A Proposed Framework for the Port Colborne Community-Based Action Plan (PCCAP)

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1.0 INTRODUCTION

The objective of the following document is to present a general framework (or outline) of the proposed Port Colborne Community-Based Action Plan (PCCAP). The results of the Port Colborne Community-Based Risk Assessment (CBRA) and the latest information gathered through consultation with the Ontario Ministry of the Environment and Climate Change (MOECC) were used to help guide the development of the framework.

Vale continues to accept and support the work, conclusions and scientific foundations of the CBRA, and importantly the specific conclusion that there are no unacceptable health risks to individuals living in Port Colborne as a result of historical emissions of nickel, copper and cobalt. However, in an effort to reach a positive conclusion to the CBRA process, Vale has drafted the Port Colborne Community-Based Action Plan (PCCAP) as outlined in this document. The document reflects input from the MOECC through several discussions largely focused on appropriate methods to reduce exposure levels in a manner which benefits the broader community of Port Colborne. Vale is presenting this compromise position on a without prejudice basis to the MOECC in an effort to resolve differing points of view on both regulatory matters and matters of science. In the event that a successful resolution is not reached on this Community-Based Action Plan, Vale reserves the right to resort to previous positions on both threshold issues and risk mitigation measures. Nothing in this PCCAP should be taken as acceptance or endorsement of the regulatory, scientific or factual areas where there has previously been disagreement between Vale and the MOECC.

1.1 Background

- The Port Colborne Community Based Risk Assessment (CBRA) was the first “wide area” risk assessment conducted in Ontario, and focused on a 29 km^2 area of potential impact in and around Port Colborne.

- The purpose of the CBRA was to assess, on a comprehensive and community-wide basis, the current day environmental and human health risks associated with elevated concentrations of nickel, copper, cobalt, and arsenic in Port Colborne soils from historic atmospheric deposition.

- The CBRA consisted of three (3) individual component risk assessments, including: a Human Health Risk Assessment (HHRA); an Ecological Risk Assessment (ERA) of the Natural Environment; and, an Ecological Risk Assessment (ERA) of Agricultural Crops.

- After much public input and review, all three (3) final component risk assessment reports of the CBRA were finalized and submitted to the Ontario Ministry of the Environment and Climate Change (MOECC) between 2005 and 2008. The MOECC began their review in 2010 after the completion of the public consultation process.

- In May of 2011, the MOECC provided comments and requests for clarification on the three (3) finalized risk assessment reports.

- In an effort to address the remaining MOECC concerns, Vale undertook additional analyses and studies in 2012 and 2013, producing new data and findings that were used to refine the results of the original risk assessments.

- In 2014, the Update Report was developed and provided, under a single cover, a primary source of information as it relates to the various scientific studies and investigations completed over the fifteen (15) year period of the CBRA and provided supplemental risk assessment results based on the additional investigations and analyses carried out by Vale.

- In May of 2016, the Ontario MOECC provided Vale with their comments and concerns on the 2014 Update Report (MOECC, 2016a).

- As there remained a considerable difference of opinion on several matters of science, the discussion transitioned to a communications and community-based action plan as the path to bridge the gap and complete the CBRA.

- Vale considered a wide spectrum of possible options and developed an action plan designed to benefit the community as a whole, which was presented to key stakeholders (MOECC, Niagara Region Public Health Department, City of Port Colborne) for feedback.

- In October 2016, the MOECC provided extensive feedback and suggested that Vale derive "alternative soil thresholds". It also requested that an external Qualified Person endorse the action plan and that the anticipated reduction in exposure resulting from the proposed action be determined.

2.0 PROPOSED FRAMEWORK FOR A PORT COLBORNE COMMUNITY-BASED ACTION PLAN

The PCCAP framework is organized into three (3) main Sections that correspond to the three (3) component Risk Assessments of the CBRA - Human Health, Natural Environment, and Crops.

2.1 Community-Based Action Plan – Human Health

The latest MOECC (2016a) review of the 2014 Update Report identified a number of concerns related to the assessment of human health hazards, including:

- the application of an oral Toxicity Reference Value (TRV) (of 20 µg/kg/day) used to characterize human health risks/hazards;
- the methods used to estimate background dietary exposures to nickel;
- the bioavailability and bioaccessibility estimates used for nickel in soil;
- the methods used to estimate indoor dust concentrations from outdoor soil; and,
- the incidental soil and dust ingestion rates used to estimate exposures for toddlers.

All of the concerns listed above have an impact on the final proposed Risk Based Soil Concentrations (RBSCs) for nickel.

2.1.1 RBSC Development Comments from the MOECC

- After further conversation with the MOECC, it was determined that the MOECC has specific concerns surrounding toddlers and their potential exposure to nickel present in soil and indoor dust via incidental ingestion of soil and dust.

- As such, the MOECC suggested an approach for developing risk-based soil concentrations (RBSCs) to be protective of toddlers consuming soil and dust. The approach suggested by the MOECC was a 'modified' approach used to derive the 'S1 Soil Component Value' under Ontario Regulation 153/04.

- Under Ontario Regulation 153/04, the MOECC Approved MGRA Model (November, 2016) presents an 'S1 Soil Component Value' for nickel, protective of toddlers in direct contact with soil in a residential setting, of 330 µg/g. The S1 component uses an oral TRV of 20 µg/kg/day, a default generic soil allocation factor (SAF) of 0.2 (or 20%), a default oral Relative Absorption Factor (RAF) of 100%, and a default dermal RAF of 0.2.

