# REPORT

Community Based
Risk Assessment
Port Colborne, Ontario,
Ecological Risk Asessment,
Natural Environment –
Response to October 2008
Consultant Report

Vale Inco Limited

**PROJECT NO. NT34654**

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| REPORT TO | **VALE INCO LIMITED**<br>**187 Davis Street**<br>**Port Colborne, Ontario**<br>**L3K 5W2** |
| FOR | **Port Colborne Community Based Risk Assessment** |
| ON | **Ecological Risk Assessment, Natural Environment – Response to October 2008 Consultant Report** |

**January 27, 2009**

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# EXECUTIVE SUMMARY

Watters Environmental Group Inc. (WEGI) peer reviewed the Natural Environment September 2004 report which had been written by Jacques Whitford Limited (Jacques Whitford) and incorporated their comments in a letter document entitled: "Independent Consultant Peer Review Report for the Community Based Risk Assessment (CBRA) – Ecological Risk Assessment on the Natural Environment in Port Colborne, Ontario" dated October 2008. Issues raised by WEGI in their October 2008 document pertained to uncertainties in Jacques Whitford's natural environment, study of which led to the development of the proposed Port Colborne-specific CoC soil standards.

Jacques Whitford has provided in the current report commentary to each of the uncertainty issues raised by WEGI. All of the issues which were raised by WEGI have been resolved within this report.

As stated in the cover letter of the independent third party reviewer (CH2MHill) of the Ecological Risk Assessment (ERA) for the Natural Environment, "It is apparent that great effort was spent to thoroughly assess risk to the natural environment … Few ERA's have the benefit of having such an extensive site specific data to support the analysis". It is this paucity of field data that gives Jacques Whitford's 2004 assessment of the Natural Environment in Port Colborne a high degree of certainty in the results.

We believe that WEGI in their 2008 report have misinterpreted and misconstrued the importance of the extensive field program and the associated high degree of confidence that is inherent in the results of the assessment. This report provides detailed justification for the validity of the findings of the 2004 natural environment assessment.

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# NATURAL ENVIRONMENT – RESPONSE TO CONSULTANT REPORT

## 1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) produced a report entitled: “Port Colborne CBRA [Community Based Risk Assessment] – Ecological Risk Assessment, Natural Environment” in September 2004. The focus of this report was on the natural environment areas in and around Port Colborne. That is the focus was in areas that were not urban or active agricultural lands, although interaction between birds and mammals and the agricultural areas was also considered in the evaluation.

Field work, laboratory and greenhouse studies were carried out primarily in 2001 and 2002 after preliminary field investigations in 2000, with subsequent studies in 2003 building on the earlier investigations. The Chemicals of Concern (CoCs) evaluated comprised nickel, arsenic, cobalt and copper. Of these elements, nickel was targeted as the primary CoC because of its much higher soil concentrations relative to, and defined ratios of, the other three CoCs to nickel.

Following the CBRA process, a public review and comment period for the final report was identified, ending December 16, 2004. During this review period, Jacques Whitford received written comment from the Public Liaison Committee’s (PLC) Consultant and two written submissions from the public. Jacques Whitford prepared a response to these comments and a Technical Sub-Committee (TSC) meeting was held on January 20, 2005 to review the comments and Jacques Whitford’s response. Following the TSC meeting, the TSC Chair prepared a TSC Recommendations Report that was presented to the PLC at a public meeting held on February 17, 2005. A subsequent addendum was issued by Jacques Whitford, dated March 2005, responding to comments received on the final report and documenting the CBRA public review process following tabling of the Final September 2004 Ecological Risk Assessment (ERA) – Natural Environment report.

In 2008, the PLC’s consultant, Watters Environmental Group Inc. (WEGI), again peer reviewed the Jacques Whitford September 2004 report and incorporated their comments in a letter entitled: “Independent Consultant Peer Review Report for the Community Based Risk Assessment (CBRA) – Ecological Risk Assessment on the Natural Environment in Port Colborne, Ontario” dated October 2008. A copy of the WEGI document is found in Appendix A of this text.

However, most if not all of WEGI’s comments in their October 2008 document were already addressed in an earlier Jacques Whitford document entitled: “Port Colborne Community Based Risk Assessment Ecological Risk Assessment – Natural Environment – Addendum Report” dated March 2005. Copies of this March 2005 report had been distributed to both to WEGI and other members of the Technical SubCommittee of the Public Liaison Committee, including the Ontario Ministry of the Environment (MOE). It is surprising to Jacques Whitford that although the addendum is mentioned once in the WEGI report, none of WEGI’s comments in their October 2008 review document acknowledge the responses contained in the Jacques Whitford’s March 2005 document.

In any event, Jacques Whitford has provided herein expanded commentary to each of the issues raised by WEGI in their October 2008 document pertaining to the proposed Port Colborne-specific CoC soil standards, namely:

1. Study Objective
2. Definition of Study Area
3. Identification of Potentially Missing Species
4. Arsenic Extraction Data
5. Averaging of Environmental Concentrations
6. Weighting of Various Lines of Evidence
7. Risk Characterization
8. Uncertainty Analysis
9. Natural Environment Report Conclusions

Note that for clarity, the above topics do not follow precisely the order of presentation in the WEGI (2008) report, but rather have been rearranged to follow a logical structure.

Also note that despite the title of the WEGI October 2008 report as having been conducted by an "independent consultant", the report itself acknowledges (page ii, third paragraph; page iii, first paragraph) that the review has not been undertaken independently, but rather the technical review has also incorporated issues raised by others.

## 2.0 STUDY OBJECTIVE

The objective of the CBRA, as stated in the Technical Scope of Work (TSOW) is as follows:

> *"The CBRA process has the objective of finding out what risks exist, if any, and determining how to remove such risks in a scientifically acceptable and practical manner."*

The text cited from the TSOW by the PLC Consultant is not identified in that report (Jacques Whitford 2000) as an objective of the ERA, but rather an endpoint and Jacques Whitford is satisfied that the ERA successfully attained that endpoint. The objective of the CBRA has not been altered and there are thus no changes to be discussed. The objective for the natural environment ERA was first stated in the Approach to Data Analysis and Interpretation (reproduced in Volume 2, Tab 18 of the Natural Environment ERA, Jacques Whitford 2004):

> *The primary objective of the ERA-Natural Environment is to develop the weight of evidence that emissions of CoCs from the Refinery are having effects and will continue to present undue risk to the natural environment of Port Colborne. The natural environment we define as populations of wild animals and plants in the Port Colborne area. Where there is undue risk, the ERA has the follow-up objective of estimating CoC concentrations that produce "safe" or more acceptable levels of risk to populations of wild animals and plants.*

This is further expanded upon in the objectives as outlined in the final report which replaces the subjective term "undue risk" with more concise information in order to provide clarity and provides additional detail, building on rather than modifying the original objective:

> *The primary objective of the ERA is to determine if historical emissions of CoCs from the refinery and deposited in soil present an unacceptable risk to the natural environment of the Port Colborne area. Ultimately, the Regulatory Authority, the Ontario Ministry of the Environment, will determine what constitutes safe or acceptable levels following review of the CBRA reports. However, **for this ERA, an unacceptable risk is defined as an estimated risk linked to the occurrence of soil concentrations of CoCs that prevents sustainable population(s) of flora and fauna or a sustainable level of ecological functioning within the defined Study Area.** Where an unacceptable risk is estimated, the ERA has the follow-up objective of estimating the levels to which CoCs must be lowered or controlled in order to produce "safe" (acceptable) levels of risk for the natural environment.*

*Specific objectives of the study are to:*

- *Identify receptors (species or species groups, communities, habitats) that allow for an assessment as to whether soil CoCs represent a risk to the natural environment within the defined Study Area;*
- *Undertake an assessment of risk that is based on the integration of three lines of investigation: 1) qualitative assessment of the natural environment, 2) quantitative statistical analysis of study area data and 3) quantitative exposure and risk assessment;*
- *Determine ecological risk at a population level for ecological receptors found within the Study Area;*
- *Determine if any potential risks associated with CoCs are different for the major soil types (clay and organic) and habitat types (woodlots and fields) found in the Study Area; and,*
- *Determine "safe" (acceptable) soil CoC concentrations for the soil types (clay and organic) and habitat types (field and woodlot) if an unacceptable risk is found to occur.*

# 3.0 DEFINITION OF STUDY AREA

## 3.1 Defining the Study Area by the 200 mg/kg Isopleth

At the initiation of the natural environment ERA the identification of a general study area was based on the 200 mg/kg soil nickel isopleth as mapped based on soil data collected by the Ministry of the Environment (MOE 1998; 1999). This soil nickel isopleths concentration represents the MOE generic guideline for soil nickel, namely 200 mg/kg. The study area was identified for the purpose of conducting site characterization that was initiated by Jacques Whitford in the year 2000. The findings of the site characterization were presented in a report completed by Jacques Whitford in March 2001. This report identified the key natural features, flora and fauna on which the ERA would focus, as well as providing the background for the development of a field data collection program. This was the primary purpose for the identification of a general study area for the ERA.

It was recognized that as more soil data were collected by Jacques Whitford in 2000 and 2001 that a fine tuning of the 200 mg/kg isopleth for soil nickel based on the MOE 1998 and 1999 soils data would be undertaken. This fine tuned 200 mg/kg isopleth for soil nickel is presented in Figure 2-2, page 2-6, of the final report. A comparison of the location of the 200 mg/kg isopleth based on the original MOE soil data set as identified on Map 1 in the final report is very similar to that found in Figure 2-2 of the report (see Figure 1 of the March 2005 Addendum report for a comparison). As stated above, the primary purpose for the identification of a study area for conducting the ERA was so that ecological site characterization, Valued Ecological Component (VEC) selection and a data collection program could be determined to supplement the MOE soil sampling data where appropriate to assess the potential risk to the natural environment as a result of elevated levels of CoCs in the soils of the local Port Colborne area. The minor differences in the location of the 200 mg/kg isopleth, or 500 mg/kg isopleth, for soil nickel based on the full soil data set does not, and would not, alter the findings of the ERA's site characterization for the local environment, the selection of VEC's for the purpose of risk assessment nor the locations for collection of field data. That this is the case is based on the fact that the 200 mg/kg isopleth for soil nickel identified in Figure 2-2 dose not include or exclude natural features or flora and fauna that are found to occur in the study area on which the ERA was conducted. Therefore, minor changes to the location of the boundary of the 200 mg/kg isopleth, does not have an effect on the interpretations or findings of the natural environment ERA. To have an effect on the studies findings, the location of the 200 mg/kg isopleth based on the full soil data set would have had to result in a significant change in the site characterization of the local areas natural environment. This was not the case.

## 3.2 Excluding Residential Areas

As stated in Jacques Whitford first report presented to the PLC in March 2002, based on the Canadian Council of Ministers of the Environment (CCME) 1997 guidelines, "For the purposes of an ecological risk assessment for the natural environment, social features in the environment or humans are not considered to be ecological receptors in the assessment of adverse effects" (Jacques Whitford 2001, section 3.1, page 28). Following these accepted government guidelines, urban/residential areas of Port Colborne were not considered to be part of the study area as defined for the natural environment ERA.

Nevertheless, the issue regarding the assessment of risk to pets has been raised by the public. When assessing pets (as opposed to naturally occurring wildlife), risks are typically evaluated with consideration for pets as individuals because of the importance that people place on their individual pets. In the ERA report (Jacques Whitford 2004), we evaluated the endpoint of an effect level at or near the No Observed Adverse Effects Level (NOAEL). In an assessment of pets, the NOAEL would be considered appropriate so there is only a small deviation from this.

