December 9, 2021

David Livingstone
Chair, Giant Mine Oversight Board
BOX 1602, 5015 - 50TH AVENUE
YELLOWKNIFE NT X1A 2P2
Livingstone21@hotmail.com

Dear David Livingstone:

**Giant Mine Oversight Board (GMOB) Comments on the Human Health Risk Assessment (HHRA) for Legacy Contamination around Yellowknife Department of Environment and Natural Resources (ENR) Responses**

Thank you for providing Environment and Natural Resources (ENR) an opportunity to respond to the Giant Mine Oversight Board (GMOB) comments on the Human Health Risk Assessment (HHRA) for Legacy Contamination around Yellowknife.

Please find ENR's responses to GMOB's comments attached to this letter.

Sincerely,

Alex Lynch
A/Director
Environment and Natural Resources

Attachment

c. Ben Nind
Executive Director, Giant Mine Oversight Board

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Johanne Black
Director of Treaty and Negotiations
Yellowknives Dene First Nation

William Lines
Community Liaison and Technical Advisor
Yellowknives Dene First Nation

Clarel Jupiter
Health Research Project Coordinator
Yellowknives Dene First Nation

Jennifer Drygeese
Director, Health and Wellness
Yellowknives Dene First Nation

Sarah Gillis
Director, Environment
Yellowknives Dene First Nation

Femi Baiyewun
Regulatory Manager
Yellowknives Dene First Nation

Rasel Hossain
Director, Contaminants and Remediation Division
Crown-Indigenous Relations and Northern Affairs Canada

Allan Torng
Senior Environmental Health Advisor, Department of Health & Social Services
Government of the Northwest Territories

1) **Concerns/questions regarding assumptions for fish consumption from traditional use areas from the Yellowknives Dene First Nations:**

    a. **Quantity of fish consumed per year from the traditional use area; and**
    b. **Source of fish, Yellowknife Bay fish have lower concentrations of As or Hg than those caught in the unnamed lake.**

a) The Traditional Land Use Area (TLU) is defined as the current areas local Indigenous peoples are using who have a traditional lifestyle that includes hunting, fishing, and gathering. The dietary survey undertaken as per the Giant Mine Human Health and Ecological Risk Assessment (HHERA) told us that Great Slave Lake (GSL) provides the majority of fish consumed, and that being whitefish. This HHRA used the assumption of 80 fish per year consumed, with 10 of those coming from the TLU Area and 70 from GSL. Further clarification regarding consumption concerns was provided in an August 16, 2021, email from Alex Lynch (ENR) to William Lines (YKDFN):

*The assessment was also intended to provide risk characterization information for individuals representative of the majority of community members, and while there may be individuals who eat more fish that was assumed in the assessment there will also be individuals who eat less. As you know all of the studies are intended to integrate with each other (HHRA and YKHEMP) therefore if there are individuals who are concerned that they may be eating more fish than the assessment included, who are concerned about their arsenic exposure, there are options to determine their current body burden.*

Based on YKDFN concerns regarding consumption numbers, GNWT has collected additional fish samples in September 2021, and plan for more this winter, from the TLU inland lakes.

b) The concentrations of arsenic in fish in Yellowknife Bay are lower than in Mason Lake and Duck Lake in the TLU. However, the differences in the concentrations are not substantially different. Nonetheless, calculations were carried out to determine whether the results of the HHRA would change if the assumptions on the amount of fish consumed from lakes in the TLU were changed. If someone in the YKDFN were to eat all their fish from Mason or Duck Lakes (i.e. in the order of 80 fish per year), their risk would increase slightly but would still remain in the low risk range. Thus the results of the HHERA would remain unchanged. As indicated above, the GNWT is continuing to collect fish from the TLU inland lakes and these data will be used to increase the robustness of the dataset currently used in the HHRA.

2) **The CanNorth HHRA states that details on the background derivation are in Appendix D, however, the Appendices were not attached to the HHRA report that was forwarded by GNWT.**

The appendices were not included in the version that was sent to the Giant Mine Oversight Board (GMOB) as they were not posted publicly in the final report. The appendices were sent to GMOB on August 28, 2021, to provide additional details on the approach taken for background derivation.

