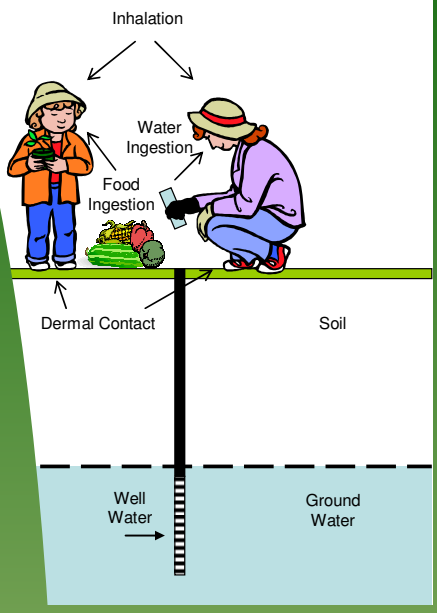
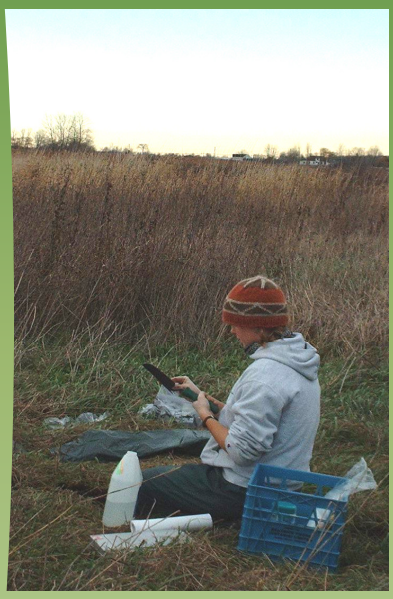
Port Colborne Community Based Risk Assessment



Human Health Risk Assessment



Volume I: Main Report

December, 2007

Jacques Whitford

VALE INCO

PORT COLBORNE COMMUNITY BASED RISK ASSESSMENT – HUMAN HEALTH RISK ASSESSMENT FINAL REPORT

Volume I

Project No. ONT34643

Prepared for

Vale Inco Limited
Toronto, Ontario

Prepared by

Jacques Whitford Limited
7271 Warden Avenue
Markham, Ontario
L3R 5X5

December 2007

Jacques Whitford

PORT COLBORNE COMMUNITY BASED RISK ASSESSMENT – HUMAN HEALTH RISK ASSESSMENT

December 2007

Prepared for Vale Inco Limited

by

Jacques Whitford Limited

This report of December 2007 presents the scope, methodology, results and findings, and conclusions of the Human Health Risk Assessment (HHRA), one of three components of the Port Colborne Community Based Risk Assessment (CBRA). The other two CBRA components include an Ecological Risk Assessment and a Phytotoxicity Study on Agricultural Crops; documentation on both have been included in separate reports prior to 2007. All three CBRA components involved the assessment of risk to receptors of Port Colborne from exposure to concentrations of Chemicals of Concern (CoC), Nickel, Copper, Cobalt and Arsenic in soil; ie. Port Colborne soil that had become impacted from airborne particulate deposition of 60 years of historical stack emissions by the then Inco Nickel Refinery.

This HHRA report should be interpreted within the overall context and goals of the CBRA Technical Scope of Work of November 2000. This Technical Scope of Work was prepared by Jacques Whitford and reviewed and accepted by the Ontario Ministry of the Environment, the Niagara Regional Health Department, the CBRA Public Liaison Committee (PLC), and the PLC's consultant.