Reviewing the specific Toxicity Reference Values (TRVs) selected for mammals in the natural environment ERA, Lowest Observed Adverse Effects Level (LOAELs) were selected for nickel, cobalt and arsenic. A NOAEL was selected for copper. For copper, there would thus be no difference in TRVs if pets were evaluated and thus the consideration of wildlife as surrogates for pets exposed to the same environmental concentrations is conservative.

For nickel, cobalt and arsenic, somewhat more conservative values may have been selected, and these are estimated as follows:

- Nickel – TRV a factor of 3 lower
- Cobalt – TRV a factor of 2.6 lower
- Arsenic – TRV a factor of 2.5 lower

The implication of this is that it is reasonable to assume that wildlife are reasonable surrogates for pets exposed to similar concentrations if pets are not likely to receive more than 1/3 of the exposure of wildlife (e.g. get 1/3 or less of their diet from hunting and/or foraging). This would seem to be a reasonable assumption for pets. Given that the potential risk to mammals in the natural environment is very low, the overall conclusion would be that the potential risk to domestic mammalian pets (e.g., dogs, cats, rabbits, guinea pigs, hamsters, ferrets, chinchillas, mice, rats, hedgehogs, ponies, horses, goats, etc) is also low.

It is true that squirrels were not specifically assessed in the natural environment ERA; however, the mammals evaluated include species that are considered more sensitive than squirrels and were specifically selected as more sensitive species representative of the same ecological niche. The shrew in particular is generally considered to be the mammal most sensitive to soil contamination due to its small size and voracious appetite. Meadow voles were also selected because of their small size, making them more sensitive than larger herbivores. Since shrews and voles were not found to be at risk, then by extension, other larger mammals including squirrels are considered also to not be at risk.

## 3.3 Gaps in Distribution of Sampling Stations and Insufficient Sample Size

Jacques Whitford does not share the opinion that there are gaps in the sampling locations or an insufficient number of samples collected. For the study, sampling sites were identified based on a set of predetermined criteria (located in the secondary and primary study area based on soil Ni concentrations, organic and clay soils, and woodlots and fields). As the study area is heterogenic with respect to these criteria, the resulting sampling pattern may appear to be irregular when mapped; nevertheless the data collected is scientifically representative of environmental media and potential receptors in the study area.

It should be pointed out that over 700 samples of environmental media and biota (not including the hundreds of soils samples) were collected. As stated in the cover letter of the independent third party reviewer, CH2MHill, October 2, 2003, “It is apparent that great effort was spent to thoroughly assess risk to the natural environment Few ERA’s have the benefit of having such an extensive site specific data to support the analysis”. As a final point, a critical review of the location of sample sites as presented on Map 1 shows that a significant portion of the sample stations are located in the area where soil CoCs are known to be at their highest concentrations. In this respect the irregularity or “patchiness” of the sampling can be considered to have generated a data set that is conservative for the assessment of potential risk.

# 4.0 IDENTIFICATION OF POTENTIALLY MISSING SPECIES

The potential for missing species was taken into account in the Natural Environment report (Jacques Whitford 2004) through the completion of field surveys. For example, as presented in Table 3-7, the results of the breeding bird survey conducted in the Port Colborne area by Jacques Whitford were compared to the number of species recorded in other parts of the Regional Municipality of Niagara. In addition to this comparison, the report also details on Page 3-23 species that would be expected to occur in the Study Area but that were not observed. As the report states, “None of these species are common or are expected to be abundant in the [Niagara] Region due to their habitat requirements. The apparent absence of these species in the Study Are is likely due to a combination of habitat paucity and general limitations of bird surveys”. Similar comparisons to species distribution maps, historical data and habitat availability were undertaken for flora, amphibians and mammals. The Ecological Site Characterization concluded that, “Field investigations of the Study Area’s flora and fauna identified that the woodlots and fields (fallow/old fields) support a species diversity that is typical for the Regional Municipality of Niagara” and that, “No significant or obvious gaps in species occurrence or representation were noted during the assessment” (Page 3-33).

The potential for missing species was addressed through field surveys, but anthropogenic influences could also be responsible for altering species composition due to non-Inco influences. Anthropogenic influences cannot easily be separated from the impact of contamination in the Port Colborne area. The species that were selected for use in the ERA were considered representative of the species and ecological processes in and around Port Colborne and were agreed upon to by the PLC and TSC.

The question of determining species absence or low numbers in any local landscape is very difficult given the level of investigation that would be required (time period of study; assessment of natural population dynamics including emigration and migration; requirements for detailed comparative assessment of a number of local areas in a region; and so on). For clarification, to have 99% confidence that all bird species that breed in a local area are identified would take at least three years of extensive field inventory for four seasons. This is because in a fractured landscape such as is found in the Port Colborne area, the number of bird species that breed in, or inhabit the woodlots and fields can be expected to change yearly by as much as 25% ***due solely to natural emigration and migration in the local area***. That is why detailed analysis of this type was not considered appropriate for the CBRA. Instead, an extensive data set of environmental media (soil, sediment, water, biological tissue) was collected so that a quantitative assessment of potential risk to a broad range of potential bird and mammal species, which potentially inhabit the study area, could be undertaken.

The basis for the approach used in the natural environment ERA can be found in guidance provided by the Canadian Council of Ministers of the Environment (CCME, 1996). The basic premise of the CCME approach is the three tiered framework:

i. Screening Assessment;

ii. Preliminary Quantitative ERA; and,

iii. Detailed Quantitative ERA.

The CCME (1996) guidance provides a descriptive figure outlining some of the key differences in the three tiers. This is illustrated in Figure 1.

**Figure 1: CCME Tiered Framework**

| Screening Assessment | Preliminary Quantitative ERA | Detailed Quantitative ERA |
|---|---|---|
| Simple | ⟷ | Complex |
| Qualitative | ⟷ | Quantitative |
| Descriptive | ⟷ | Predictive |
| Literature | ⟷ | Field |

Source: CCME 2000.

One of the primary purposes of the Screening Assessment is to determine whether further ERA studies are required (i.e. Preliminary Quantitative or Detailed Quantitative ERAs). A screening assessment may be found to be sufficient to rule out adverse impacts for some aspects of the assessment while not for others. This allows the risk assessment to focus more detailed studies on the specific areas that relate to the greatest uncertainties and/or the highest potential risks. The level of assessment detail is thus refined throughout the ERA process. Note that the Screening Assessment relies primarily on literature information while the more Detailed Quantitative ERA relies primarily on field data.

In the case of species inventories combined with population counts, this information satisfies all of the descriptors in Figure 1 for a Detailed Quantitative ERA. Some of this work (e.g. initial species inventories) was undertaken in the natural environment ERA, making this portion of the study in keeping with a Preliminary Quantitative ERA. This was however, not the only component of the evaluation which was based on multiple lines of evidence to further strengthen the findings and reduce uncertainty. Following the CCME approach, the assessment conducted was concluded to be adequate such that further, more detailed assessment of the type requested by WEGI would not be expected to provide any significant degree of added value in terms of reduction of uncertainties and is thus not required for the CCME tiered approach.

## 5.0 ARSENIC EXTRACTION DATA

The four extraction techniques included in Table 2-8 and 2-9 cannot be used to effectively quantify arsenic extraction from soil. DTPA, oxalate and strontium nitrate extractions function by extracting cations of metals from soil (i.e. nickel, copper and cobalt). Since arsenic is a metalloid and not a metal, it does not form cations under aqueous conditions and thus cannot be quantified using these extraction techniques. The data are not “missing” as indicated in the review comments, but rather the data do not and cannot exist as the test is not applicable to arsenic.

The aqueous extraction, on the other hand, can be used to extract arsenic from soil which can then be quantified by hydride generation atomic absorption analysis. However, in the case of Port Colborne soils, aqueous extractions of the nickel, copper and cobalt only extracted a small proportion of CoCs from the soil. Given that arsenic soil concentrations in Port Colborne are generally low (arsenic:nickel ratio approximately equal to 1:35) in comparison to the other CoCs, analysis of arsenic from aqueous extractions would likely have been below the analytical detection limit.

In addition, with very few exceptions, concentrations of arsenic observed in analyzed plant tissues were below analytical detection limit (0.2 mg Arsenic/kg). As such, testing for arsenic as a phytotoxic element (the purpose of the extraction) was not necessary in examination of Port Colborne soils.

With respect to the WEGI comment on protocols in Volume II, there is no Section D here or anywhere else we check; therefore Jacques Whitford cannot provide a response.

Although arsenic extraction tests of the aforementioned nature were not carried out on Port Colborne soils, there was a significant collection of total arsenic concentrations in environmental media (i.e. water, sediment, soils, and biological tissue). Also, the oral bioaccessibility of arsenic, for mammals and avian species was determined through *in vitro* testing and used in the natural environment ERA. The methodology for the *in vitro* test is considered more appropriate for arsenic than the sequential extraction test. Detailed methodology for the *in vitro* extraction is provided in Attachment B to Appendix 8 of the *Port Colborne CBRA Human Health Risk Assessment* report (Jacques Whitford 2007). In all other cases the total concentration of arsenic in environmental media was used to conduct the risk assessment. Given that there was no increased potential risk to VECs through the use of the total concentration of arsenic there would be no further requirement to better understand the environmental availability of arsenic, as was conducted for the other CoCs. Therefore, Jacques Whitford believes that the data collected and presented for arsenic in the Port Colborne environment is sufficient to support the findings of the natural environment ERA. Referring again to the CCME tiered approach to ERA followed in this assessment, the level of assessment was adequate and a more detailed analysis was concluded to not be required in terms of arsenic extraction.

# 6.0 AVERAGING OF ENVIRONMENTAL CONCENTRATIONS

The WEGI October 2008 report contains a section titled “averaging away the risks”; however, this section does not actually discuss the risk estimation method, but rather discusses specific data on environmental concentrations. Nonetheless, our response discusses both the averaging and the impact on the estimation of risks.

All data were not actually averaged in the ERA as suggested by the WEGI comment. Data were differentiated by the magnitude of concentration. Data from woodlots were also differentiated as concentrations of CoCs tended to be higher in these areas. In addition, localized areas of high concentrations were specifically examined, not just the upper estimates of averages.

It is important to understand that biota and tissue concentrations are not in and of themselves indicators of risk. Risk is defined as being associated with an adverse effect. A change in tissue concentrations may be an impact or an effect, but is not itself an adverse effect and does not provide any information on whether an adverse effect may or may not exist. To evaluate this, the exposure must be combined with information on the hazard (i.e. the adverse effect). Examination of concentrations alone may be useful for some purposes, but does not provide any information on potential risks.

The ERA report does not state that relationships between soil concentrations and tissue concentrations of CoCs do not exist. Therefore, the purpose of Tables 1 and 2 in the Independent Consultant’s comments is unclear and not related to the objective of the ERA. The ERA was purposed to look for risks to natural populations in the vicinity of Port Colborne, not to determine if relationships exist between soil CoC concentrations and other factors.

The WEGI report indicates two specific sets of data as being inappropriately averaged. These include frog gastrointestinal tract concentrations and vole tissue concentrations. Note that these data are used in the assessment only indirectly, specifically in the evaluation of exposures to predators; hence these data have no bearing on the conclusions of the ERA report (Jacques Whitford 2004).

## 6.1 WEGI Concerns Regarding Averaging

The WEGI October 2008 report asserts that "Averaging the data negates the appearance of potential risk by blending high field values with low one." This statement appears to be based on a giant leap from measured concentrations in frog gastrointestinal tracts to risk. Note that the frog gastrointestinal tract was analyzed separately from the rest of the frog not because the data would be useful when analyzed separately, but rather to understand and account for the contribution of the undigested material in the gastrointestinal tract as a source of uncertainty. The observation that these concentrations appear to generally be higher in the Primary study area than in the Secondary study area is correct and interesting; however, it does not indicate that there is a difference in risk between the two areas or associated with the measured data.

