Port Colborne Community Action Plan (PCCAP)

Guidance Regarding Chronic Copper Poisoning (CCP) in Sheep in the Vicinity of the Port Colborne Refinery

Key Guidance

- Copper concentrations in soils east of Vale Canada's Port Colborne Refinery are elevated due to historical emissions from the refinery. The company accepted responsibility for the contamination and undertook the Port Colborne Community-Based Risk Assessment (CBRA). All CBRA documentation is available at http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx
- The Port Colborne Community Action Plan (PCCAP) was initiated to address certain issues that arose from the CBRA. This document is available at Vale's CBRA website.
- The CBRA agricultural risk assessment focused on crops and did not specifically address animal husbandry.
- Sheep can be sensitive to dietary Cu toxicity, which is referred-to as chronic copper poisoning (CCP)
- Copper in feed is the most common cause of CCP.
- Biosolids addition to agricultural fields could also be a source of dietary Cu for sheep that could contribute to CCP. The addition of biosolids to any land is subject to provincial approval in accordance with the Nutrient Management Act (https://www.ontario.ca/laws/statute/02n04)
- The Nutrient Management Act does not allow biosolids addition to soil containing Cu at 100 mg/kg or higher.
- Vale has assessed the likelihood that CCP could occur on the lands with elevated Cu north and east of the refinery (see below). Because the Cu in these soils is poorly bioavailable, it is unlikely that CCP would occur as a result of vegetation grown on these lands.
- If you suspect CCP is occurring on your farm, contact the Vale Port Colborne information helpline at 289-478-8253 or by email at Ontario.questions@vale.com.

An Assessment of the Potential for Chronic Copper Poisoning in Sheep as A Result of Historical Contamination of Land Near the Former Port Colborne Nickel Refinery

Copper (Cu) is an essential trace element/micronutrient for mammals. Some species are known to be susceptible to copper poisoning, including Bedlington Terriers (a dog breed) and sheep. In sheep, such Cu toxicity is called chronic copper poisoning (CCP), and in Ontario it occurs with sufficient frequency that the Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) provides an information circular on the topic on its website (http://www.omafra.gov.on.ca/english/livestock/sheep/facts/health-copper.htm). According to another circular from the Ontario Veterinary College (OVC), the Finn sheep strain is more tolerant than the Texel strain, for example, so caution should be exercised when raising Texel sheep in areas where CCP might occur (https://ovc.uoguelph.ca/ruminant_health_management/copper-toxicity-sheep).

As a result of the historical contamination of soils with Ni, Cu, Co, and As from the Inco Nickel Refinery in Port Colborne between 1918 and 1984, the issue of potential CCP in the agricultural soils to the east of the refinery should be considered. Although there is currently no sheep farming on these lands, there is the potential that someone may wish to farm sheep in future on these lands.

According to the OVC circular, feed is the most common source of excessive copper in sheep diets, and dietary Cu would be considered "high" at 10-20 ppm (dry weight) and toxic above 20 ppm.

Greenhouse and field plot studies were conducted as part of the Port Colborne Community-Based Risk Assessment (CBRA) and these studies provide data on the likely Cu content of forage crops on these lands east of the refinery site. The locations from which the various data points were collected are found in Fig. 1. All of these locations are on Vale-owned land. The agricultural field plot data and biomonitoring data are most applicable. Field data (soil and plant tissue [Cu]) are provided in Tables 1 and 2. The overall average tissue [Cu] was 9.3 ppm, 95%CI [6.7, 11.8] (n=29) for soil [Cu] ranging from 108 ppm to 684 ppm.

Table 1. Copper content of soil and vegetation in year 2000 field trials.

Source	Plant Type	Soil [Cu]	Tissue [Cu]
Table 4-2*	corn	684	20.0
Table 4-3*	oat	684	8.9
Table 4-4*	radish	684	39.0
Table 4-5*	radish	684	10.6
			19.6 [0.6,38.7]
Table 4-2*	corn	527	13.1
Table 4-3*	oat	527	8.2
Table 4-4*	radish	527	5.5
Table 4-5*	radish	527	5.8
			8.2 [3.3,13.0]
Table 4-3*	oat	108	5.7
Table 4-4*	radish	108	3.0
Table 4-5*	radish	108	3.9
		Average [95%CI]	4.2 [1.4,7.0]

*Tables 4-2-4-5 are from the CBRA Crops risk assessment, Vol. 1 - Part 4 INCO Field Crops Report Final.pdf

Table 2. Copper content of soil and vegetation in year 2001 field trials.