3) **In the offsite HHRA, CanNorth mentions the Palmer publication and states that it supports their use of the CCME as the background value for areas > 25 km from the roaster stacks. However, this is a misunderstanding of the results and intent of the Palmer study: they showed that the mine roaster stack emissions continue to have much greater influence on soil arsenic concentrations, both in distance from the mines and in depth below the surface, than has been considered up to now.**

The Palmer publication had two distinct and independent evaluations: 1) the origin and distribution of As in soil close to emission point sources; and 2) estimating geochemical background of As in surficial materials across the Slave Geological Province (Palmer et al. 2021). The comment refers to the conclusions of the first purpose; however, it is Palmer's conclusions for the second purpose that support the use of the CCME background value of 10 mg/kg for areas greater than 25 km from the roaster stacks. For the estimation of natural background in the Slave Geological Province (Palmer et al. 2021), the GSC database from geochemical surveys conducted across the Slave craton was used, with additional data from two till surveys (Kjarsgaard et al. 2013 and Normandeau 2020). Data outside a 20km radius of Yellowknife were analyzed (Palmer et al. 2021) and it was concluded (4.4 of Palmer et al. 2021) that upper threshold estimates of natural As background concentrations in the region were within the ranges of 11 mg/kg- 49mg/kg (Table 1 of Palmer et al. 2021). This conclusion supports the use of the CCME background concentration of 10 mg/kg for areas beyond 25 km of Yellowknife in the offsite HHRA.

4) **There are some differences in the data incorporated in the Palmer paper vs. the Stantec report regarding sample depth:**

- **Palmer et al. use the "public health layer" (soil < 10cm depth) in their overall statistical analysis after removing mine-influenced samples,**
- **Whereas Stantec uses data from 10-70 cm depth with the assumption that they were unaffected by roaster emissions.**

ENR appreciates GMOB's concerns in the differences in approach between our work and Palmer's. It is important to recognize that the purpose and intent of these two bodies of work are indeed different.

ENR feels confident that the considerations and statistical tools applied to validate the decisions made are sound. The Stantec study developed background concentrations within 25 km of Yellowknife and the Palmer study determined background outside of 20 km of Yellowknife.

As mentioned previously, there were two separate purposes for the Palmer et al. (2021) study: 1) the origin and distribution of As in soil close to emission point sources; and 2) estimating geochemical background of As in surficial materials across the Slave Geological Province (Palmer et al. 2021). For the first purpose, Palmer et al. (2021) used the "public health layer" soil (Palmer et al. 2021). However, to estimate the geochemical background of As in the region, the GSC data was used, which was based on composite till samples collected from hand dug pits 10-70 cm below the surface (Palmer et al. 2021). Therefore, for the purposes of determining background concentrations, the Palmer study and Stantec report use similar approaches regarding sample depth.

As a result of new soil data being available within the region, the GNWT undertook a larger guideline revision process. As part of this process, a reassessment of arsenic background concentrations in soils was required and the GNWT retained Stantec to determine background arsenic concentrations in support the guideline criteria development. The arsenic background was then used in the derivation of the arsenic in soil criteria. The new soil criteria will be reflected within the revisions of *GNWT's Environmental Guideline for Contaminated Site Remediation,* with proposed public engagement in 2022. It is important to note that the guideline is intended for soil remediation within the communities of Yellowknife, Ndilǫ and Dettah, out to a radius of 25km surrounding Yellowknife. As GMOB has noted, Stantec's background soil concentration for arsenic was used within CanNorth's HHRA to determine incremental risk above background for residents of Yellowknife/Ndilǫ/Dettah using lands for recreational/traditional activities out to a 25km radius.

ENR's background approach considered the following:

- Canadian Council of Ministers of the Environment (CCME) defines 'ambient background' as *"a sum of natural background concentrations and large scale regional anthropogenic contamination"*. ENR/Stantec felt that this was an appropriate application taking into the account the impacts of arsenic dust dispersion on lands out to a 25km radius.
- The geographic scope was defined to extend to a 25km radius around Giant/Con. Recent academic research has demonstrated that at that distance, arsenic concentrations significantly reduce.
- The Stantec dataset for the background derivation included:
    - Geological Survey of Canada (GSC) data, however excluded samples from within Giant/Con sites;
    - Excluded data within 5km of Giant/Con;
    - Jamieson (2017) data from Yellowknife (samples >10cm).