In understanding the scope of the work undertaken, it is important to understand the objectives of the assessment. These were outlined previously in Section 2.0. Establishing concentration trends was not part of the objective of the risk assessment and although noted by the risk assessment team and considered in understanding the dynamic interrelationships of the various organisms in the study area and their environment, does not dictate the results of the assessment.

The WEGI report goes on to discuss an "untested assumption that there are no impacts". There is no such assumption stated in the natural environment report, no such assumption was made by the risk assessment team and the report makes no such conclusion. In fact the original objective stated in the Approach to Data Interpretation document made the specific assumptions that there are impacts. The very reason that the study was undertaken is the clear knowledge of and acceptance of the fact that there are indeed impacts. The site characterization discussed in Chapter 2 outlines the impacts and Drawings 2-2 through 2-6 clearly identify the areas of greatest impacts in terms of soil CoC concentrations. The data from the analysis of various tissue samples are naturally expected to follow similar patterns and this is neither surprising nor particularly note worthy but is simply expected. Again, the existence of impacts may indicate a potential for risks, but does not indicate the existence of risks and in terms of concentration/location trends, does not provide any direct information on risks with which to satisfy the objective of the assessment. If it did, the assessment could have stopped after the site characterization as presented in the Chapter 2 drawings.

## 6.2 Averaging of Risks

The statistical methods that were employed in the ERA are appropriate for accessing population level ecosystem functioning. The standard deviations of the datasets are expected to be greater than the mean as these data are expected to be log normally distributed. As such, using the UCLM is a conservative and unbiased approach to selecting concentrations for quantitative evaluation in the ERA.

The ERA looked at the potential risk of the CoCs on *populations* of receptors, with a population spatially defined as those animals within the Study Area (both the Primary and Secondary Study Areas used for data collection purposes). This was discussed with members of the Technical Sub-committee (TSC) and Public Liaison Committee (PLC) throughout the process between 2000 and 2001, and was an approach selected due to the large spatial scope of the ERA, rather than the usual smaller scope of a Site Specific Risk Assessments (SSRA). The use of Upper Confidence Limits on the Means (UCLMs) for assessing risk at the population level was detailed in the Data Interpretation Protocol Report (2002) that was presented to the TSC and PLC. The values used to estimate exposure of receptors to CoCs were high, largely based on UCLMs or maximums within data sets collected on the Vale Inco property. For example, the soil nickel concentrations inputted into exposure calculations were as follows (from Tables 6-17 and 6-18):

- Overall – 2650 mg-Nickel/kg
- Woodlots on clay soils – 1630 mg-Nickel/kg
- Fields on clay soils – 1090 mg-Nickel/kg
- Woodlots on organic soils – 15,200 mg-Nickel/kg
- Fields on organic soils – 2020 mg-Nickel/kg

The areas within the study area where the above soil nickel values are found to occur are presented in Figure 1 (attached). A review of Figure 1 graphically demonstrates that for the assessment of potential risk to a population in the study area, the assessment area is in fact based only on a small sub area of the total study area. As can be seen by the above numbers, the soil nickel concentrations used to estimate soil exposure to receptors are far higher than the 200 mg-Nickel/kg used to define the outer boundary of the Study Area, and far higher than even the outer boundary of the Primary Study Area, which is 500 mg-Nickel/kg (see Figure 1). If one wishes to assess the risk of receptors in the area with the highest soil nickel concentrations (i.e., the Reuter Road Woodlot), the scenario of "woodlots on organic soils" actually represents these values, with a high soil nickel concentration of 15,200 mg-Nickel/kg.

Trends in data were assessed in statistical analyses reported in Chapter 6, and effects potentially caused by CoC concentrations were statistically analysed and reported in Chapter 8. Variability of such data as earthworm CoC concentrations is controlled for by modeling it against the variable soil nickel concentrations (i.e., quantitative data) rather than Primary and Secondary Study Area (i.e., categorical data). The "averaging" of data was used for calculating exposures for derivation of a risk quotient; this was largely done for multiple scenarios, representing a variety of conditions. Additionally, the summary values inputted into exposure calculations represent areas with the highest soil nickel concentrations, as can be seen in Figure 1.

Finally, with respect to the concern that a specific assessment for the potential risk to an ***individual*** of a population that inhabits a ***specific individual area*** with the ***highest levels*** of soil CoCs, WEGI is directed to sections 11.2 and 11.3 and 11.4 of the ERA Report (Jacques Whitford 2004).

It is Jacques Whitford's opinion that the data analysis and statistical methods applied to the data set provide realistic estimates of VEC exposures to CoCs and of the potential risk to population sustainability in the Port Colborne community.

## 6.3 CoC Relationships

Data specific to frogs, voles and earthworms have been identified by WEGI (2008) as specific sources of uncertainty due to differences in concentrations between the Primary and Secondary study area. To understand the significance of these differences to the results of the assessment, how the data are used should be considered. The comment is correct that data for frogs and voles were averaged for these two study areas. Tadpole concentrations were not used directly in the analysis of risks. The comment is only partially correct for earthworms which used different values for each scenario evaluated for cobalt and arsenic. As discussed in the previous section, the analysis was based on two habitat types (field and woodlot) and two soil types (organic and clay), of which the organic woodlots, had the highest concentrations. The organic woodlots may also be thought of as a subset of the Primary study area where the highest soil nickel concentrations occur and thus this represents a finer breakdown of areas than Primary and Secondary areas.

As indicated in Table 2 of the WEGI (2008) report, only one vole sample was collected in the Secondary study area. The results for this one sample were averaged in with the twelve samples from the Primary study area for use in the analysis of dietary intake to red foxes, red-tailed hawks, and raccoons. If the one sample from the Secondary study area had not been included in the dataset evaluated, the vole concentrations used in evaluating dietary intake to raccoons, red foxes and hawks would be 5% higher for nickel, 1% higher for copper, 4% higher for cobalt and unchanged for arsenic. These concentrations are not sufficiently different from those used in the calculations to affect the resulting quotient estimates. A quantitative sensitivity analysis was conducted to verify this conclusion.

For frogs, a greater number of samples were obtained, with results being available for 25 frogs in the primary area and 24 in the Secondary study area. The averaged data from both of these areas were used only in the assessment of dietary intake to predators, namely raccoons and red foxes. In addition, these predators are assumed to consume a variety of other foods, with amphibians accounting for 5% and 7.4% of the diet of red foxes and raccoons, respectively. A test of statistical difference of the means indicated that cobalt and arsenic concentrations in frogs did not differ significantly between the Primary and Secondary study areas. A quantitative sensitivity analysis for nickel and copper, using statistics based on the Primary study area only (nickel and copper concentrations each 36% higher for a dietary increase of 2 to 3%), resulted in no discernable difference in the quotient estimates.

For nickel and copper in earthworms, the statistical analysis documented on page 6-38 of the natural environment ERA confirmed that the concentrations in purged worms do not differ significantly between soil type or habitat and the pooling of these data is thus appropriate.

The additional comment is made by WEGI (2008) that differences in individual sampling sites may be significant. While Jacques Whitford concurs that such differences exist though statistical significance is more difficult to determine for small datasets, the data are used only for the evaluation of dietary intakes to predatory birds and mammals. Predators tend to be mobile and assuming that their diet would be restricted to foods from areas represented by individual sampling stations is not considered by Jacques Whitford to be reasonable. In fact, the process of separating data by habitat types and soil types was designed specifically to approximate the highest potential exposures to predatory birds and mammals based on small home ranges limited to the areas with the highest CoC concentrations. Further consideration of concentrations of the CoCs in food types from individual stations is not considered warranted.

In summary, although some differences do exist in concentrations between the Primary and Secondary study area, the method of interpretation of these data in the ERA does not affect the results of the assessment.

## 6.4 Specific Problems with Averaging ERA Data

Whole worm raw data are located in Volume V, Tab 37. In 2001, 13 composite samples of earthworms were collected from 13 different sampling locations. The stations W-H-2 in the Primary Study Area and W-M-5 in the Secondary Study Area were not sampled. The total number of tissue samples collected in 2002 was 35, as indicated in Table 5-6. This number is comprised of samples taken to determine worm distribution in the Reuter Road and Snider Road woodlots (5 samples) and to determine if a correlation exists between worm abundance and worm tissue concentration (30 samples). Table 6-9 summarizes the number of earthworms sampled to determine if a correlation exists, thus explaining why the table states that 30, not 35, samples were analyzed for this purpose. With regard to soil, 38 soil samples were collected in 2002. Eight of these samples were collected from the Reuter and Snider Roads woodlots. The remaining 30 soil samples, corresponding to the 30 samples of earthworms, were collected under the earthworm field sampling regime.

WEGI indicates that there is a “loss of information” in the Tables of Chapter 6 due to the presentation of the pooled data for the study area; however, they also note that the combination of the data results in high standard deviations in the statistical summaries. This is due to the fact that the information is not lost so much as presented in a more consolidated manner. Also, as indicated previously, these data are generally log-normally distributed and the high standard deviations are thus expected. As noted previously, differences in concentrations based on sampling location are expected and the site characterization section already discusses where impacts are greater. With regards to impacts on suggestions for remediation, the issue of remediation is outside the scope of the natural environment ERA and is addressed under separate cover in the Integration Report. The derivation of risk based target concentrations in the CBRA is not directly impacted by the presentation of the data in question.

# 7.0 WEIGHTING OF VARIOUS LINES OF EVIDENCE

The weighting given to the various studies is based on the tiered approach to risk assessment outlined in CCME (1996) guidance. This was illustrated previously in Figure 1.

In the Port Colborne ERA of the natural environment, the tiered approach was followed, leading to multiple lines of evidence used to further refine our understanding of the Port Colborne environment and the potential effects of the CoCs on the selected Valued Ecological Components (VECs). While ERAs are typically less detailed and primarily desktop studies, the scale of the Port Colborne ERA allowed for collection of a large body of field data, providing better information and reducing uncertainties. The field data are considered to be free of bias such as that introduced through laboratory testing methods. The field data inherently account for:

- Differences in the chemical forms of metals (e.g. highly soluble salts typically used in laboratory studies documented in the literature versus compounds with low bioavailability such as the relatively insoluble nickel oxides common in impacted Port Colborne soils);

- Combined effects of the CoCs and other chemicals (e.g. lead) in the Port Colborne soils, whether naturally occurring or from anthropogenic sources (i.e., resulting from human activities);
- Differences based on soil types and soil constituents such as organic content, particle size, moisture content, etc.;
- Actual species found or not found in the area; and,
- Natural adaptation of local species and/or absence of species.

The reliance on various lines of evidence as applicable to specific VECs followed these basic premises provided by the CCME (1996) guidance (see Figure 1). Namely, field data is better than literature, complex information (appropriately interpreted) tells us more than simple data, predictive models and quantitative information provide additional knowledge that may not be attained from descriptive or qualitative information. Port Colborne specific information was considered significantly more robust than literature information for the simple reason that <u>the complexity of the natural systems cannot be accounted for by a simple desktop study</u>. This simple fact was the primary reason for the extensive field program conducted for the Port Colborne natural environment ERA and the basis of Jacques Whitford's approach to the CBRA. The extensive field program is what makes the conclusions of the natural environment ERA well supported and the uncertainties low. To suggest that the field data are less reliable than simplistic calculations based on over simplified numerical approximations and literature based input values is to ignore the complexity of the natural environment, interrelationships and complex physical and chemical interactions of all of the interrelated components of the environment and the food web.