Source	Plant Species	Soil [Cu]	Tissue [Cu]
Table 1*	corn	388	5.2
Table 10*	oat	388	6.9
Table 11*	oat	388	8.2
Table 2*	corn	388	6.1
Table 7*	oat	388	6.1
Table 8*	oat	388	7.0
		Average [95%CI]	6.6 [5.6,7.6]
Table 1*	corn	596	6.4
Table 10*	oat	596	10
Table 11*	oat	596	14.5
Table 12*	oat	596	9.8
Table 2*	corn	596	5.4
Table 3*	corn	596	1.4
Table 4*	radish	596	12.8
Table 5*	radish	596	11.2
Table 6*	radish	596	8.2
Table 7*	oat	596	10
Table 8*	oat	596	9.5
Table 9*	oat	596	6.6
		Average [95%CI]	8.8 [6.7,10.9]

*Tables 1-12 are from the CBRA Crops risk assessment, Vol I - Part 4 Appendix F1-F6.pdf

The goldenrod biomonitoring data can be used as a proxy for wild forage on the lands having elevated Cu east of the refinery. Goldenrod Cu concentrations associated with soil Cu concentrations of 653 ppm and 987 ppm were 6.85 and 13.1 ppm respectively in clay and organic soil (Table 3).

Soil	Site	Soil Copper Concentration (mg/kg)	Plant Copper Concentration (mg/kg DW)	Plant: Soil Copper Ratio	pH	Soil CEC (meq/100g soil)
Clay	Reference	23.29 ± 5.99	7.33 ± 1.39	0.31	6.78 ± 0.94	36.92 ± 8.16
	Medium	85.54 ± 57.81	9.65 ± 2.24	0.11	7.1 ± 0.43	50.92 ± 26.67
	High	653.29 ± 226.65	6.85 ± 1.42	0.01	6.1 ± 0.11	55.42 ± 11.1
Sand	Reference	11.38 ± 2.87	11.37 ± 4.7	1.00	6.81 ± 0.43	20.38 ± 4.11
	Medium	94.75 ± 11.32	7.54 ± 1.96	0.08	6.93 ± 0.17	13 ± 2.45
Organic	Reference	37.67 ± 4.04	9.37 ± 1.11	0.25	5.95 ± 0.1	129.67 ± 4.73
	High	987.38 ± 768.11	13.1 ± 7.31	0.01	5.65 ± 0.57	123.9 ± 50.57

Note: Presented values are means ± standard deviations.
*DW = plant tissue concentration expressed as mg/kg dry weight

Table 3. Copper concentrations in goldenrod tissue and soil from the Biomonitoring study. This was originally Table 5-6 of the found on page 5-13 (pdf page 17/32) of the pdf document entitled ***Vol I – Part 5 Biomonitoring Report Final.pdf*** of the CBRA Crops risk assessment. The file can be found in the CBRA documentation on the Vale Canada website found at the following URL: http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx

The soil copper contours around the refinery are shown in Fig. 2. The approximate limits of the 1000 ppm and 500 ppm Cu contour lines include the refinery site where the year 2000 radish data were collected, as well as the organic test plot (denoted with “OR” in Fig. 1). These locations will never have crops planted on them going forward. The refinery site is an industrial site which will never be used for agriculture (but was used for the CBRA studies), while the organic field plot site is in a woodlot owned by Vale.

There is a very small area within the impacted area from the historical metal deposition zone in which soil Cu concentrations are elevated to levels which might be thought to represent a high risk for CCP. However, because the Cu in soil is present in poorly bioavailable forms (Stantec, 2014; Dutton et al., 2019), elevated Cu concentrations in plants that might serve as forage for sheep do not appear to have been realized. The copper content of forages across Ontario has been documented and shown to be highly variable, with plant tissue Cu concentrations in some regions not being dissimilar from those measured in the CBRA crop studies, even though soil Cu concentrations across Ontario were up to 300-times lower than in the impacted areas east of the refinery. The Ontario forage copper report is available at http://www.agtest.com/articles/CopperContent.pdf.

CCP is unlikely to be an issue as a result of historical copper contamination on the impacted lands not owned by Vale east of the Port Colborne Refinery site.

References

Dutton, M.D., L. Vasiluk, F. Ford, M. Bellantino Perco, S.R. Taylor, K. Lopez, G.T. Bolger, Y. Gopalapillai, and B. Hale. 2019. Towards an exposure narrative for metals and arsenic in historically contaminated Ni refinery soils: Relationships between speciation, bioavailability, and bioaccessibility. Sci. Tot. Environ. 686: 805-818. https://doi.org/10.1016/j.scitotenv.2019.05.164.

Stantec, 2014. Port Colborne Community-Based Risk Assessment 2014 Update Report. September, 2014. Stantec Consulting Ltd., 1-70 Southgate Drive, Guelph, Ontario. http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx

