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Department of Environment
Ministère de l'Envrionnement

April 29, 2004

NWB File:
NWB1NAN0208

Mr. Philippe di Pizzo
Executive Director
Nunavut Water Board
P.O. Box 119
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via Email & Fax to:
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867-360-6369

Dear Mr. di Pizzo:

Re: License NWB1NAN0208 - Nanisivik Mine Human Health and Ecological Risk Assessment Oct 2003 - GN Comments (Department of Environment).

Please find enclosed the **Government of Nunavut – Department of Environment comments on the *Nanisivik Mine Human Health and Ecological Risk Assessment (HHERA) Oct 2003***.

It has only been in the most recent months that the GN-DOE has had the capacity to thoroughly review the details contained within the HHERA. The GN-DOE acknowledges that the HHERA document underwent a number of reviews, and that it was approved by the NWB on November, 2003. However, in preparation for Nanisivik technical meetings, GN-DOE staff felt it was necessary to review the document in order to gain a better understanding of the overall Reclamation and Closure Plan. The enclosed comments are being sent as a result of our preparation for the Nanisivik Technical Meeting.

After our review, we find that the hazard screening procedure for both the Human Health Risk Assessment and the Ecological Risk Assessment is in question. Our review would indicate that possibly 11 additional elements should have been carried forward for risk assessment. This preliminary hazard screening determines the basis for the HHERA and if screened incorrectly the document determines incomplete conclusions.

More specifically, we are very concerned about the misquoting of guideline values, the carelessness on data transcriptions among tables, and the validity of the 1985 geochemistry survey data as background soil values. In addition, we were surprised to find that the HHERA does not include contamination from hydrocarbons. All of these

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issues result in inaccurate and invalid conclusions, and put in question the transparency and credibility of the HHERA.

The purpose of the HHERA was to "evaluate whether known concentrations of elements in surface soil at the site would present a significant risk to human or ecological health based on future use of the property after mine closing" (Executive Summary, pg. vi). The HHERA as it is does not allow for an accurate and clear assessment of the risk on human and ecological health. The implications of a poor assessment, particularly on human health, are of serious concern to the GN-Department of Environment.

Given that the *Nanisivik Mine Human Health and Ecological Risk Assessment Oct 2003*, has already been approved by the NWB, the GN-DOE only requests that the board review the attached comments to determine if any future action is required.

Please contact me directly if you have any questions or comments regarding the attached.

Sincerely,

Original signed by

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GN Comments (Department of Environment).

SPECIFIC CONCERNS & QUESTIONS

1. *Section 3.2.1 - Current Data, pg. 12, 4th paragraph.*
   It reads "For the purpose of the risk assessment…only soil samples that accurately reflect concentrations…are relevant to potential exposures."

   How were soil samples concentrations selected to reflect 'accuracy'? More data and clarification is needed. There should be information in the HHERA of sufficient detail that a reviewer can check and verify the calculations which were performed to determine this.

2. *Section 3.2.2 – Background data, pg. 13, 4th paragraph.*
   It reads "The soil geochemistry survey completed in 1985…all data from this survey were used to represent the regional background conditions."

   This survey was done almost 10 years after mining operations started. Does this survey data truly represent background soil concentrations or it represents artificially 'higher' background soil concentrations?.

   Again this is referred to in *Section 6.2.2, Table 6.12, pg. 50, "Evaluations of Assumptions in the Risk Analysis", Numeral 3.*
   It reads "1985 geochemistry survey is representative of natural background conditions.

   However, *Section 7.1.1 – Town Area, pg. 56, 3rd paragraph.*
   It reads "EPC for Lead in town area (192.3 mg/kg) is not significantly different (ANOVA p>0.005) from the 1985 site-specific background data for the town area (204.2 mg/kg).

   This statement is also repeated in a *footnote on Table 7.1, pg. 57.*
   It reads "****It could not be determined with certainty that the 1985 Background 95% UCL concentrations were unaffected by anthropogenic (i.e. Mining) activities**…"

   These statements are in contradiction with the assumption (pg. 13 and 50) that the 1985 geochemistry survey data is representative of the natural background concentration of metals.