## 7.1 Leaf Litter Study

At the outset of the CBRA, the leaf litter study had been suggested by the Ministry of the Environment as a line of evidence to assess the potential effect of the CoCs on litter decomposition by soil invertebrates. Jacques Whitford followed the MOE's suggestion and engaged a qualified sub-consultant, Kilty Springs Environmental, to undertake the field program. Jacques Whitford undertook separate statistical analysis of the data collected by Kilty Springs Environmental, including a generalized linear model of the mass of dry leaf litter against such factors as total tree basal area, soil type and soil nickel concentrations (p. 8-46). After controlling for the influence of total tree basal area (since bigger trees and/or more trees are likely to produce more leaves), the statistical analysis showed a statistically significant contribution of soil nickel concentration to the prediction of leaf litter mass at a site. This was found to be a positive relationship, with greater leaf litter mass tending to be found at sites with higher soil nickel concentrations. We acknowledge that there is much variability in the raw data, but the statistical analysis undertaken for this study takes into consideration this variability. We also acknowledge that the slope of the plot in Figure 8-23 is shallow, indicating that, although an effect is present, it is not a large effect. We further concur that conclusions based on this information alone are tenuous at best; however, since multiple lines of evidence were considered, conclusions were not based on this information alone and although the data has a high degree of natural variability, leading to a relatively large uncertainty, the overall conclusions have a higher associated confidence and lower uncertainty as a result of inclusion of this study in the assessment.

## 7.2 Frogs and Toads

WEGI's comment ignores the fact that quantitative evaluation of amphibian populations using the quotient method is not well developed and is generally considered to be too conservative to even attempt in most cases. The natural environment ERA highlighted that "specific nickel concentrations at roughly 80% (19/24) of the ponds and ditches within the Primary and Secondary Study Areas would put tadpoles at potential risk according to this conservative TRV". The WEGI comment is entirely incorrect in stating that the assessment shows frogs and toads are at risk. The important points are that the quotient method is a conservative method; that it identifies potential risk, not actual risk; that the method is not generally used for amphibians, that the TRVs selected are considered highly conservative and since the TRVs are below typical background surface water concentrations in Southern Ontario. These data could as easily be used to say that most frogs in Southern Ontario are at risk. Despite this, frogs are still found in Southern Ontario so there is clearly an over conservatism in the quantitative evaluation. To rely heavily on such data showing that frogs and toads are at risk, as the reviewer suggests, would not be prudent.

Furthermore, the assessment finds specifically that there is no potential risk indicated for toads due to the simple fact that the literature data available shows that toads are not highly sensitive to metals. The presence of populations of the rare Fowler's toad in the area further supports this finding. In this case, the findings agree and thus are strengthened and uncertainty is low. The reviewer's suggestion that contradictory findings for frogs means that the data for toads is equally unreliable is not supported by the findings. Frogs and toads are not the same and clearly do not share the same sensitivities. It is thus inappropriate for the findings for frogs to prejudice the conclusions for toads and *vice versa*.

For the natural environment study, the frog calling and ditch surveys clearly identified that no significant reduction in population numbers was found to occur. Looking back at Figure 1, these surveys can be characterized as complex (accounting for complex interactions occurring in the natural environment), quantitative (particularly in the case of the frog call survey), descriptive and based on field data. This satisfies three of the four defining criteria for a Detailed Quantitative ERA and a greater certainty is thus appropriately assigned to the frog call and ditch survey findings than the quotient calculations which are based on a simplistic characterization of exposures and risks (preliminary quantitative) and literature data. The quotient results can thus be concluded to be appropriately assigned to fall somewhere between a screening assessment and a preliminary quantitative ERA. Given the known high degree of uncertainty in quantitative evaluation of risk to frogs, the calculation, though quantitative, was concluded to be very preliminary for a quantitative calculation. The degree of confidence in the results of the quotient method is thus low. Combining this with the fact that the results contradict our knowledge of frog populations in Southern Ontario and the study area, there is a strong and valid basis to reject the findings of the calculations as being unreliable.

With respect to the occurrence of the Northern Leopard frog in the study area, the following statement is made in Section 3.8.4 of the report:

> *"The roadside survey appeared to underestimate the distribution and abundance of the commonly recognized Rana species, Bullfrog, Northern Leopard Frog and Green Frog. The roadside survey found the Bullfrog to be uncommon in the Study Area, being recorded in low numbers at only two stations with large, well established dugout ponds. The Green Frog was recorded at three stations and the Northern Leopard Frog was found to be sporadically distributed, recorded at ten stations. However, surveys of ditches and ponds (old and new farm ponds dug into the clay soil) in the*

> *summer of 2001 found that all ponds and deep water ditches held large numbers of both adult and tadpole Green Frogs and Northern Leopard Frogs, and both species were common and well distributed throughout the Study Area."*

This is a detailed field survey, taking into account complex environmental interactions and thus is expected to produce better, more reliable information than the quotient method.

Jacques Whitford believes that these lines of direct evidence to scientific field observations provide strong support for the conclusion that the CoCs concentrations present in surface waters of the study area do not represent an unacceptable risk to the frog and toad populations.

## 7.3 Maple Sap, Wood Cores

The maple sap was collected for the Human Health Risk Assessment, and we did not believe that the statistical analysis of this maple sap collection would provide a worthwhile contribution to the ERA. Also note, that metal content of sap does not provide any information regarding health of the woodlots. However, the maple sap data was useful to demonstrate the soil-plant barrier to the movement of CoCs into the environment (see section 6.4.1 and Figure 6-8, page 6-14).

For the woodlot health study, wood cores were collected and analyzed for the four CoCs. The cores were subdivided by 20 year increments before they were analyzed. The wood core analysis was conducted so as to provide *potential additional data* should the woodlot health study find that woodlot productivity was reduced significantly in areas with elevated soil levels of CoCs. As the woodlot heath study did not find a significant reduction in woodlot productivity, even for woodlots where the highest levels of soil CoCs occurred, further discussion on the core analysis is not provided. However, the data of the wood core laboratory analysis is provided in the ERA Report in full (see Volume V, Tab 43).

# 8.0 RISK CHARCTERIZATION

## 8.1 Definition of Acceptable Risk

The October 2008 PLC consultant report incorrectly defines unacceptable risk based on a numerical value. In this assessment, an unacceptable risk was defined in the September 2004 report (Jacques Whitford 2004; See Section 2.0 of the current report). Since October 2004, Ontario has defined an acceptable level of risk based on one that "achieves the same level of protection for each valued ecosystem component that is intended to be achieved by the applicable full-depth generic site condition standard." (Ontario Regulation 153/04). Further information on the guiding principles on which the current soil standards are based can be found in Section 2.3 of the rationale document detailing their development (MOEE 1996). Those same principals and the current Ontario definition of acceptable are considered by Jacques Whitford to be consistent with the definition of acceptable as used in the natural environment ERA.

## 8.2 Changing the Risk Quotients

The comments by WEGI substantially overstate the significance of the quotient method. The reviewer is referred to the 13 pages of text in Chapter 10 discussing the uncertainties, much of which involves uncertainties in data and assumptions that are implicit in the application of the quotient method in this assessment. Refinement and improvement of the assumptions, data and calculations led to changes in calculated hazard quotients between the 2003 draft report and the 2004 final report. The values in the draft report can be discarded and the final report is considered to replace this. However the following additional explanation is provided.

Changes to the risk quotients from the first draft report to the final report were explained in the appendices of the final report and in the March 2005 addendum report (Jacques Whitford 2005), specifically Jacques Whitford's response to questions posed by draft report reviews from CH2MHill and the PLC consultant and the previous review of the final report by the PLC consultant. Revisions were made that reflected changes to the values input into the risk quotient, including the following:

- Toxicity Reference Values were re-examined and modified to more accurately present toxicity values to receptor species;
- Diets of some receptors were re-examined and modified to reflect more accurately actual diets in the Port Colborne area;
- Potential exposure of CoCs due to inhalation of air was omitted as part of the exposure calculation; and,
- Ingestion rates were modified based on a re-examination of normalizing the ingestion rates in relation to body mass and moisture content of diet items.

The PLC consultant correctly notes that the quotient method is simplistic and has many associated uncertainties. As discussed in Section 4.0, the complexity of the natural systems cannot be accounted for by a simple desktop study and the field data and field observations are considered more robust, where these are available. The reviewer needs to recognize that for the species evaluated for which comprehensive field data cannot be reasonably obtained, the quotient method, with its inherent uncertainties may be the best method available. Although this method is typically applied using conservative assumptions and conservative input values, additional consideration was given to reducing some of the larger sources of uncertainty in the assessment of birds and mammals. As noted in Chapter 9 of the ERA, "the assessment is conservative due to the use of TRVs based on laboratory experiments, which represent conservative exposure conditions for receptors when compared to natural conditions." Additionally, the method does not account for scalability of results. For instance, copper is more readily absorbed by mammals at low doses than at high doses, with the body regulating uptake while the quotient method, even with adjustment for bioaccessibility, assumes a linear uptake, without accounting for such a reduction.

Additive and synergistic effects were taken into consideration. Evaluations of each CoC are presented in Sections 7.2.1 through 7.2.4 and summarized in Section 7.3.1. As summarized on page 7-16, a literature review of each of the four CoCs revealed few additive, less than additive or greater than additive effects between the four CoCs. As a result, the TRVs for each of the four CoCs were used separately in the assessment. The report further notes that, "Since the potential combined effects of the CoCs, if any, that may impact on toxicity are not well understood, a detailed *numerical analysis* of additive, synergistic or other interactions is not feasible". However, the field observations and ecotoxicity testing of examined receptors which had been exposed to actual Port Colborne soils containing all of the CoCs would, thus, account for potential combined effects.

Clearly it is not possible for the assessment to account for all of the myriad sources of uncertainty, some conservative and some not, in the assessment. In this case, however, the evaluation of uncertainties concluded that the findings, even with consideration of the various uncertainties inherent in the quotient method, were adequate to support the conclusions of the risk assessment.

# 9.0 UNCERTAINTY ANALYSIS

The uncertainty analysis follows the accepted approach for a qualitative evaluation of the sensitivity of the conclusions to the various sources of uncertainty. Guidance given by the MOE (2006) on uncertainty assessment states that a "discussion of uncertainty" should be included that explains how, "uncertainty could affect the interpretation of risk" (Ontario 2004; MOE 2005). The MOE (2005) further outlines that the discussion of uncertainties should include the following:

- *Description of the risks in terms of magnitudes and types of uncertainties involved,*
- *Interpretation of the significance on the overall assessment of risk, and*
- *Factoring of information on the uncertainty in risk estimates, be it overestimation or underestimation, into the risk management decision in designing a suitable risk reduction strategy.* (MOE 2005).

The above mentioned discussion of how the various uncertainties could affect the interpretation of risks and the specific outline of required content for this discussion is precisely what the uncertainty chapter (Chapter 10) in the ERA (Jacques Whitford 2004) includes. The tabular format used in this chapter specifically and clearly presents the information in a format similar to that outlined in the bullet points cited above from the MOE guidance document. The information corresponding to the first bullet is provided in the uncertainty chapter (Chapter 10, Jacques Whitford 2004) table columns labeled "Risk Analysis Study Factor / Assumptions" and "Justification" which discusses the magnitude and type of uncertainty associated with each aspect of the assessment reviewed. The second bullet above corresponds to the table columns "Analysis Likely to Over/Under Estimate Risk?". This column interprets the impact of the uncertainty on the overall assessment of risk. The third bullet above corresponds to the table columns "Uncertainty Likely to Change Risk Conclusions?". This final column puts the interpretation of each uncertainty identified into the context of the conclusions of the assessment and thus determines the impact on the risk management decisions.

The uncertainty discussion included in the ERA thus satisfies the requirements outlined in MOE guidance. Since the comment is not specific, no further response can be given.