- The Yellowknife/Ndilǫ municipal boundary straddles over both Yellowknife Greenstone Belt (YGB) and non-YGB. The natural geology is elevated in arsenic, specifically within mineralized areas on the Yellowknife Greenstone Belt.
- It was determined that two soil criteria numbers within the City, driven by specific YGB location, would be impractical for residents, and for regulators. In order to improve the use of the guidelines, ambient background concentrations were derived for two areas to account for:
    1) Outside of municipal boundaries, within the 25km radius, including Dettah.
    2) YGB/Municipal Boundaries.
- Based on previous academic research, soils within the depths of 0-10 cm is defined as the 'public health layer'. Soil >10 cm depth is considered to represent background conditions, those not impacted by anthropogenic sources. As a result of considerations for the work carried out by Queens and Palmer on arsenic concentrations vs soil depth, Stantec carried out a statistical analysis. The results confirmed, from an aerial deposition influence, the 10cm depth 'cut off' as appropriate, and confirmed that soil samples within 5km of Giant/Con are to be removed from the data set.

5) **There are some differences in the data incorporated in the Palmer paper vs. the Stantec report regarding statistics:**
    - **Palmer et al. state that "The application of statistical techniques requires careful consideration of the data distribution and since geochemical data are rarely normally and lognormally distributed many parametric methods (e.g., use of the mean and standard deviation) are typically not appropriate. Estimates using non-parametric methods are much more robust against the influence of extreme outliers that are often present in geochemical datasets".**
    - **Stantec statistics are based on a requirement of parametric data distribution (i.e., normal or log-normal distribution).**

A significant amount of effort went into Stantec's data analysis and the selection of statistical methods for the calculation of the summary statistics. ENR finds the use of parametric statistical techniques acceptable for use with our dataset. It is important to note that the soil background report was reviewed by a number of experts. The following can be found in the Stantec report:

- A preliminary evaluation of the underlying data distribution was performed by plotting histograms for the reported available data, as grouped by data source and underlying geology (YGB and Non-YGB). For each dataset, normality was improved when data were log-transformed (Figure 3, Appendix B), suggesting that the underlying data may be lognormally distributed. (Stantec - Section 2.0)

- Boxplots of soil arsenic concentrations were generated based on the two potential options for data analysis. These boxplots were then used to identify outliers which were further examined using Dixon's outlier test (for n<25) or Rosner's outlier test (for n≥25). Sample points that were confirmed as outliers were removed from the datasets. (Stantec - Section 2.4).
- Data suitability for parametric statistical techniques was evaluated by testing the combined data for goodness of fit to a parametric data distribution in United States Environmental Protection Agency's ProUCL statistical tool (Version 5.1). (Stantec - Section 3.1 and 3.2)

6) **The effect of these differences of background values needs to be evaluated. This discussion should extend to whether the currently planned residential clean-up criteria for the Giant Mine townsite of 160 mg/kg remains appropriate given the new scientific evidence regarding the As background in the region.**

The As background for the region (outside of 20km radius of Yellowknife) presented in Palmer et al. (2021) does not influence the currently planned residential clean-up criteria for the Giant Mine townsite of 160 mg/kg. The Giant Mine townsite is located within 25 km of Yellowknife on the Yellowstone Greenstone Belt (YGB), which is associated with naturally elevated As concentrations.

Discussions were held between GNWT and the Government of Canada with respect to upcoming revisions to soil criteria. The background arsenic soil concentration of 94 mg/kg used within the HHERA for the GMRP was derived using a slightly different soil data set and a slightly different analysis than was used by Stantec. It is noted that there is no significant difference between a background concentration of 94 mg/kg and 114 mg/kg.

It is standard practice in contaminated site remediation for larger, more complex projects to develop site specific remediation criteria; the GMRP has taken a risk-based approach to the use of the current residential criteria of 160 mg/kg. This approach under the GNWT *Environmental Guideline for Contaminated Site Remediation* ensures an acceptable risk to humans or ecological receptors, as was determined within the HHERA.

