks in the risk assessment report, which provides confidence that the material tested are likely to be representative of the particulates being modelled in the project and cumulative assessment of the HHRA. Concentrations of hexavalent chromium were below the reportable detection limit of the method (<0.2 mg/kg). **Hexavalent chromium represents <1% of the total chromium for site specific soils impacted by mineral extraction activities.**

2. **Natural versus Anthropogenic Form:**

    a. Natural geologic materials typically contain very little hexavalent chromium, and are predominantly composed of the Cr(III) valence state. Cr(III) is the thermodynamically stable valence state under ambient redox and temperature conditions. Cr(VI) is thermodynamically unstable, acting as a strong oxidizing agent. Cr(VI) rarely occurs naturally due to its high affinity for reaction with organic carbon or other reducing substances, reducing to Cr(III) [1],[2].

    b. Releases of Cr(VI) to the natural environment are due almost entirely to human industrial activities such as metal plating, disposal of chromium containing industrial by products and coal ash. Cr. Combustion sources such as industrial and commercial fuel combustion represent important anthropogenic sources to the atmosphere.

    c. Natural geologic materials are known to be nearly exclusively composed of Cr(III), with the exception of some oxidised near surface materials[3], for example chromite ore extraction. The mining and milling of iron ore deposits proposed for the Howse Project are not considered to be a potential source of of hexavalent chromium.

3. **Published Literature Values**: Average proportion of hexavalent chromium in a study of house dust in a highly industrialized urban environment, where combustion sources of hexavalent chromium are prevalent, has been measured to be 12%.[4] This suggests an upper bound of hexavalent proportion near chromium electroplating industries is ~1/7th, a value which is likely to overestimate the proportion of hexavalent chromium in natural geologic materials, and which is inappropriate for naturally encountered chromium.

Based on the above, it is AECOMs position that the Health Canada (2010) toxicological reference values, which are based on occupational exposure to hexavalent chromium, and assume 1/7th (14%) of total chromium as the toxicologically important hexavalent form, maintain an adequate if not enhanced level of conservatism in the HHERA as presented. No additional risk estimates are therefore calculated assuming 100% hexavalent chromium composition. Calculated lifetime incremental cancer risks for a composite receptor (as communicated in AECOMs Errata to the risk assessment technical report [date TBD] and presented below) are therefore conservative and sufficiently protective in their application. No unacceptable risks as a result of exposure to chromium are predicted (i.e., all predicted health risk. associated with chromium are considered negligible).

[1] Basu, D., K. Blackburn, B. Harris, M. Neal, AND F. Stoss. HEALTH ASSESSMENT DOCUMENT FOR CHROMIUM. FINAL REPORT. U.S. Environmental Protection Agency, Washington, D.C., EPA/600/8-83/014F.
[2] Canadian Council of Ministers of the Environment. 1999. Canadian soil quality guidelines for the protection of environmental and human health: Chromium (total 1997) (VI 1999). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg
[3] Burns, V.M. and Burns, R.G. (1975) Mineralogy of chromium. Geochimica et Cosmochimica Acta, 39, 903–910.
[4] Lioy P. J., Gochfeld, M., Fan Z., Shalat S., Black K., and Lin L. Final Report submitted to NJDEP: Chromium Exposure and Health Effects in Hudson County: Phase I. November, 2008.

COPCs/Exposure Scenario	Inhalation Cancer Slope Factor (mg/kg bw/day)-1	Revised Total Inhalation Dose (mg/kg bw/day)				Weighted Cancer Risk Estimate				REVISED TOTAL INHALATION ILCR	Incremental Change from Baseline
		Toddler	Child	Teen	Adult	Toddler	Child	Teen	Adult		
		Fraction of 80 yr. lifetime				Fraction of 80 yr. lifetime					
		0.06	0.09	0.1	0.75	0.06	0.09	0.1	0.75		
Baseline											
Arsenic	27	2.16E-08	1.89E-08	1.12E-08	1.00868E-08	3.50E-08	4.60E-08	3.03E-08	2.04E-07	3.16E-07	NA
Berylium	7.3	7.44E-10	6.52E-10	3.87E-10	3.47496E-10	3.26E-10	4.29E-10	2.82E-10	1.90E-09	2.94E-09	NA
Chromium	46	3.85E-08	3.37E-08	2.00E-08	1.79571E-08	1.06E-07	1.40E-07	9.19E-08	6.20E-07	9.57E-07	NA
Project											
Arsenic	27	6.33E-08	5.55E-08	3.29E-08	2.95519E-08	1.03E-07	1.35E-07	8.88E-08	5.98E-07	9.25E-07	6.09E-07
Berylium	7.3	3.38E-09	2.96E-09	1.75E-09	1.57587E-09	1.48E-09	1.94E-09	1.28E-09	8.63E-09	1.33E-08	1.04E-08
Chromium	46	9.32E-08	8.16E-08	4.84E-08	4.34793E-08	2.57E-07	3.38E-07	2.23E-07	1.50E-06	2.32E-06	1.36E-06
Cummulative											
Arsenic	27	1.66E-07	1.45E-07	8.61E-08	7.73707E-08	2.69E-07	3.53E-07	2.32E-07	1.57E-06	2.42E-06	2.11E-06
Berylium	7.3	9.44E-09	8.27E-09	4.90E-09	4.40511E-09	4.13E-09	5.43E-09	3.58E-09	2.41E-08	3.73E-08	3.43E-08
Chromium	46	2.34E-07	2.05E-07	1.22E-07	1.09263E-07	6.46E-07	8.49E-07	5.59E-07	3.77E-06	5.82E-06	4.87E-06