# 10.0 NATURAL ENVIRONMENT REPORT CONCLUSIONS

On page iii of the WEGI October 2008 report, selected parts of the natural environment report have been cited. Note that text Chapter 9 cited by WEGI as containing the report conclusions is not actually the concluding chapter of the report and the conclusion cited is only specific to that particular chapter. Additional analysis follows this chapter and the conclusions of one chapter part way through the report should not be construed as the final conclusions to the report. Presenting this information as if it were the conclusion for the entire report misses entirely the examination of what are considered "safe" soil concentrations, the discussion of uncertainties, and the discussion of localized impacts:

> *"… the study did identify that very high soil concentrations of CoCs (>20,000 mg Nickel/kg) in woodlots located directly adjacent to the Refinery site is potentially causing a local effect on earthworm abundance. Additionally, these high soil CoC concentrations may be affecting other soil decomposers, as indicated by an assessment of leaf litter decomposition. Even though these localized potential effects are not found elsewhere in the Study Area and CoCs do not pose a risk to the earthworm community or the productivity of woodlots in the Study Area on the whole, it is recommended that management of potential risk to the natural elements of these woodlots should be considered."*

"Safe" soil concentrations are presented in the report (Tables ES-11 and 11-5), based on the above discussion and the empirical model developed in Chapter 11, that the WEGI report claims has not been developed. It is unclear whether WEGI neglected to include the final two chapters of the report in their review, as the empirical model is clearly presented. WEGI also provides an interpretation of "empirical model" as being based on the "use of the quotient method to calculate risk to various populations"; however, this highly restrictive interpretation of "empirical model" is WEGI's alone and is not contained in the natural environment report, the TSOW or the original "Approach to Data Analysis and Interpretation" (reproduced in Volume 2, Tab 18 of the Natural Environment ERA) and was never the interpretation intended by the project team. Oxford's Canadian dictionary defines empirical as "based or acting on observation or experiment, not on theory." The model provided satisfies this definition. In fact, the "Approach to Data Analysis and Interpretation" protocol for this ERA (Jacques Whitford 2004) specifically defines the approach as not being based solely on the quotient method, stating that "various assessment methods are integrated to establish community-specific soil CoC concentrations that are safe for specific receptors on certain soils and in certain habitats." The natural environment report thus satisfies this endpoint.

# 11.0 SUMMARY

Watters Environmental Group Inc. (WEGI) peer reviewed the Natural Environment September 2004 report which had been written by Jacques Whitford Limited (Jacques Whitford) and incorporated their comments in a letter document entitled: “Independent Consultant Peer Review Report for the Community Based Risk Assessment (CBRA) – Ecological Risk Assessment on the Natural Environment in Port Colborne, Ontario” dated October 2008. Issues raised by WEGI in their October 2008 document pertained to uncertainties in Jacques Whitford’s natural environment, study of which led to the development of the proposed Port Colborne-specific CoC soil standards.

Jacques Whitford has provided in the current report commentary to each of the uncertainty issues raised by WEGI. All of the issues which were raised by WEGI have been resolved within this report.

As stated in the cover letter of the independent third party reviewer (CH2MHill) of the Ecological Risk Assessment (ERA) for the Natural Environment, “It is apparent that great effort was spent to thoroughly assess risk to the natural environment … Few ERA’s have the benefit of having such an extensive site specific data to support the analysis”. It is this paucity of field data that gives Jacques Whitford’s 2004 assessment of the Natural Environment in Port Colborne a high degree of certainty in the results.

We believe that WEGI in their 2008 report have misinterpreted and misconstrued the importance of the extensive field program and the associated high degree of confidence that is inherent in the results of the assessment. This report provides detailed justification for the validity of the findings of the 2004 natural environment assessment.

# 12.0 REFERENCES

CCME. 1996. *A Framework for Ecological Risk Assessment: General Guidance.* The National Contaminated Sites Remediation Program, Canadian Council of Ministers of the Environment. March 1996.

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# APPENDIX A

WEGI Comments of October 2008

**INDEPENDENT CONSULTANT PEER REVIEW REPORT FOR THE COMMUNITY BASED RISK ASSESSMENT (CBRA)**

**ECOLOGICAL RISK ASSESSMENT ON THE NATURAL ENVIRONMENT IN PORT COLBORNE, ONTARIO**

WATTERS ENVIRONMENTAL GROUP INC.

WORKING DRAFT

# INDEPENDENT CONSULTANT PEER REVIEW REPORT FOR THE COMMUNITY BASED RISK ASSESSMENT (CBRA)

# ECOLOGICAL RISK ASSESSMENT ON THE NATURAL ENVIRONMENT IN PORT COLBORNE, ONTARIO

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October 2008
Reference No. 04-0007

# EXECUTIVE SUMMARY

A final Ecological Risk Assessment report concerning the impacts of emissions from a former Inco nickel refinery on the Natural Environment within the City of Port Colborne, Ontario was prepared by Jacques Whitford (JW), on behalf of its client, Vale Inco (Inco). This five-volume report is entitled, "*Community Based Risk Assessment Port Colborne, Ontario; Ecological Risk Assessment Natural Environment*" and dated September 2004 (the Natural Environment Report), and is one component of a Community Based Risk Assessment (CBRA) that is attempting to address potential impacts from former Inco emissions on agricultural crops, the natural environment, and human health within the City of Port Colborne. The Natural Environment Report relates to Sections 2.1.3 and 3.1 of the *Technical Scope of Work* (TSOW) document, which was prepared by JW in November, 2000 (i.e., at the outset of the CBRA).

The Ontario Ministry of the Environment (MOE) defines an "unacceptable risk" as having a soil chemical concentration above a specific generic standard provided in its regulation. For nickel, that value is 200 micrograms per gram (ug/g) (or parts per million ["ppm"]). Words such as "protection" and "safety" that are used in this report relate to the MOE's generic standard.

The CoCs for the CBRA currently are nickel, copper, cobalt and arsenic. Although not included as a CoC for the CBRA, there is ongoing debate about whether lead should be added to this list. JW's/Inco's study objective, as found in the TSOW (TSOW, page 12) was to produce, "*an empirical model that predicts safe concentrations of CoC's based on relevant soil parameters, such as texture, pH and organic content, for Port Colborne soils*". However, the Natural Environment "Final Report" describes the primary objective (Final Report, page vi), "*to determine if CoCs in soils, as a result of* [Inco] *Refinery emissions, present a potentially unacceptable risk to the natural environment found in the Port Colborne area. For the ERA, an unacceptable risk is defined as an estimated risk linked to the occurrence of soil concentrations of CoCs that prevents sustainable population(s) of flora and fauna, or prevents a sustainable level of ecological functioning, within the defined Study Area.*" The reason for this change in objective is not explained in the report.

The assessment involved two years of data collection and field investigations in 2001 and 2002. The ERA-NE involved studies and assessments of selected Valued Ecosystem Components (VECs), including decomposers (earthworms, woodlot litter), amphibians (frogs; tadpoles and adults; Fowler's toad), plants (maples and woodlots), mammals (meadow voles, raccoon, red fox and white-tailed deer), and birds (red-tailed hawk, American woodcock, American robin, and

Red-eyed vireo).Following technical review of previous "drafts" of the report, JW produced and released a "Draft" report for public and agency review in July of 2003. That "Draft" document was the subject of community and agency input, and was also reviewed by Inco's external (peer) review consultant (CH2MHill). The "Final" report (2004), which is the primary subject of this review, is produced with the objective of attempting to address the concerns and comments raised by the public, agency, peer and Independent Consultant with the "Draft" report (2003).

In response to matters raised by the community and its consultants after release of the "Final" report in 2004, JW produced an "addendum" to the Natural Environment Report dated March 2005. The "Final" Report (2004) and "addendum" report (2005) formed the basis of the submission from Inco to the Ministry of Environment (MOE) in early 2005.

Watters Environmental Group Inc. (Watters Environmental) is the current Independent Consultant to the City of Port Colborne and the Public Liaison Committee (PLC) for the CBRA. In this capacity, Watters Environmental was requested to review the Final Natural Environment Report to provide an opinion on whether the conclusions in the report are supported by the data and its analysis and interpretation in the report. Based on the technical review undertaken, and on issues raised by members of the Port Colborne community, this report represents the opinions of Watters Environmental with regards to the Natural Environment Report.

The Natural Environment Risk Assessment Study Process comprised:

- a baseline inventory of plants and animals in the Port Colborne Area,
- identification of VECs and components of the natural environment considered to be most sensitive to CoCs (such as earthworms),
- identification of specific pathways (and organisms) for study (considering both the aquatic and terrestrial ecosystems), and
- conducting studies for CoCs to determine the levels that cause impairment to the most sensitive plants and animals; in other words to determine the "safe" level(s) of CoCs for protection of Port Colborne's natural environment.

**Watters Environmental's Findings**

Based on the technical review undertaken, and on issues raised by members of the Port Colborne community, it is the view of Watters Environmental that the data and analyses undertaken do not support JW/Inco's conclusions or findings, as follows:

An immediate difficulty in assessing whether the conclusions reached in the Natural Environment Report are supportable is that there are actually two, quite different, conclusions presented:

In the Executive Summary of the Report, a very clear and strong statement is made that:

"*Following a number of lines of evidence to assess potential risk caused by soil CoCs, no unacceptable risk to elements of the natural environment in the Study Area as a whole was identified. As a result of these findings, no immediate need to mitigate or manage risk to the natural environment has been identified.*"

However, the conclusions in Section 9 (Conclusions) are quite different, stating that:

"*Based on the results of the general field observations undertaken for this study, it is evident that existing CoC concentrations in the soil or other environmental media do not represent a toxicity level that is lethal to local flora and fauna. Quantitative assessment of the potential risks to VECs in the natural environment undertaken in this study support these qualitative observations*"

As will be seen, we have a disagreement with the authors of the Report that the conclusions in the executive summary are supported by the evidence presented in the report. In some ways, the second conclusion in Section 9 is more concerning in two regards:

i. The conclusion is that CoC concentrations are such that lethal concentrations have not been reached. The objective of the Natural Environment studies was to determine if sustainable populations exist within the Port Colborne area and whether the ecosystems within the study area are functioning sustainably – NOT whether fatal concentrations exist, and

ii. The objective of the Natural Environment Study as outlined in the TSOW was to develop an empirical model that predicts safe concentrations of CoCs… for Port Colborne soils. The intent was to use the quotient method to calculate risk to various populations and to validate the empirically-derived results with observations of the natural environment. However, the conclusions are largely based on general field observations and the qualitative assessment.

The reason for this important shift in emphasis and the consequences of the change are not satisfactorily explained.

As noted, I it is the opinion of Watters Environmental that the data do not support either conclusions of JW because, the manner in which the data were analyzed and interpreted introduced significant uncertainties into the findings, and thus there are too many uncertainties to justify the conclusions drawn. Our own interpretation of the data presented in the report leads, in many instances, to draw an opposite conclusion on the influence of CoCs on the Natural Environment, to that presented by Jacques Whitford. For example, where JW see no adverse effect on frogs and toads in the aquatic environment, we see evidence of impacts on the amphibia populations, in both the empirical modeling and the observational studies. Further, Watters Environmental is of opinion that JW has simply not provided sufficient scientific justification or rationale to support their contention that there is no unacceptable risk to the Natural Environment of Port Colborne. This opinion is based on the following:

- There are elements of the study and the analyses and interpretation of results that lead to significant unacceptable uncertainties about the conclusions,

- The Study Area(s) originally included a "Primary Study Area", a "Secondary Study Area" and a "Reference Area" based on reported soil levels of CoCs, with intent to characterize exposure and risk in each. However, the Final Report merged the data from the Primary and Secondary areas, which significantly increases uncertainty in the study results. In simple terms, merging the study areas "averages away" potential risks by blending the data over a large area resulting in standard deviation for the data sets often exceeding the mean value,

- Within the Study Area(s), there are gaps in the general distribution of sampling points that exclude large areas of potentially important habitat (such as the wetland and wooded areas on Inco lands to the west of Reuter Road),

- There is insufficient sample size for several of the VECs studied to draw any reasonable conclusions on these components of the natural environment,

- The Study Area excludes the "urban" (residential) areas of Port Colborne, which has important elements of the Natural Environment both in terms of flora and fauna. As a result of this exclusion, the impact of CoCs on domestic animals and other "urban" elements of the Natural Environment have not been fully addressed,

- The Study did not attempt to identify missing or reduced species that would be expected to be present in the habitat and ecology present in the Study area,

- The Study makes arbitrary choices in selecting or rejecting lines of evidence for assessing risks and, uses selective weighting for study components when drawing conclusions,

- The Study did not attempt to assess the impact of arsenic on the Natural Environment.