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This reaffirms that using the 1985 survey data was not appropriate as background soil concentration. Particularly since statistically there is no difference between the EPC and the 1985 Background level concentration, as in the case of Lead, which is a critical metal in determining the extent of clean up needed.

3. Furthermore, *Section 3.2.1 - Current Data, pg. 13, 2nd paragraph.*
It reads "EPCs calculated using this second data set [sample interval within 0.3m of the soil profile] were lower than EPCs based on only the surface soil samples"

This means that the surface soil layer (0.1-0.15m) has higher metal concentration that the subsurface layer (0.3m). This implies that the surface soil is contaminated, again reaffirming that the survey data (when considering only surface samples) does not truly represent background soil values.

In addition to this point, it becomes clear that it is very important to consider airborne transport of pollutants, particularly due to dust dispersion and transportation. This is of great importance in considering pathways of exposure, particularly for Lead, since Lead sulphide is present in powder form.

4. Adding to the previous points, *Section 7.1.3 - General Mine Area, pg. 58, 2nd Paragraph.*
It reads "that the EPC for copper in the General Mine Area is not significantly different (ANOVA p>0.05) from the 1985 site specific background data, and copper is therefore not carried forward as a hazard into the risk assessment."

How was it determined that the difference between EPC (66.7 mg/kg) and 1985 SSB (45.4 mg/kg) was not significantly different? If the difference is significant, the HHERA needs to be re-written to include copper as a hazard in the risk assessment.
There should be information in the HHERA of sufficient detail that a reviewer can check and verify the calculations which were performed to determine this.

5. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 11 "1985 Specific Background (SSB) 95% UCL"*
There are different SSB values for Lead and Zinc in both tables. Since these are background level values they should be the same among tables. In particular the differences are:

	Lead (Pb) [mg/kg]*	Zinc (Zn) [mg/kg]*
Town Area		
HHRA	31	29
ERA	204.2	322.8

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Dock Area		
HHRA	31	29
ERA	287	690.2
Mine Area		
HHRA	31	29
ERA	67.9	89.7

* Assumed units, since units do not appear in either Table.

The correct values for this column (11) should appear in both Tables (6.1 and 7.1).

6. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 11 "1985 Specific Background (SSB) 95% UCL".*
In examining the background values (Column 11) according to the ERA (See Table above), the background values for the town and the dock area are larger than the mine ones. Is this correct? The expectation would be to have higher values in the mine area since it is there where mineral extraction happened.

   Having higher concentration of Lead and Zinc in the town and dock area, when compared to the mine site data, points at a likelihood of contamination in the town and dock area. Again the validity of the 1985 survey data as background data is highly questionable.

7. *Section 5.0 – Risk Assessment Framework, pg. 16, Box 2.*
It reads "For the HHRA result were screened against only human health based guidelines primarily taken from CCME and where these were not available from OMOE."

   All metal screening guidelines are available from CCME, with the exception of Boron. However, in Table 6.1 the OMOE standards for Silver, Cobalt, Nickel and Zinc were used, instead of CCME ones. This need to be corrected.

   In addition, *Section 6.1.1 Hazard Identification, pg. 19, 2nd paragraph.*
It states "For the HHRA, these metals are then screened specifically against human health based generic guidelines. In order of preference, these guidelines are taken from CCME (1999), OMOE (1996) or the USEPA (2002)."

   Again, the CCME guidelines should have been preferentially used in Table 6.1 (pg. 20), which is not the case. This needs to be corrected.

8. *Section 6.1.1 – Hazard Identification, pg. 19, 2nd paragraph.*

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It reads "Based on preliminary screening data…the elements Antimony, Barium, Beryllium, Chromium, Mercury, Molybdenum, Selenium, Tin, and Vanadium were eliminated from the HHERA."

The HHERA does not contain data to support the screening out of these elements. The information needed should be of sufficient detail that a reviewer can check and verify the calculations which were performed to screen out those elements.

9. *Table 6.1, pg. 20, Column "Applicable Guideline" in the "Hazard Screening Procedure for Human Health Risk Assessment".*
Many of the human health generic soil guidelines appear to be incorrect. In reviewing the sources quoted for the guidelines for soil ingestion, the quoted values in Table 6.1 differ from the values in the guidelines. See Table A (at the end of this document).

