Appendix 6
REMEDIATION SOIL QUALITY GUIDELINES FOR ARSENIC FOR YELLOWKNIFE AND INUVIK

The Canadian Council of Ministers of the Environment (CCME) soil quality guideline for arsenic is 12 mg/kg (CCME, 1997). This soil quality guideline was derived using an assumed natural ambient background arsenic concentration in soil of 10 mg/kg. However, previous investigations have demonstrated that the CCME soil quality guideline of 12 mg/kg is frequently exceeded in ambient background soil samples collected in and around the City of Yellowknife and the Town of Inuvik, Northwest Territories (NWT) (Stantec 2020a, Stantec 2020b). Under these conditions, CCME (1997) indicates that soil quality guidelines for arsenic should be re-evaluated to incorporate the local/regional ambient background soil concentrations. Additionally, CCME (1996) recognizes that site-specific soil quality remediation objectives may be appropriate where derived effects-based generic soil quality guidelines exceed the local ambient background levels. Therefore, the Government of the Northwest Territories – Department of Environment and Climate Change (GNWT-ECC) retained Canada North Environmental Services Inc. (CanNorth) to update the arsenic soil quality guidelines (SQGs) for remediation in areas around Yellowknife and Inuvik based on the updated ambient background arsenic in soil concentrations presented in reports by Stantec (2020a, 2020b).

Based on a review of the ambient background arsenic in soil concentrations reported by Stantec (2020a, 2020b), CanNorth (2021) developed guidelines for three separate geographical areas, as summarized below:

1. **Yellowknife A:** Within the municipal boundaries of Yellowknife and within the Yellowknife Greenstone Belt (YGB) (Figure 1);
2. **Yellowknife B:** Within 25 km of the City of Yellowknife, but outside the municipal boundaries of Yellowknife and not within the YGB (Figure 1); and
3. **Inuvik:** Within the municipal boundaries of Inuvik (Figure 2).

The ambient background soil concentrations adopted by CanNorth for these three areas, as derived by Stantec (2020a, 2020b), are summarized in **Table 1**.

Table 1 Ambient Background Soil Concentrations

Location Name	Geographic Boundaries	Ambient Background Soil Concentration (mg/kg)
Yellowknife A	Within the Yellowknife municipal boundary and YGB (see Figure 1)	114[a]
Yellowknife B	Outside the Yellowknife municipal boundary and YGB (see Figure 1)	41[b]
Inuvik	Inuvik (see Figure 2)	50[c]

Notes:
YGB – Yellowknife Greenstone Belt.
a. 95% UCLM derived by Stantec (2020a) for arsenic concentrations in YGB soil samples collected within 25 km of Yellowknife at depths of ≥10 cm.
b. 95% UCLM derived by Stantec (2020a) for arsenic concentration in non-YGB soil samples collected within 25 km of Yellowknife at depths of ≥10 cm.
c. 95% UCLM derived by Stantec (2020b) for soil samples collected at a depth of 15 cm from Inuvik (Town) and Inuvik (Regional Ambient Background) combined.

For the three identified areas, guidelines were developed for four land uses (Agricultural, Residential/ Parkland, Commercial, and Industrial) following the CCME framework (CCME 1996), with additional site-specific modifications considered such as months of snow cover in a year and predicted rates of arsenic transfer from soil to plants.

Guidelines specific to both human and environmental health were derived, consistent with the CCME framework. The human health guidelines were based on eating local vegetables for agricultural and residential/parkland land uses and soil ingestion and dermal contact for commercial and industrial land uses. The ecological guidelines were based on the protection of plants, earthworms, and wildlife. The lowest of the derived values for the various exposure pathways for human health and the environment were selected as the human health guideline and the environmental health guideline, respectively.

However, the derived environmental health guidelines were based on ecological toxicity studies for sensitive plants and earthworms that are not native to the NWT and may not be applicable to Yellowknife or Inuvik. Additionally, observations from plant samples collected from the Giant Mine site show that plants are growing well in areas with arsenic concentrations that are considerably higher than the derived environmental health guidelines. Therefore, CanNorth (2021) recommended that the updated arsenic criteria for the three identified geographic areas be based on the protection of human health, consistent with the previous arsenic in soil remediation guidelines for Yellowknife and Inuvik.

Finally, the derived human-health risk-based guidelines were compared to the distribution of ambient background soil arsenic concentrations that were reported for the three geographic areas by Stantec (2020a, 2020b). It was determined that the human-health risk-based guidelines for the two areas within 25 km of Yellowknife were "generally above the majority of the ambient background concentrations". Therefore, the human health criteria were selected as the final updated criteria for these two areas. However, for Inuvik, the human health criteria were at the upper range of ambient background concentrations for the commercial and industrial land uses and "within the range of ambient background concentrations" for the agricultural and residential/parkland land uses". Thus, to avoid establishing criteria that would commonly be exceeded by ambient background soil concentrations, the final soil quality guideline for Inuvik for all land uses was set to be equal to the 90th percentile of ambient background soil arsenic concentrations from Stantec (2020b).

The final proposed criteria for Yellowknife and Inuvik, derived using the methods described above, are summarized in **Table 2**. The geographic areas to which these guidelines are applicable are shown in **Figure 1** and **Figure 2**.

Table 2 Proposed Remediation Soil Quality Criteria for Arsenic

Location Name	Geographic Boundaries	Soil Quality Guideline (mg/kg)			
		Agricultural	Residential / Parkland	Commercial	Industrial
Yellowknife A	Within the Yellowknife municipal boundary and YGB (see Figure 1)	115	120	163	163
Yellowknife B	Outside the Yellowknife municipal boundary and YGB (see Figure 1)	42	47	90	90
Inuvik	Inuvik (see Figure 2)	100	100	100	100

Notes:
YGB – Yellowknife Greenstone Belt.

References

Canadian Council of Ministers of the Environment (CCME). 1996. Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada.

CCME. 1997. Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health: Arsenic (Inorganic). http://ceqg-rcqe.ccme.ca/download/en/257

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Stantec. 2020a. Yellowknife Background Soil Arsenic Review. Final report. Prepared for Government of Northwest Territories, December.

Stantec. 2020b. Inuvik Background Soil Arsenic Review. Final report. Prepared for Government of Northwest Territories, December.