Cecile Willert, P.Eng.
Report Writer and Principal Investigator

LICENSED PROFESSIONAL ENGINEER
C.E. WILLERT
90287533
PROVINCE OF ONTARIO

Eric Veska, Ph.D., P. Geo., C.Chem.
Project Manager

PROFESSIONAL GEOSCIENTIST
ERIC VESKA
PRACTISING MEMBER
0280
ONTARIO

William Stiebel, M.Sc., P.Geo.
Project Officer

PROFESSIONAL GEOSCIENTIST
WILLIAM H. STIEBEL
PRACTISING MEMBER
0004
ONTARIO

ACKNOWLEDGEMENT

Jacques Whitford Limited would like to first express thanks to Vale Inco Limited for the opportunity to conduct one of the first major community wide risk assessments in Canada, if not in North America. Their support has allowed for the collection of an extensive amount of field data and the initiation of scientific research and experimentation involving nickel speciation and bioavailability to better assess the potential exposure of receptors to nickel in the environment.

Appreciation is extended to our reviewers of the Public Liaison Committee, its Technical SubCommittee consisting of the Ontario Ministry of the Environment, the Niagara Regional Health Department, Dr. Evert Nieboer, and the PLC's consultant, as well as to the general public. We would also like to thank the HHRA third-party reviewer, CH2M HILL for their insightful review. Comments and suggestions made by all of the reviewers have helped to improve the overall quality of the HHRA report.

Lastly, we would like to thank those employees of Jacques Whitford Limited who have had involvement throughout the 7 year HHRA process, including but not limited to: Mahaboob Alam, Chad Amirault, Rena Chung, Anthony Ciccone, Ian Collins, Greg Crooks, Kristine Ewing, Jennifer Foell, Dolores Forde, Wai Chi Kwan, Christopher Ollson, Van Ortega, Sanya Petrovic, Alison Ronson, Mary Spano, William Stiebel, Eric Veska, Cecile Willert, Shannon Wolfe, and Kevin Wong.

ES.0 EXECUTIVE SUMMARY

ES.1 Introduction

This report presents details on the Human Health Risk Assessment (HHRA) conducted for Vale Inco Limited (Inco) by Jacques Whitford Limited (Jacques Whitford) as part of the Port Colborne Community Based Risk Assessment (CBRA). The HHRA was conducted according to the guidelines of the Ontario Ministry of the Environment (MOE), as described in *Guidance in Site-specific Risk Assessment for Use at Contaminated Sites in Ontario* (MOE, 1996c) and in general accordance with more recent guidance in *Procedures for the Use of Risk Assessment under Part XV.1 of the Environmental Protection Act* (MOE 2005).

Inco operated a nickel refinery (the Refinery) in the City of Port Colborne during the years 1918 through 1984. Airborne particulates resulting from Refinery operations were emitted and deposited on soils adjacent to, and downwind of, the Refinery site. The particulates deposited from the emissions contained traces of Refinery process metals (e.g. nickel), and the soils in which they accumulated may now contain elevated concentrations of these same metals. Inco has acknowledged responsibility for the airborne particulate emissions of nickel, copper, cobalt and arsenic and is the proponent in the Port Colborne CBRA process.

The CBRA was conducted for chemicals of concern (CoCs) that appear at elevated concentrations in Port Colborne soils as a result of historical emissions from the Inco Refinery. The CoCs included in the CBRA and HHRA are nickel, copper, cobalt, and arsenic.

The primary objective of the HHRA was to determine whether the soil concentrations of CoCs in Port Colborne area present an unacceptable risk to human health in the Port Colborne community.

ES.2 Site Characterization

Site parameters specific to Port Colborne were, to the maximum extent practical, used in the estimation of human exposure to CoCs. Site-specific parameters measured and adopted in the HHRA included those addressing land use, time-activity patterns and lifestyle characteristics of Port Colborne residents, and CoC concentrations in a range of water, air, food, and soil matrices.

ES.3 Problem Formulation

The Study Area within the Port Colborne community was divided into 5 separate HHRA Zones (lettered Zones A through E) (Figure ES-1). The HHRA Zones were selected based on similar land uses to provide generalized areas from which typical CoC exposures could be assessed. Two background zones, Zone E and Zone F for local and regional background, respectively, were included in the HHRA assessment for comparative purposes.