   If using CCME guidelines, as indicated in the HHERA, then several metals needed to be carried forward for the 'Background Soil Concentration Comparison' part of table 6.1.
   In particular these 11 metals are (aside from the ones already carried forward):
   - Town Area (3): Cobalt, Copper and Nickel.
   - Dock Area (5): Boron, Cadmium, Copper, Lead and Zinc.
   - General Mine Area (3): Silver, Boron and Copper.

   Units are not reported in Table 6.1 for metals concentration, it is assumed they are mg/kg. The unit's information is critical for comparison purposes. It is a *fundamental* scientific procedure to report units along with numerical data.

10. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 4 "Applicable guideline values".*
The applicable guideline values for screening purposes should be the same, since the applicable guideline is CCME (2002) – Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health.
In any case, is there an explanation why the 'Applicable guidelines' quoted for the HHRA are 'larger' than the ones for ERA? It should be that the more strict guidelines should be applied to HHRA and not the contrary.

11. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 6 "Number of Samples".*
In Table 6.1 the number of samples (Dock Area) for Lead and Cadmium is '0', while is reported as '29' in Table 7.1. These values should be the same since they refer to the total number of samples tested for the applicable metal concentration.

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In addition, in Table 7.1 the "% exceeding guideline" (Column 8), is 79.3% and 82.8%, for Pb and Cd. This is a significant amount of samples exceeding the guideline; hence this information should also appear on the HHRA Table (6.1).

12. *Table 6.1 (pg. 20) and Table 7.1 (pg. 57), Column 8 "% Exceeding guideline"*
In Table 7.1 the "% exceeding guideline" (Column 8, Dock area), is 79.3% or Pb. This is a significant amount of samples exceeding the guideline, EVEN THOUGH the guideline has been misquoted, CCME (2002) value for Lead (Residential/Parkland) is 140 mg/kg (not 300 mg/kg as reported in the table). Hence the number of samples exceeding the actual guideline is likely higher than reported. This needs to be corrected.

13. *Table 6.9, pg. 45, Surface Soils $SSTL_{HH}$ (mg/kg) – Non-Carcinogenic Effects.*
A comparison between maximum soil concentrations and the SSTL values is not presented, however it was done for Table 7.13, pg. 78, "Overall Ecological Site-Specific Threshold Limits derived for the Nanisivik Mine Site".
This comparison is important to asses the difference between the maximum concentrations and the SSTL chosen values.

Metal	Max Soil Conc. (mg/kg)	$SSTL_{HH}$ Residential	$SSTL_{HH}$ Hunting/Rec.
Cadmium	230	35	50
Lead	9350	70	1050
Zinc	131000	10800	23400

From the data above, the maximum concentration of Cadmium is 5-7 times larger than $SSTL_{Cd}$, for Lead is 9-13 times larger than the $SSTL_{Pb}$, and for Zinc max value is 6-12 larger than $SSTL_{Zn}$. This gives an indication that clean up is necessary and likely in wide areas (vs. only on 'hot spots').

14. *Table 6.12, pg. 52,* "*Evaluations of Assumptions in the Risk Analysis*", Numeral 3.
It reads "Lead toxicity assessment was based on blood Lead levels".
The blood Lead levels were from generic scientific literature. Since the residents and workers of the Nanisivik/Arctic Bay area have been exposed to Lead for a period of time, it would have been more accurate to use actual Lead blood levels from the residents/workers in the area.

Using actual Lead blood level information (which is likely higher than generic literature values) would have rendered a better picture on the sensitivity of this population to Lead. From here it is possible that a stricter remediation and clean up, that is lower SQROs, likely are necessary.

15. *Table 6.12, pg. 52,* "*Evaluations of Assumptions in the Risk Analysis*", Numeral 3.

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It reads "It is important to note that the forms of Lead that have been associated with tumor development in laboratory animal experiments were Lead salts of Lead acetate and Lead phosphate".