The GMRP has an approved Closure and Reclamation Plan (CRP) from the Mackenzie Valley Land and Water Board. Remediation will proceed based on the current residential criteria of 160mg/kg as outlined in the approved CRP.

**7) The report assumes teens eat 91% as much as adults and provides a reference, however anecdotal experience suggests that this age group generally eats a lot more than adults. This percentage value should be re-examined.**

The conversion percent value was re-examined and the results are still valid. The data from different food surveys show that teens eat more milk and dairy products than adults; however that is the one of only category where the data show that their consumption is significantly larger (GOA, 2018, Richardson 1997). As indicated in the HHERA the fraction for teens were developed from Richardson (1997) for First Nations people. The life style conversion factors were based on a consideration of the consumption of wild game, fish and berries which are the foods considered in the HHRA. The data are provided below. As seen from the table, teens eat a bit more fruit and berries but less fish and wild game. This is also observed in the general population data where teens eat less fish (93%) and meat (92%) than adults.

The value of 91% used in the HHRA is derived from the fish consumption from First Nations people and is a conservative estimate of the fraction of food as the amount of game is much lower. If an average of the three groups was used the value would have been 87%.

| **Food Group** | **Age Category** | |
|---|---|---|
| | **Teen** | **Adult** |
| **Wild Game** | | |
| Intake rate (g/d) | 175 | 270 |
| Conversion Factor (-) | 0.65 | 1 |
| **Fish** | | |
| Intake rate (g/d) | 200 | 220 |
| Conversion Factor (-) | 0.91 | 1 |
| **Fruits and Juices** | | |
| Intake rate (g/d) | 258 | 245 |
| Conversion Factor (-) | 1.05 | 1 |

Note Data from Richardson (1997) for First Nations People (fish and game) and the general population (fruits and juices)

**8) A question of seasonal effects to fish tissue concentrations (might they be higher or lower in winter, E.g. Under ice) in response to potential changes in water chemistry. This may need further research to put it into context for the study.**

The GNWT will consider this in future research related to legacy arsenic in the region.

References

Government of Alberta. (2018). Inventory and Analysis of Exposure Factors for Alberta. [PDF, ISBN: 978-1-4601-3591-4] Edmonton, Alberta. Environmental Public Health Science Unit, Health Protection Branch, Public Health and Compliance Division, Alberta Health.

Jamieson, H.E., K.M. Maitland, J.T. Oliver, and M.J. Palmer. 2017. Regional distribution of arsenic in near-surface soils in the Yellowknife area. Northwest Territories Geological Survey; NWT Open File 2017-03.

Kjarsgaard, B.A., A.P. Plourde, R.D. Knight, and D.R. Sharpe. 2014. Geochemistry of regional surficial sediment samples from the Thelon River to the East Arm of Great Slave Lake, Northwest Territories, Canada. Geological Survey of Canada Open File 7649.

Kjarsgaard, B. A., Knight, R.D., Sharpe, D.R., Kerr, D.E., Cummings, D.I., Russell, H.A.J., 15 Lemkow, D. 2013. Till Geochemistry Studies of the Thaidene Nene MERA Study area. In, 16 Mineral and Energy Resource Assessment of the proposed Thaidene Nene National Park 17 Reserve in the area of the east arm of Great Slave Lake, Northwest Territories. Wright, D.F., 18 Ambrose, E J, Lemkow, D., Bonham-Carter, G (eds.). Geological Survey of Canada, Open 19 File 7196, p. 313-337, https://doi.org/10.4095/292459 (Open Access).

Normandeau, P.X. 2020. Indicator minerals and till geochemistry applied to volcanogenic massive sulphide (VMS) and other greenstone belt related deposits exploration in the Slave Geological Province, NT. NTGS Open Report 2020-008.

Palmer, M.J., H.E. Jamieson, A. Borčinová Radková, K. Maitland, J. Oliver, H. Falck, and M. Richardson. 2021. Mineralogical, geospatial, and statistical methods combined to estimate geochemical background of arsenic in soils for an area impacted by legacy mining pollution. Science of the Total Environment, 145926.

Richardson, G.M. 1997. Compendium of Canadian human exposure factors for risk assessment. O'Connor Associates Environmental Inc., Ottawa ON.