Figure ES-1

HHRA Zones
Port Colborne, ON

Legend

HHRA Zones
- A
- B
- C
- D
- E
- F (Southern Ontario)
- Inco Property

Topographic Features
- Inco Refinery
- Roads

0 500 1000 1500
Metres

N

Job Number: ONT34644
Date: October 2003
Dwn by: C. Amirault
Approved by: Kevin Wong

Map Parameters
Projection: UTM
Datum: NAD 83
Scale 1 : 30,000

Regional NIAGARA

Jacques Whitford
Consulting Engineers
Environmental Scientists
Risk Consultants

Receptors for the HHRA were Port Colborne residents, of life stages infant through adult, with reasonable maximum opportunities for potential CoC exposure. Receptor characteristic data utilized in the HHRA were obtained from a questionnaire administered to the residents of Port Colborne, literature values, or a combination thereof.

ES.4 Toxicity Assessment

The components of the toxicity assessment included an examination of CoC routes of exposure and associated toxicity, the identification of CoC carcinogenicity/non-carcinogenicity based on the route of exposure, and the selection of inhalation and ingestion (oral) CoC Toxicity Reference Values (TRVs). Potential risks associated with absorption (dermal) exposures were evaluated using oral TRVs adjusted for absorption efficiency as per U.S. EPA (1989) guidelines.

The TRVs used in the HHRA are based on the bioavailability of specific chemical species under documented conditions. A relative oral bioavailability factor is necessary to adjust for differences in the chemical form of the CoCs between Port Colborne soils and the TRVs. Relative oral bioavailabilities specific to Port Colborne soils were established through the testing of *in vivo* and/or *in vitro* CoC bioavailability of Port Colborne soils. When no site-specific information was available the default relative bioavailability was taken as 100%.

ES.5 Exposure Assessment

In the HHRA, the potential exposures of residents to CoCs were assessed in a conservative manner. The three major routes of CoC exposure considered in the HHRA were inhalation, ingestion, and dermal exposure.

Representative surface soil CoC concentrations were selected from sampling data primarily collected by the MOE (1998-1999) and Jacques Whitford (2000-2003), as well as other soils studies conducted in the area that were made available for this purpose. Indoor exposure to particulate-bound CoCs was examined via a program of dust sampling in Port Colborne homes undertaken by Jacques Whitford.

The selection of representative CoC concentrations in drinking water was based on sampling of the municipal water supply, dug and drilled wells, and background sources. The data for each of these sources were obtained from sampling by Jacques Whitford, the Ontario Drinking Water Surveillance Program (DWSP), and the MOE. Samples of surface water were obtained from the off shore area of Nickel Beach.

Ambient air CoC concentrations were selected based on data of air filter samples collected throughout Port Colborne for chemical analyses. These samples were collected at short term monitor sites at several locations, at several monitor locations during simulated agricultural activities and at a long term monitoring site within the community. Measured ambient air CoC concentrations were used to calibrate an atmospheric dispersion transport model which estimated the long term CoC concentrations in ambient air for each HHRA Zone. Indoor air sampling data were also included in the HHRA; although limited, these data were used to generalize trends, support assumptions on the relationship between indoor and ambient air, and decrease reliance on literature values.

Potential exposures to CoCs in the diet of Port Colborne residents were estimated for supermarket food, as well as for foods grown and/or harvested locally.

Arsenic was not detected in a large number of samples of supermarket foods, garden produce and drinking water. Because the levels of arsenic were smaller than the lowest-achievable analytical detection limits obtained at the time of the chemical analysis of the samples, the measured concentrations below the analytical detection limit required estimation. The impact of this estimation on the exposure estimates introduced a large range of uncertainty of about an order of magnitude. Since arsenic exposures could thus not be estimated reliably, they were not carried forward to a quantitative estimation of risks.