The form of Lead in Nanisivik is largely Lead sulphide (galena, CAS 1314-87-0). In general Lead salts are absorbed in the gut; hence Lead salts are first dissociated and solubilized by gastric acids. The particular chemical composition of the Lead salt is not as relevant, as it is the presence and dose of Lead itself. This reason should have not been used to disregard the potential carcinogenity of Lead.

16. *Table 7.1, pg. 57, Column "OTR1 Rural parkland" for Silver (Ag) in the "General Mine Area."*
The value listed is 0.27 ug/g when if fact, from the MOEE 1993 document "Ontario Typical Range of Chemical Parameters in Soil, Vegetation Moss Bags and Snow," the OTR for Silver is 0.11 ug/g.

Nonetheless, in Table 7.1, Silver is carried forward as a hazard for the Quantitative Ecological Risk Assessment for the General Mine Area, but the correct OTR should be used and 0.27 ug/g be corrected to 0.11 ug/g.

17. *Table 7.3, pg. 59, Column 3 "Dock Area".*
The value for Surface Water Exposure Point Concentration for the Dock Area, for Zinc (3.30573 mg/L) is 2 orders of magnitude larger than the values for the Town and the Mine Area.

This implies that the surface water near the Dock area is more contaminated than the one in the town and mine area. More information and action plan are required in this topic.

18. *Section 7.7 – Site-Specific Threshold Limits, pg. 78, 2nd and 3rd paragraphs.*
In 2nd paragraph it reads "…$SSTL_{ECO}$ for Lead for Ptarmigan is lower than the highest measured concentration at the mine site."
In 3rd paragraph it reads "…there might be some **perceived benefit** [*emphasis added*] to ecological receptors **if** [*emphasis added*] remedial activities are undertaken."

These paragraphs seem to be incomplete and contradictory. There is no clarity on the need for remediation, even though clean up is needed according to the $SSTL_{ECO}$ values for Ptarmigan (for Lead). The SSTL value in this case is about half of the maximum soil concentration value (4569 vs. 9350 mg/kg, for SSTL

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and max. respectively). Clarification is needed on what it means and what is implied when an $SSTL_{ECO}$ value is smaller than the maximum soil concentration.

This is similar to the case of Zinc values for Ptarmigan and Arctic Fox, where the maximum soil concentration values are as high as 3 times the SSTL values. Clarification is needed on what it means and what is implied when an $SSTL_{ECO}$ value is smaller than the maximum soil concentration.

19. *Table 7.14, pg. 79, "Evaluation of Assumptions and Uncertainties in the Ecological Risk Assessment", Numeral 3.*
It reads (Numeral 3, 3rd column) "…since SSTLs were all well above EPCs, and maximum measured concentrations".

The second part of the statement is not accurate; there are SSTLs that are in fact smaller than the maximum measured concentrations (See Tables 7.13, pg. 78), specifically in the case of Lead for Ptarmigan, and Zinc for Ptarmigan and Arctic Fox (See previous comment). This is an invalid conclusion. Correction is needed.

20. *Table 7.14, pg. 80, Column 2, "Justification", Numeral 1.*
Incorrect cross-reference. Receptor Characteristics should be changed from, "See Section 7.3 (Receptor Identification)" to "See Section 7.2 (Receptor Identification)."

21. *Table 8.2, pg. 84, "SQROs (mg/kg) for Surface Soils: Dock Area".*
The values on the 1st row (Human Health SSTL) need to be changed, in accordance to corrections on Table 6.1 (pg. 20) as suggested on points 9 & 10 above.

When Human Health SSTL are added, the SQROs values change for Cadmium (from 2800 to 35), for Lead (from 4570 to 700), and for Zinc (from 44000 to 10800). These changes on SQROs values have significant implications on the clean up and remediation planning, since likely there will be a larger number of sampling exceeding the SQROs values.

22. *Tables 8.1 to 8.3, pg. 84. compared with Tables 7.13 (pg. 78) and 6.9 (pg. 45).*
The values for Ecological SSTL for Cadmium and Copper are slightly different than in Table 7.13 (pg. 78). For instance the lower SSTL, and hence SQRO value for Cadmium should be 2840 mg/kg (not 2800 mg/kg), for Copper 5920 mg/kg (not 5900 mg/kg).