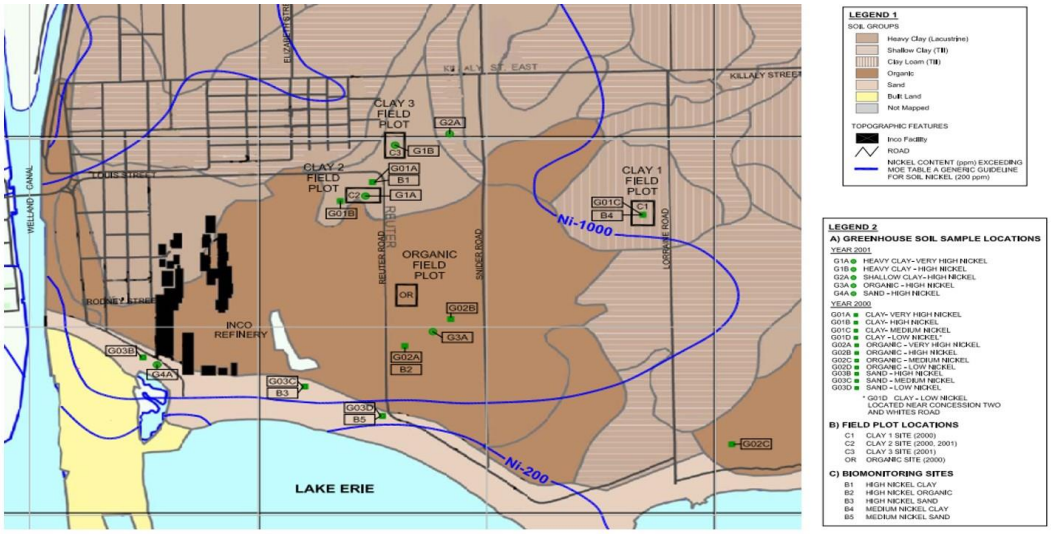

Fig. 1. Locations of (1) agricultural soil sampling for greenhouse studies , (2) agricultural field plot studies, and (3) sampling sites for the biomonitoring studies. This figure was extracted from Drawing 3-1 found on page 3-12 (pdf page 17/72) of the pdf document entitled ***Vol I – Part 3 GreenHouse Report Final.pdf*** of the CBRA Crops risk assessment. The file can be found in the CBRA documentation on the Vale Canada website found at the following URL: http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx

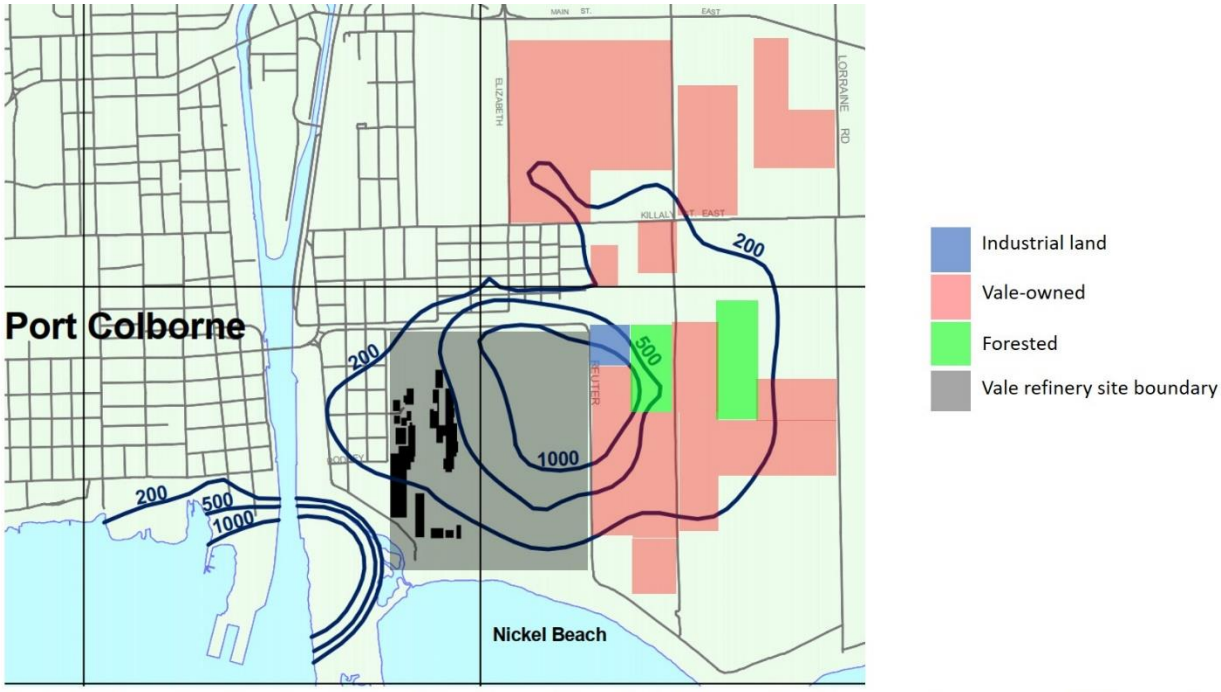

Fig. 2. Soil Cu contour lines (ppm) around the refinery. The red shaded area identifies approximate areas of Vale-owned lands. This figure was modified from Fig. 2-6 found on found on page 2 -16 (pdf page 76/310) of the pdf document entitled ***FINAL MAIN REPORT_Dec_2007[1].pdf*** of the CBRA Human Health risk assessment. The file can be found in the CBRA documentation on the Vale Canada website found at the following URL:
http://vale.com/canada/EN/aboutvale/communities/port-colborne/CBRA/CBRA-documentation/Pages/default.aspx