ES.6 Risk Characterization

Cancer and non-cancer risks to nickel, copper and cobalt were estimated quantitatively in each HHRA Zone. Hazard quotients (HQs, non-cancer) and exposure ratios (cancer threshold effects) were compared to the MOE benchmark of one for acceptable threshold type risks. For non-threshold effects, total and incremental lifetime cancer risks (ILCRs) were estimated. The ILCRs were compared to the MOE benchmark of one in one million as an acceptable level of risk.

No non-cancer HQs exceeded the threshold benchmark of one for oral, dermal or inhalation exposures to nickel, copper or cobalt.

The results of this assessment indicate that nickel inhalation risks to residents of Port Colborne are very low. There is unlikely to be an elevated risk from nickel inhalation even for residents of the single home with the highest measured nickel concentrations in indoor air.

Potential risks associated with arsenic were evaluated on a qualitative basis because of the absence of detectable concentrations in foods, produce and drinking water. Oral and dermal exposures in Port Colborne were evaluated by comparison of arsenic in soils in Port Colborne to arsenic soil concentrations in other Ontario communities where health studies, in particular bioassays, were performed. Since the soil arsenic concentrations in Port Colborne are lower than

those in soil in other communities where bioassays were completed, and since health effects were not observed from exposure to higher soil concentrations in those communities in which the bioassays were completed, by extension, no health risks are expected to residents of Port Colborne. This conclusion is considered applicable to inhalation as well as oral and dermal exposures to arsenic since the primary source of arsenic in air is likely to be resuspension of soil.

ES.7 Conclusion

The results of the assessment of conservative exposure scenarios indicate that the concentrations of nickel, copper, cobalt and arsenic in the Port Colborne environment do not pose an unacceptable risk to residents as defined by the MOE target risk levels. In a quantitative evaluation of uncertainties, arsenic oral/dermal exposures were found to have uncertainties too large to make the evaluation reliable.

Sensitivity analyses did not reveal any major sources of uncertainty that would be expected to have the potential to change the conclusions of this assessment.

A Risk Based Soil Concentration (RBSC) was derived for nickel in soil. The evaluation determined that RBSCs were not required for copper or cobalt because the computed values were less than the maximum measured. The objective of the RBSC is to provide a concentration that would serve as a future Port Colborne-specific human health remediation guideline for soil. The benchmark ensures that soil concentrations below this value are protective of human health. The evaluation of RBSCs for Port Colborne is summarized in Table ES-1.

Table ES-1: Evaluation of Final Risk Based Soil Concentrations (RBSCs)

CoC	Risk Based Soil Concentration (mg/kg)
Nickel	20,000
Copper	RBSC not required
Cobalt	RBSC not required
Arsenic	RBSC not required

There are no residential areas in Port Colborne where measured soil concentrations exceed the 20,000 mg/kg nickel RBSC. Concentrations higher than the nickel RBSC were measured in two samples in the Inco owned woodlot on the east side of Reuter Road, immediately east of the Inco refinery property. Although no risk is present to human health based on the current land use in this area (woodlot), if this woodlot was to be redeveloped for residential use, an appropriate remedial action and soil management plan for soils above the 20,000 mg/kg nickel RBSC would have to be implemented at that time.

The Nickel RBSC of 20,000 mg/kg nickel differs from the intervention level of 8,000 set by the MOE (2002). There are two dominant factors that cause this difference. The first is the re-evaluation of the intake of nickel from supermarket foods. In the current study, actual foods from local supermarkets, farmers markets and shops were analyzed for nickel content in a comprehensive study of dietary nickel. The second factor is the fraction of nickel in Port Colborne soils that after ingestion is absorbed into the blood. In the current study, a weight of evidence approach weighted several methods of analyzing this factor including the results of live animal tests using actual soils from Port Colborne, literature studies documenting absorption in humans and animals, studies of nickel speciation in Port Colborne soils, and laboratory methods of measuring nickel solubility in various media including acids. The result was a lower estimate of dietary nickel intake from supermarket foods and a lower absorption of nickel from ingested soils, yielding an overall increase in the RBSC over the previous intervention level.