Similarly the SSTL value (Human Health) for Zinc (General mine area) should be 23400 mg/kg (not 23200 mg/kg).

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If the purpose was to round up the values to the nearest thousand, then it should be uniformly applied on Tables 8.1 to 8.3. Otherwise more care is needed when transcribing data among tables.

23. *Tables 8.4, pg. 84, Column 7 "Soil Quality Remedial Objective" in "Comparison of Sample Concentrations to SQROs".*
The values in Column 7 "Soil Quality Remedial Objective (mg/kg)" are different than the values for SQROs on Tables 8.1 to 8.3. The carelessness in the transcription of data among tables is shocking, particularly in this very critical table where the main conclusions for the whole HHERA are drawn.

When using the appropriate SQRO data in Column 7, then Column 9 changes to include Cadmium in the Town area and General mine area, since the 'Comment' should be "EPC< SQRO<Max, risk management of hot spots may be required". This appears to be the case in the conclusions (bullet 7, pg. 87), but it is not the case in Table 8.4. Correction is needed. In addition, the SQROs values from Tables 8.1 to 8.3 have been used in the graphs at the beginning of the HHERA (pp. ix-x).

Need to also check the conclusions (Column 9) for Cadmium in the Dock area. If the SSTL for human health is used, then the SQRO (35 mg/kg) is similar than EPC (33 mg/kg), and both smaller than Max (156 mg/kg). This indicates that area-wide clean up is necessary in the Dock area.

Need to also check the conclusions (Column 9) for Lead in the Dock area. If the SSTL for human health is used, then the SQRO (700 mg/kg) which is smaller than EPC (916.2 mg/kg), and both smaller than Max (4330 mg/kg). This indicates that area-wide clean up is necessary in the Dock area.

In addition the value of Lead on Column 4 (Generic Soil Quality Guideline: Ecological), should be 140 mg/kg not 300 mg/kg. This change will result in a larger number of samples exceeding the guideline. Hence corrections are needed accordingly in the rest of the Table.

24. *Tables 8.4, pg. 84, Columns 3 and 4 "Generic Soil Quality Guidelines" in "Comparison of Sample Concentrations to SQROs".*
The values in these columns should change accordingly to the actual guideline values, as pointed for Table 6.1 (pg. 20) and Table 7.1 (pg. 57). The metals carried over for risk assessment and the conclusions from Table 8.4 should change accordingly. The changes in Column 3 and 4 will likely indicate the need for area-wide clean up required for a number of metals (vs. no site clean-up required or localized hot spot clean up required). This is of critical importance for the transparency and credibility of the HHERA.

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25. *Conclusions, pg. 87, Bullet 7.*
It reads "…a limited number of sample concentrations exceeded the SQROs, indicating that isolated "hot spots" may require risk management".
<u>This conclusion needs to be rewritten after the appropriate changes</u> in Tables 6.1, 7.1 and 8.4. There is a likelihood of more samples exceeding the SQROs; hence that remediation will not be limited to "hot spots".

26. *Conclusions, pg. 88, Bullet 8.*
It reads "…Cadmium, Lead and Zinc EPCs in the dock area are lesser than their SQROs, indicating that there is not unacceptable area-wide impact."
<u>This conclusion needs to be rewritten after the appropriate changes</u> in Tables 8.2 and 8.4. There is likelihood that EPCs will exceed the SQROs. This will result in clean up needed in the Dock area.

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TABLE A. NANISIVIK HHERA - SCREENING COMPARISON MAX VALUES & GENERIC GUIDELINES