- As the study progressed the risk quotients used for certain VECs changed without adequate justification, and

- Notwithstanding the above, the "uncertainty analysis" contained in the Report does not provide the analysis required.

The combined result of the above issues, and particularly the blending of the data, is that the standard deviation for data sets is often greater than the mean value, and the risks are most probably underestimated, particularly for species that are not mobile or show limited range.

In subsequent sections, this document provides detail of the above noted observations and conclusions and opinion of Watters Environmental.

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# 1.0 INTRODUCTION

Vale Inco (Inco) operated a nickel refinery in the City of Port Colborne from 1918 to 1985. During that time, the refinery emitted several chemicals into the environment, including nickel, copper, cobalt, arsenic and lead. To assess the extent of impact that these emissions have had on the natural environment, crops and human health within the City of Port Colborne, and the nature and extent of cleanup (if required), Inco is undertaking a Community Based Risk Assessment (CBRA). The CBRA comprises a Human Health Risk Assessment (HHRA), and an Ecological Risk Assessment (ERA) that consists of an assessment of the impact of the CoCs on the natural environment (ERA NE) and their impact on crops grown in the Port Colborne area. This Report relates to Sections 2.1.3 and 3.1 of the *Technical Scope of Work* document, which was prepared by JW in November, 2000 (i.e., at the outset of the CBRA).

The CBRA currently address impacts from four chemicals, namely nickel, copper, cobalt and arsenic, referred to collectively as the Chemicals of Concern (CoCs). Although not included as a CoC for the CBRA, there is ongoing debate about whether lead should be added to this list.

A Public Liaison Committee (PLC) was established to oversee the CBRA process and to help facilitate community consultation. Watters Environmental Group Inc. (Watters Environmental) is the current technical consultant to the PLC and City of Port Colborne.

This document was prepared by Watters Environmental to outline current residual comments and technical concerns (from community members and Watters Environmental) on the final technical report prepared by Inco's consultants, Jacques Whitford (JW) to address impacts to the Natural Environment of Port Colborne.

# 2.0 BACKGROUND

The whole of Port Colborne has been highly influenced by human activity over the past two centuries of settlement, with extensive agricultural cultivation, deforestation and woodlot management, disturbed sand dunes, and the introduction of artificial structures as drainage channels. In effect, there is no part of the Port Colborne area that can be regarded as "natural" although the usual populations of animals and plants typical of urban/agricultural areas in Southern Ontario should be expected to be found thriving in the study area if there is no undue, adverse effect by emissions from the Inco Refinery.

The original study plan for assessment of the Natural Environment involved characterizing exposure and risk across the following three areas:

- Primary Study Area (105 hectares),
- Secondary Study Area (462 hectares), and
- Reference Area.

Within each of these areas, Valued Ecosystem Components were studied, which were: earthworms, frogs (tadpoles), Fowlers' Toad, American Woodcock, American Robin, Red-eyed Vireo, Red-tailed Hawk, Meadow Vole, White-tailed Deer, Raccoon, Red Fox and as a measure of woodlot health, soft maples, woodlots and leaf litter. After Inco's peer review, the common shrew was also added. Household pets were specifically excluded, which was an enduring concern of the community that was steadfastly resisted.

A line-of-evidence approach was used, taking into account data from three approaches: dose-response experiments, calculated risks (compared with literature values known to cause impacts), and field observations.

# 3.0 TECHNICAL ISSUES

The following describe specific technical issues with the Natural Environment Report relevant to assessing whether the proposed soil nickel levels are as protective as the MOE's generic standards.

## 3.1 AVERAGING AWAY THE RISKS

The study area for the ERA NE consists of two general areas for the purpose of data collection: a Primary Study Area (105 hectares) and a Secondary Study Area (462 ha). A Reference Area, consisting of woodlands, wetlands and conservation areas, was also sampled for data collection.

The Primary and Secondary Study Areas were selected based on soil sampling conducted by the MOE in order to direct data collection efforts in areas where soil COC concentrations are high to moderate (i.e., they were established for the purpose of ensuring representative sample collection, not with the intent of combining all the data into one average number representative of the whole of the Port Colborne Area for each variable studied).

Within the Secondary and Primary Study Areas, sampling sites were sampled for a broad range of biota representing valued ecosystem components and capable of establishing food chain relationships. The analytical results show significant differences (sometimes two orders of magnitude difference) from one sampling location to another for CoCs and biota/tissue types. While samples from the Primary Study Area generally show higher levels of CoCs than those from the Secondary Study Area, there are instances where the Control Area results are higher in CoC levels than in the Study Area. In other words, the CoC levels in some sampling locations in the Primary and Secondary Study Areas are not significantly different from those in the Reference Area.

A draft of the ERA Report issued in January 2003 () combined the individual data points from the Primary Area and the Secondary Area to into just one "representative" average number for each biota/tissue type and CoC for the Primary and the Secondary Areas. This was then considered in the assessment of risk to the VECs. The Independent Consultants cautioned JW that this approach, over such a large geographic area, would "average out" meaningful data showing high and low values within the Primary and Secondary Study Areas.

Notwithstanding the raising of this very important concern, JW subsequently, in the 2004 report, collapsed much of the data for various Port Colborne VECs into *just one* data set for the entire "Study Area". This one combined data set is now referred to as "Primary and Secondary Areas" (i.e., combined into one) in Tables 6.3 and 6.13, and as the "Study Area" (i.e., one combined study area comprising the previous Primary Study Area and the Secondary Area) in Tables 6.4, 6.5, 6.6, 6.7, 6.9, 6.10 and 6.12. In other words, *all* of the study area data for each parameter is now treated as one data point. The mean values, sometimes consisting of 50 or so samples, comprising wide ranging values, taken from High and Moderate Exposure Areas are now used to typify an area of 567 hectares.

To put this into context if one was describing a water body, and one had 50 data points for a given CoC, it might possibly be acceptable to discuss "mean" values, because water solutions generally mix well resulting in much lower variability than is the case for example, with metals in soil. However, in the case of the ERA samples, where much of the risk assessment data is from amphibians, worms, insects and other biota living on, in, and around the soil, the variability is enormous and largely unpredictable. Within the "Study Area", the difference between the maximum CoC value and the minimum CoC value is often as much as 100-fold (and higher), for various amphibian and other tissue results. The use of "mean" values minimizes the significance of the individual site data sets to the point where they have virtually no usefulness and thereby marginalizes much of the large ERA field data.

**The Problems with "Averaging"**

The standard deviation for the combined nickel and other CoC results is frequently greater than the mean value. Some of these variations are due to sampling and analytical variability, but most of it is due to the practice of averaging the results over such a broad area.

Such large standard deviations indicate that the data are extremely variable, and are indicative of data sets that should not be simply "averaged", but which should be further evaluated to determine whether data trends emerge within the data set(s).

In fact, preliminary review of some of the *individual sample sites* within the Primary and Secondary (and Reference) Areas indicates that there are major differences in CoC levels in various tissues, and that data patterns can be observed. Some sites in the Primary Area have CoC levels that are similar to those in the Reference Area; others have CoC levels that are significantly elevated. These patterns are obviously lost once the data are averaged.

This problem of averaging out the potential high risk values relating to localized areas with the Primary Study Area was expressed to JWEL as a result of the PLC Consultant's review of earlier draft ERA reports. The earlier ERA reports (up until July 2003) dealt with both the Primary and Secondary Areas as separate components in comparison to the Reference Area. The response in the current ERA is a step backwards, the earlier version's tables showing CoC concentrations in various tissues being in three groupings (Primary Area, Secondary Area, and Reference Area). Even at this degree of averaging, as discussed above, concern had been expressed to JWEL that the average values had far too much variability. The final report has even more.

It is understood that such a large data base needs to be broken down, and averaging within carefully established geographic limits is certainly a way to provide a sense of the degree to which a soil or an organism living in a given soil may be contaminated. However, the use of a mean value spread out over such a large study area becomes a way of obscuring or obliterating any local variations, whether high or low. In this case, it is a mechanism virtually guaranteed to obfuscate potentially meaningful data trends within the study areas.

Meaningful trends can be seen in the data for various types of tissue from Control, Secondary and Primary Study Areas, and some of these are shown below. However, JWEL's final September 2004 ERA does not show such trends, because of the blending of Primary and Secondary Study Area data.

In addition, it is suggested that within the Primary Area, at least, there are localized areas that will have lower or higher CoC levels, and that closer examination of the latter would help accomplish one of the goals of the ERA – to evaluate the potential risk of CoCs to the natural environment, on a more local level than for the entire study area of 572 hectares. Averaging the data negates the appearance of potential risk by blending high field values with low ones.

The following section shows that it is possible to use the data presented in table form in an earlier JW draft (January, 2003) of the ERA NE report to demonstrate that relationships do exist for many organism tissues. These relationships demonstrate that higher soil levels of CoCs are consistent with higher tissue levels of the same CoCs for various organisms.

Examples of potential CoC relationships can be seen in the frog Gastrointestinal (GI) tract data. Just using frog GI tract data reported by JW, the following tables indicate the concentrations for nickel, copper, cobalt, arsenic and lead.

**Table 1: Frog GI Tract Data – Individual Sites**

| PRIMARY SITES | | | | | |
|---|---|---|---|---|---|
| **Sample** | **Pb** | **Ni** | **Cu** | **Co** | **As** |
| H-1-E | 0.95 | 101 | 30.9 | 8.19 | 2.4 |
| H-1-A | | 76.9 | 106 | 2.77 | 3 |
| H-1-B | 3.53 | 27.2 | 26.5 | 1.15 | 1 |
| H-1-C | 1.29 | 1.04 | 10.4 | 0.26 | 4.1 |
| H-1-D | 0.62 | 6.77 | 43.3 | 0.803 | 0.7 |
| H-1 Average | 1.5975 | 42.582 | | | |
| H-1 Std. Dev. | 1.317052 | 44.25842 | | | |
| | | | | | |
| H-2-A | 1.65 | 5.28 | 12.6 | 0.446 | 0.6 |
| H-2-B | 0.47 | 4.17 | 15.8 | 0.379 | 0.3 |
| H-2-C | 0.43 | 2.24 | 11.3 | 0.478 | 0.25 |
| H-2-D | 0.93 | 2.13 | 9.87 | 0.346 | 0.6 |
| H-2-I | 0.7 | 7.24 | 26.2 | 0.788 | 0.7 |
| H-2 Average | 0.836 | 4.212 | 15.154 | 0.4874 | 0.49 |
| H-2 Std. Dev. | 0.497172 | 2.152596 | 6.552258 | 0.176002 | 0.201246 |
| | | | | | |
| H-3-A | 0.6 | 7.66 | 8.47 | 0.439 | 0.3 |
| H-3-B | 1.71 | 51.1 | 17.1 | 1.29 | 0.3 |
| H-3-C | 0.45 | 4.62 | 9.75 | 0.258 | 0.25 |
| H-3-D | 1.07 | 31.8 | **236** | 1.24 | 0.3 |
| H-3-E | 1.12 | 23.2 | 20.6 | 0.788 | 0.3 |
| H-3 Average | 0.99 | 23.676 | 58.384 | 0.803 | 0.29 |
| H-3 Average (outlier removed) | | | 14.0 | | |
| H-3 Std. Dev. | 0.496337 | 18.96012 | 99.41845 | 0.46311 | 0.022361 |
| H-3 Std. Dev. (outlier removed) | | | 5.8 | | |
| | | | | | |

**Table 1: Frog GI Tract Data – Individual Sites (Continued)**

| PRIMARY SITES | | | | | |
|---|---|---|---|---|---|
| **Sample** | **Pb** | **Ni** | **Cu** | **Co** | **As** |
| H-4-A | 0.19 | 2.45 | 12.7 | 0.212 | 0.3 |
| H-4-B | 0.91 | 17.7 | 47.9 | 0.688 | 0.35 |
| H-4-C | 0.63 | 9.83 | 10.7 | 0.567 | 0.25 |
| H-4-D | 0.31 | 1.98 | 9.12 | 0.217 | 0.25 |
| H-4-E | 2.02 | 40 | 21.5 | 1.16 | 0.4 |
| H-4 Average | 0.812 | 14.392 | 20.384 | 0.5688 | 0.31 |
| H-4 Std. Dev. | 0.731587 | 15.68593 | 16.1096 | 0.392046 | 0.065192 |
| | | | | | |
| H-5-A | 3.65 | 36.3 | 73.2 | 1.9 | 0.7 |
| H-5-B | 4.23 | 35.3 | 81.9 | 2.52 | 1 |
| H-5-C | 10.2 | 108 | 47.2 | 5.29 | 2.4 |
| H-5-D | 5.1 | 40.5 | 37.8 | 2.79 | 1.5 |
| H-5-E | 12 | 26.8 | 43.7 | 2.14 | 1.1 |
| H-5 Average | 7.036 | 49.38 | 56.76 | 2.928 | 1.34 |
| H-5 Std. Dev. | 3.799307 | 33.14494 | 19.5175 | 1.364027 | 0.658027 |

**Note the bold type represents possible outlier data.** There may be other outliers in this data set.

The data indicates:

- Site H-5 has the highest average nickel values, followed by Site H-1, followed by H-3.
- The lead data follows the same pattern.
- The copper and cobalt data follows almost the same pattern (except for Cu and Co, Sites H-1 and H-3, which appear to be statistically similar).

Such an apparent relationship might be statistically meaningless, or it might indicate a real relationship between COCs and these locations relative to that of the Inco refinery. Averaging obliterates such relationships and contributes to an untested assumption that there are no impacts.

**CoC Relationships for Selected Biota – Primary, Secondary and Reference Areas**

The January 2003 ERA report is the last ERA report that provided separate CoC values for tissues from the Primary, Secondary and Reference Areas. The following data tables were prepared from the data in Table 6-3 of the January 2003 draft ERA report. They indicate an obvious relationship between tissue levels and the proximity of the organisms to the refinery, based on the average CoC results for Primary, Secondary, and Reference Areas.

**Table 2: Concentration Levels of Tissues from Primary, Secondary, and Reference Areas of NE ERA**

| | | Nickel | | | Copper | | |
|---|---|---|---|---|---|---|---|
| | | Reference | Secondary | Primary | Reference | Secondary | Primary |
| **Tadpoles (Table 6-3)** | | | | | | | |
| GI Tracts | Mean | 48.1 | 166 | 219 | 62.1 | 86.2 | 83 |
| | SD | 44.4 | 106 | 104 | 56.4 | 49 | 21.3 |
| | N | 3 | 3 | 3 | 2 | 3 | 3 |
| Remaining Carcass | Mean | 3.49 | 18.9 | 40.4 | 9.63 | 15.8 | 29.2 |
| | SD | 1.29 | 15.8 | 55.3 | 2.5 | 12.5 | 20.6 |
| | N | 2 | 3 | 3 | 2 | 3 | 3 |
| **Frogs (Table 6-4)** | | | | | | | |
| GI Tracts | Mean | 5.61 | 14.8 | 26.9 | 30.2 | 45.4 | 38.8 |
| | SD | 9.44 | 21.5 | 30.2 | 24.6 | 36.6 | 48.2 |
| | N | 25 | 24 | 25 | 25 | 24 | 25 |
| Livers | Mean | 0.28 | 0.49 | 0.5 | 120 | 118 | 266 |
| | SD | 0.29 | 0.43 | 0.37 | 71.2 | 124 | 141 |
| | N | 25 | 24 | 25 | 25 | 24 | 25 |
| Remaining Carcass | Mean | 0.21 | 0.48 | 1.08 | 10.2 | 6.89 | 27.7 |
| | SD | 0.14 | 0.53 | 1.3 | 6.91 | 4.1 | 44 |
| | N | 25 | 24 | 25 | 25 | 24 | 25 |
| Total Body | Mean | 0.77 | | 3.69 | 16.2 | | 35.5 |
| | SD | 0.95 | | 3.94 | 6.53 | | 41.4 |
| | N | 25 | | 25 | 25 | | 25 |
| **Worms (Table 6-8)** | | | | | | | |
| Whole Earthworm | Mean | 22.5 | 132 | 380 | 19 | 37.4 | 83.6 |
| | SD | 18.2 | 89.1 | 141 | 5.81 | 11.4 | 24.7 |
| | N | 5 | 4 | 4 | 5 | 4 | 4 |

**Table 2: Concentration Levels of Tissues from Primary, Secondary, and Reference Areas of NE ERA (Continued)**

| | | Nickel | | | Copper | | |
|---|---|---|---|---|---|---|---|
| | | Reference | Secondary | Primary | Reference | Secondary | Primary |
| Vole (Table 6-13, July 2003) | | | | | | | |
| Livers | Mean | 0.17 | 0.25 | 0.44 | 62.1 | 86.2 | 83 |
| | SD | 0.14 | | 0.28 | 56.4 | 49 | 21.3 |
| | N | 12 | 1 | 10 | 2 | 3 | 3 |
| Remaining | Mean | 1.46 | 3.31 | 16 | 9.63 | 15.8 | 29.2 |
| Carcass | SD | 0.59 | | 7.12 | 2.5 | 12.5 | 20.6 |
| | N | 12 | 1 | 10 | 2 | 3 | 3 |

As noted above, these data are taken from Table 6.3 of the January 2003 ERA report. They indicate a relationship between tissue metal levels and the proximity of the tissue samples (organisms) to the refinery.

Table 6-2 in the July 2003 ERA report provides a summary of the relationships between soil/sediment/water CoC concentrations (based on information provided in ERA, Appendix C). However, the approach in Table 6-2 doesn't demonstrate the degree to which many of the tissue CoC levels are affected by the level of the CoCs in the soil or sediment or water.

**CoC Relationships – Individual Sample Site Locations**

The results for each individual sample site are found in Volume V, "Laboratory and Analytical Data and Quality Assurance/Quality Control", ERA-NE, November 2002. For purposes of example, consider results based on the data for just one tissue type (Gastrointestinal Tract) for one animal (Frog). This demonstrates the large variation between the various sampling stations across the overall study area and relationships between tissue levels and distances of the sampling stations from the refinery. This demonstrates the usefulness of the individual sampling station data in ascertaining relationships that wouldn't be detected if the individual station results for a given sample type were lumped in with all others as an average.

The raw results for nickel concentration in frog GI tract values in the Control and Primary Study Areas are as follows:

Control Area: Mean levels range from about 2 to 15 ppm Ni over five control sites. Overall range is 0.3 to 48 ppm.

Primary Study Area: Mean levels range from 4.2 to 49.4 ppm Ni over five sites just east and north of the Inco refinery. Overall range is 1 to 108 ppm Ni.

Trends: Most data sets means range from 1 to 24 ppm in the Primary Study Area, except for H-1 and H-5 which have mean Ni levels of 42.6 and 49.4 ppm, respectively. Thus, the nickel levels in tissue from most Primary Study sites are somewhat similar to the Ni level in the Control sites. Sites H-1 and H-5 are north and northeast of the Inco refinery.

It is noteworthy that the level of other COCs (and non-CoCs, including lead) follows a pattern similar to that for nickel.

Nickel and other metals showed similar variability among stations within relatively small geographic areas – relative to the large Study Area. These data indicate that it may well be the case that localized data patterns/trends occur in the other local sample areas. Such trends or patterns are completely lost when all of the data over the larger area is averaged. The Independent Consultants remain convinced that the large database collected for the ERA is not being used to its optimum purposes and erroneous conclusions consequently reached.

**Specific Problems with Averaging ERA Data**

The data collection methods are described in Section 5 of the Natural Environment report and the field sampling structure for earthworms is indicated in Table 5-1 (of the JWEL report). This indicates that there are five stations to be sampled in each of the Primary, Secondary and Reference Areas for earthworms (total of fifteen) with three replicates at each station. The Independent Consultants did not observe soil sampling in 2001 and it is not clear whether 38 soil samples were collected in 2002 as stated in Table 5-3. In Table 5-6, it is indicated that 13 samples of earthworms were analyzed in 2001 (not 15) and tissue from 35 samples in 2002, not 38. Yet in Table 6-9 (of the JW report), JW provide data from 30 sites in 2002. These discrepancies are confusing.

One would expect that the next section would provide a summary of the data collected (i.e., what are the levels of CoCs found in the data at these different collection sites). However, the report proceeds with an Exposure Assessment in which the CoC data for earthworms from Primary and Secondary Study Areas are combined in Tables 6-7, 6-8, 6-9 and 6-10.

The text on page 6-22 concludes "*the data in Table 6-7 indicate that earthworm CoC concentrations are highest in the Study Area*". There is no comment on the fact that: (i) the range for nickel is 39.8 to 1,250 ppm with a standard deviation of 263 ppm, which is a relative standard deviation (RSD) of 86%, and (ii) much of the variation could be explained by the combining of data from the Primary and Secondary Study Areas. Similar ranges are evident for copper, cobalt and arsenic.

However, if one examines the same data in the January 2003 ERA, where some data are provided in separate categories of Primary, Secondary, and Reference Areas, the standard deviations (SD) are much lower. For example, the RSD for nickel in earthworms in the Primary Study Area is only 37% (less than half the deviation as in the combined data).

This combining of data across the entire Study Area results in a loss of information. One can see from the very high ranges of values (e.g., Ni in Table 6-10 (RSD = 125%)) that, within the Study Area, there is a great range of values. When one examines the actual data in relation to their geographic position, it is clear that there is a marked gradient, with high values obtained near the Inco site and lower values further away. Thus, while there is a high variability within the 18.6 $km^2$ of the Study Area, this is explicable by the high concentrations near the smelter and the lower concentrations further away.

This is particularly relevant since JW is tasked with providing suggestions for remediation if and where warranted. The areas where recommendations for remediation might be required are indiscernible in the general summary tables, due to the averaging across the area.

## 3.2 DEFINITION OF THE STUDY AREA

**Defining the Study Area by the 200 ug/g Isopleth**

An important remaining concern with the ERA is that the definition of the study area is based on a 200 ug/g nickel isopleth that was developed using the initial MOE soil quality data, despite the fact that there is now a significant volume of additional data that could have been used to better define this isopleth. The Independent Consultants have previously shown to JW that the pattern of nickel distribution using the more recent data does not correlate with the distribution using only the original MOE data. The differences in the patterns of distribution need to be reconciled and explained, because this new data may change the boundaries of the study area and possibly affect the conclusions and interpretations of the ERA NE findings.