Name	Symbol	Min Observed Soil Conc. mg/kg**	**Max Observed Soil Conc. mg/kg****	Reported Applicable Guideline	Reported Source Guideline	**Source Guideline same as HHERA**	**Source Guidelines** 2002 CMME mg/kg	1997 MOEE ug/g	2003 USEPA mg/kg	Reported Exceeds Guideline	**Exceeds source Guideline**
TOWN AREA (Residential/Parkland)											
Silver	Ag	nd	**8**	98	b-MOEE	**N**	20	(25) 20		N	N
Arsenic	As	nd	**50**	12	a-CCME	**Y**	12	(25) 20		Y	Y
Boron	B	-	**-**	7000	c-USEPA	**Y**		1.5*	7000	N	-
Cadmium	Cd	nd	**50.2**	14	a-CCME	**N**	10	12		Y	Y
Cobalt	Co	1	**112**	2700	b-MOEE	**N**	50	(50) 40		N	**Y**
Copper	Cu	8	**166**	1100	a-CCME	**N**	63	(300) 225		N	**Y**
Nickel	Ni	2	**87**	310	b-MOEE	**N**	50	(200) 150		N	**Y**
Lead	Pb	15	**2720**	140	a-CCME	**Y**	140	200		Y	Y
Thallium	Tl	nd	**2**	1	a-CCME	**Y**	1	4.1		Y	Y
Zinc	Zn	90	**38500**	16000	b-MOEE	**N**	200	(800) 600		Y	Y
DOCK AREA (Industrial)											
Silver	Ag	1	**11**	240	b-MOEE	**N**	40	(50) 40		N	N
Arsenic	As	3.7	**5.4**	12	a-CCME	**Y**	12	(50) 40		N	N
Boron	B	2.2	**2.2**	180000	c-USEPA	**N**		2*	92000	N	**Y**
Cadmium	Cd	5.1	**156**	2090	a-CCME	**N**	22	12		N	**Y**
Cobalt	Co	6	**11**	7200	b-MOEE	**N**	300	(100) 80		N	N
Copper	Cu	56	**835**	20000	a-CCME	**N**	91	(300) 225		N	**Y**
Nickel	Ni	14	**24**	710	b-MOEE	**N**	50	(200) 150		N	N
Lead	Pb	67	**4330**	8200	a-CCME	**N**	600	1000		N	**Y**
Thallium	Tl	nd	**1**	32	a-CCME	**Y**	1	32		N	N
Zinc	Zn	2020	**41000**	100000	b-MOEE	**N**	360	(800) 600		N	**Y**

() applies to medium and fine textured soils

Color key: Reporting exceeding guidelines HHERA, October 2003

* Boron soil criteria based on hot water extract

Exceeds Guidelines (hence should be considered on the next step)

** Assumed units - units not listed on original Table (6.1)

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Ministère de l'Envrionnement

Cont. TABLE A. NANISIVIK HHERA - SCREENING COMPARISON MAX VALUES & GENERIC GUIDELINES

							Source Guidelines				
Name	Symbol	Min Observed Soil Conc. mg/kg**	**Max Observed Soil Conc. mg/kg****	Reported Applicable Guideline	Reported Source Guideline	**Source Guideline same as HHERA**	2002 CMME mg/kg	1997 MOEE ug/g	2003 USEPA mg/kg	Reported Exceeds Guideline	**Exceeds source Guideline**
GENERAL MINE AREA (Residential/Parkland)											
Silver	Ag	nd	**32**	98	b-MOEE	**N**	20	(25) 20		N	**Y**
Arsenic	As	nd	**9.7**	12	a-CCME	**Y**	12	(25) 20		N	N
Boron	B	nd	**2.3**	7000	c-USEPA	**Y**		1.5*	7000	N	**Y**
Cadmium	Cd	nd	**230**	14	a-CCME	**N**	10	12		Y	Y
Cobalt	Co	6	**35**	2700	b-MOEE	**N**	50	(50) 40		N	N
Copper	Cu	10	**108**	1100	a-CCME	**N**	63	(300) 225		N	**Y**
Nickel	Ni	10	**29**	310	b-MOEE	**N**	50	(200) 150		N	N
Lead	Pb	8	**9350**	140	a-CCME	**Y**	140	200		Y	Y
Thallium	Tl	nd	**nd**	1	a-CCME	**Y**	1	4.1		N	-
Zinc	Zn	51	**131000**	16000	b-MOEE	**N**	200	(800) 600		Y	Y

() applies to medium and fine textured soils
* Boron soil criteria based on hot water extract
** Assumed units - units not listed on original Table (6.1)

Color key: Reporting exceeding guidelines HHERA, October 2003
Exceeds Guidelines (hence should be considered on the next step)

References:

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