**Excluding Residential Areas**

Animals within the urban areas of Port Colborne, such as squirrels and domestic animals, have also not been included in the risk assessment. The concern that impact of CoCs on these animals has not been addressed under the CBRA has been a long-standing and consistently expressed concern of the community. In our opinion, this is a gap in the NE ERA.

**Irregular Distribution of Sampling Stations**

Related to the general concern over the definition of the study is a concern regarding the irregularity or "patchiness" of the distribution of the sampling stations. It is understood that some amount of unevenness is inevitable to properly address sites of special interest, such as woodlots. Although we recognize that an irregular distribution doesn't necessarily imply that inferior data will be produced, it is no guarantee that it won't. If the irregularity does produce anomalous data that require follow-up, or it produces meaningful trends, either will be lost when all of the individual station data is averaged.

If JW believe that the distribution of sampling stations does not compromise their study, then an explanation should be provided to allay the concern that readers of the ERA Report are likely to have when they examine Map 1 "Sample Site Locations". The Independent Consultants have identified this issue several times to JW in the past.

## 3.3 POTENTIALLY MISSING SPECIES

A part of a review of the natural environment would logically include identifying missing species that should be present based on habitat and ecological factors; this has not been pursued in the ERA study. Similarly, little effort was made to identify species that are present, but at very low in numbers in the Port Colborne area.

In response to the concerns that missing species had not been addressed JW's response was:

> "*Given all the potential confounding factors, and time constraints for completing this study, detailed analysis of this type was not considered appropriate for the CBRA ERA.*"

Particularly given the shift in emphasis away from a risk assessment to an observational study, this cannot be regarded as a satisfactory response. It leaves the question "Are there species or populations that would be expected to be present and thriving in Port Colborne that are absent or stressed because they are exposed to CoCs?"

## 3.4 WEIGHTING OF VARIOUS STUDIES IN DETERMINING OVERALL FINDINGS

The Independent Consultants have requested previously that JW provide a better description of the process for determining the relevance of each of the studies, limitations on them, the weight that each should be accorded, and the process that was followed for selecting studies and developing conclusions from them would be valuable. Some of the issues of the Independent Consultants are as follows:

**Leaf Litter Study**

The protocol for the Leaf Litter Study states (page 1), "*In cases where the decomposition process is decreased, the amount of materials being formed and returned to the system (i.e., leaf litter fall) is greater than the amount being broken down or decomposing. Under conditions of decreased decomposition the amount of litter on the ground may start to accumulate and nutrients would not be available to the vegetation (i.e., trees) in that area. If the disruption continued over a long period of time, the tree's growth might decrease accordingly*".

The results presented by JW in Figure 8-23, Volume 1 show the mass of dry leaf litter plotted against the soil Ni concentrations. The range of values was high for woodlots in high Ni areas and in low Ni areas. The range of litter weights given by JW is from 63.2 to 536.9 $g/m^2$, i.e., an order of magnitude difference. Several types of forest were sampled (FOD 2, FOD 7, SWD 6 and MAS 3) as indicated by examining the location of Leaf Litter Sampling Locations in Maps 1, 2 and the ELC forest classifications on Map 3.

JW plots the data and suggests, "*As soil nickel concentrations increase, dry weight of leaf litter increases (Figure 8-23), presumably indicating that decomposition is slower*". For this data, with such wide ranges in the amounts of litter collected per site and such a low slope, such conclusions are at the most tenuous. While we do not question the final conclusions that the woodlots appear to be healthy, we do question the logic on which these conclusions are based.

While the Leaf Litter Study appears to be been carried out diligently by the sub-contractor, the relevance and usefulness of its findings are questionable, as "time constraints imposed by the current situation would not allow for a detailed investigation using the normal procedures. Instead a proxy method of assessing the rate of decomposition was used".

**Frogs and Toads**

Two lines of evidence are pursued by JW: the quotient method for calculating risk and a survey of frog calling.

JW highlights in their report that the quotient method determined that 80% of ponds and ditches put tadpoles at risk as a consequence of nickel exposure. However, the report dismisses this important and concerning finding and instead relies on the subjective spring calling survey to provide evidence that no unacceptable risk exists. The scientific rationale for giving more weight to the frog calling compared with the quotient method is not clearly presented. The situation is confused even more by the selective weighting given to information provided by the calling survey. For example, the absence from many calling sites of the Northern Leopard frog, generally common throughout Southern Ontario, and the lower than expected density of calling adult frogs than would be expected compared to other areas of S. Ontario is simply not explained. Furthermore, site-specific COC concentrations were not available for the frog survey stations and so Ni in the soil in the general vicinity of frog habitat was used as a surrogate for Ni concentrations in the water bodies. Given the extreme variability between sampling sites already discussed, this is highly problematic. JW, themselves admit that this is a limitation of the analysis.

So, despite two lines of evidence leading to a concern that frog and toad populations are at risk, and admitted limitations on the value of the study, the report concludes: "*CoCs in surface water of the study area does not represent an unacceptable risk to the frog and toad populations*". The quotient method is dismissed as being "*too conservative*" and the suggestion in the conclusion that the study area "*supports high species diversity and typical abundance of adult frogs for the* *species present*" begs the question of what is happening with the species absent (e.g., Leopard Frog) in many sites, and does not appear to be consistent with other observations made in the report. Notwithstanding the dismissal of the Quotient Method for the general populations of amphibia (where a problem is identified), JW appear content to retain it for assessment of Fowlers Toad, where no problem is found.

The selective use of various lines of evidence and dismissal of others without scrupulous explanation of why this is done is very troubling. It points to a lack of scientific rigour that undermines the faith that can be placed in the conclusions of the report.

**Maple Sap, Wood Cores**

In assessing woodlot health, JW considers the results of studies of woodlot health, leaf litter decomposition and maple leaf health but did not include all the woodlot studies that were carried out such as maple sap and wood increment cores. The reason for the partial selection of studies is not clear, but it seems that considerable sampling, analytical and assessment time and effort resulted in no visible input to the ERA.

## 3.5 THE LACK OF ARSENIC DATA

While the CoCs are generally dealt with in terms of their distribution in soil and in tissues, potentially useful information on arsenic has been omitted. Tables 2-8 and 2-9 describe the various means by which CoCs can be extracted from clay and organic soils for nickel, copper and cobalt, but provide no data for arsenic. Although JW comment on this matter, the fact remains that the data are missing. JW's comment is "*Data for arsenic were not obtained due to the limitations of these extraction methods with arsenic*" (p. 2-15). This means that the four different soil extraction techniques were either not capable of extracting arsenic, and/or the studies failed to examine arsenic. In either case, the report lacks potentially useful information regarding the amount of arsenic that could be available in Port Colborne soils to either have harmful or, indeed, a beneficial effect on organisms. At the very least, Tables 2-8 and 2-9 should be renamed "Percentage of *some* CoCs …".

A conclusion following Tables 2-9 says: "*less than 1% of soil CoCs are removed, indicating that soils in the Study Area have a low leaching capacity under neutral water conditions*". This generalized conclusion, and others following it, cannot be made in the absence of data for one of the CoCs.

Similarly, in the September 2004 ERA, Vol. 2, Section D, Tables 2 and 4, no arsenic data is provided despite the table titles, which include "arsenic" along with nickel, copper and cobalt. It is understood that parts of the ERA were carried out before arsenic was established as a CoC, and possibly this accounts for some of the information gaps regarding arsenic. It is suggested that a thorough review by the authors would have determined any other gaps of this nature. Arsenic may be a more recently added CoC, but it is nonetheless a CoC and should be assessed as thoroughly as the other CoCs.

## 3.6 CHANGING THE RISK QUOTIENTS

The quotient method is a cornerstone line of evidence for many of the studies that comprise the ERA NE. It is claimed to be a standardized method, although considerable changes in risk quotients are presented from the draft report to the final report. Most notably, the American Woodcock has a risk quotient (RQ) of 0.87 for nickel in woodlots in the July 2003 ERA NE report, but a RQ of 0.24 in the September 2004 report. These changes are nowhere satisfactorily justified within the report and this is an important omission.

The method is claimed to be conservative, yet there are important aspects that demonstrate a lack of conservatism. For example, the method does not consider additive or synergistic interactions. This is an important weakness when considering metal toxicity, especially when the study area is impacted by additional heavy metals, such as lead. The inclusion of factors for bioavailability into the calculation of absorbed dose is also non-conservative.

Ironically, the suggested conservatism of the method so often cited as a strength of the method, causes its rejection as the major line of evidence in favour of observational studies in the case of amphibian where the quotient method actually indicated a problem exists.

## 3.7 INADEQUATE UNCERTAINITY ANALYSIS

An "uncertainty analysis", absent in earlier drafts, is provided in the Final Draft Report to provide a response to many concerns raised by reviewers and the public regarding approaches in the ERA and assumptions in the previous report. However, this section is less of an analysis of uncertainty and more an expression of unsubstantiated opinion as to whether genuine concerns with the ERA and identified shortcomings in the study approach are likely to underestimate or overstate the assessed risk.

# 4.0 CONCLUSIONS

It is the opinion of Watters Environmental that the data presented in the Final Draft Report of the Ecological Risk Assessment – Natural Environment do not support either of the alternative conclusions made by JW because the manner in which the data were analyzed and interpreted introduced significant uncertainties into the findings. Overall, there are too many uncertainties to justify the conclusions drawn. This opinion is based on the following:

- There are elements of the study and the analyses and interpretation of results that lead to significant unacceptable uncertainties about the conclusions;

- The Study Area(s) originally included a "Primary Study Area", a "Secondary Study Area" and a "Reference Area" based on reported soil levels of CoCs, with intent to characterize exposure and risk in each. However, the Final Report merged the data from the Primary and Secondary areas, which significantly increases uncertainty in the study results. In simple terms, merging the study areas "averages away" potential risks by blending the data over a large area resulting in standard deviation for the data sets often exceeding the mean value;

- Within the Study Area(s), there are gaps in the general distribution of sampling points that exclude large areas of potentially important habitat (such as the wetland and wooded areas on Inco lands to the west of Reuter Road);

- There is insufficient sample size for several of the VECs studied to draw any reasonable conclusions on these components of the natural environment;

- The Study Area excludes the "urban" (residential) areas of Port Colborne, which has important elements of the Natural Environment both in terms of flora and fauna. As a result of this exclusion, the impact of CoCs on domestic animals and other "urban" elements of the Natural Environment have not been fully addressed;

- The conclusions of the Study are clearly based on the observations of biologists in the field. This was not the way the study was meant to be conducted but rather, the field observations were meant to provide a "reality check" on the calculated risks. The field observations were not conducted in a way that would allow sufficient scientific rigour to reach the conclusions attributable to them. JW did not attempt to identify missing or reduced species that would be expected to be present in the habitats represented in the Study area and were not sufficiently systematic to identify stress in communities. Where potential problems were flagged, such as the frog surveys, the concerns were not considered;

- The Study makes seemingly arbitrary (or at least unexplained) choices in selecting or rejecting lines of evidence for assessing risks and, uses selective weighting for study components when drawing conclusions;

- The Study did not attempt to assess the impact of arsenic on the Natural Environment;

- As the study progressed the risk quotients used for certain VECs changed without adequate justification; and

- Notwithstanding the above, the "uncertainty analysis" contained in the Report does not provide the analysis required.

The combined result of the above issues, and particularly the blending of the data, is that the standard deviation for data sets is often greater than the mean value, and the risks are most probably underestimated, particularly for species that are not mobile or show limited range. A problem certainly appears to exist for aquatic populations (typified by frogs and toads), and woodlots in high concentration areas are clearly stressed. For the rest, the averaging of data over the whole of the Port Colborne Study Area effectively renders it impossible to draw meaningful conclusions respecting the effect of CoCs on the natural environment.