- An oral TRV for nickel (of 11 µg/kg/d) was suggested for use by the MOECC. This TRV is approximately equal to the estimated daily intake (EDI) of toddlers from all background sources (including food) of 10.6 µg/kg/d (CCME, 2015). As such, the MOECC suggested an approach similar to that used by the CCME (2015), whereby, the RBSC (protective of incidental soil and dust ingestion) was developed by allocating 10% to 20% of the EDI for toddlers (*i.e.,* 1.1 µg/kg/d to 2.2 µg/kg/d) to soil. Note that for the purposes of calculating RBSCs, the MOECC's suggested approach used an EDI of 11 µg/kg/d.

- The most significant difference between the Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) scenarios is the application of different soil/dust ingestion rates. The RME and CTE scenarios employed total soil/dust intake rates of 200 mg/d and 110 mg/d, respectively. It is noted that the CBRA Update report employed the use of a soil ingestion rate of 110 mg/day. The MOECC has indicated that 200 mg/d is also valid for use in the CBRA as a RME estimate. The CCME (2015) employs a soil ingestion rate of 80 mg/day. The RBSCs (for each soil type) developed using the MOECC's suggested approach are provided in Table 1a.

- The methods and assumptions suggested for use by the MOECC to develop RBSCs (presented in Table 1a) are summarized in Table 1b.

Table1a: RBSCs for Nickel Suggested by the MOECC to be Protective of Human Health					
Soil Type	10% EDI		20% EDI		Average RBSC[1]
	RME	CTE	RME	CTE	
Fill	*637*	1,158	1,274	*2,317*	***1,300***
Clay	*892*	1,622	1,784	*3,244*	***1,900***
Organic	*418*	760	836	*1,520*	***880***

[1]Values rounded to 2 significant figures.

Table 1b – Summary of Suggested Methods Provided by the MOECC

Parameter	Description	Units	Port Colborne 10% EDI CTE	Port Colborne 10% EDI RME	Port Colborne 20% EDI CTE	Port Colborne 20% EDI RME	COMMENTS / REFERENCES
RBSC	*Risk-Based Soil Concentration*	*ug/g*	*1,158*	*637*	*2,317*	*1,274*	RSBC as calculated by the MOECC - based on the approach that 1.1 to 2.2 ug/kg/d Ni can come from soil plus indoor dust (10% of EDI = x + 0.56x), where x = soil and 0.56x = Ni in indoor dust. For example: 0.1*EDI = SIRadj*x +DIRadj*0.56x, solving for x; x = 0.1*EDI / (SIRadj + 0.56DIRadj)
SIRadj	Adjusted soil ingestion rate	g/d	0.009	0.016	0.009	0.016	[SDIR(g/d)*FIRS(unitless)*RAForal(unitless)*Efs(d/w)*EFs1(w/yr)*ED(yr)]/[(AP(yr)*C(d/yr)]
DIRadj	Adjusted dust ingestion rate	g/d	0.013	0.023	0.013	0.023	[SDIR(g/d)*FIRD(unitless)*RAForal(unitless)*Efd(d/w)*EFd1(w/yr)*ED(yr)]/[(AP(yr)*C(d/yr)]
EDI/TRV	Background Ni Exposure - Toddler	ug/kg/d	11	11	11	11	Estimate of 11 ug/kgbw/day use by MOECC . NOTE that CCME (2015) states an EDI (for toddlers) of 10.6 ug/kg/d and a TRV of 11 ug/kg/d
FREDI	Fraction of EDI allowed to come from soil and dust	unitless	0.1	0.1	0.2	0.2	10% or 20% of EDI (11.14 ug/kg/d) as per CCME (2015) and MOECC
$Dose_{soil+dust}$	Average daily dose allowed to come from soil and dust	ug/d	18.2	18.2	36.3	36.3	1.1 ug/kg/day X 16.5 kg X 0.1 = 18.4ug/d or 2.2 ug/kg/day X 16.5kg X 0.2 = 36.8 ug/d
RAF_{oral}	Soil Relative Absorption Factor (oral RAF)	unitless	0.21	0.21	0.21	0.21	MOECC has applied the CTE RAF for all soil types (21% fill; 15% clay; 32% organic)
SDIR	Daily Soil and Dust Ingestion Rate	g/d	0.11	0.2	0.11	0.2	CTE (110 mg/d) and RME (200 mg/d) soil and dust ingestion rates as per MOECC comments on Update Report
FIRS	Fraction of SIR that is from soil	unitless	0.45	0.45	0.45	0.45	default apportionment of total soil and dust ingestion from US EPA IEUBK 45:55% - as per MOEC comments
FIRD	Fraction of SIR that is from dust	unitless	0.55	0.55	0.55	0.55	default apportionment of total soil and dust ingestion from US EPA IEUBK 45:55% - as per MOECC comments
Efs	Exposure Frequency - soil	days/week	7	7	7	7	standard exposure frequency
Efs1	Exposure Frequency - soil	weeks/yr	43	43	43	43	assumed 302/365 days of access to soil (or 63 days of cover); default S1 value is 39 weeks (91 days of cover)
Efd	Exposure Frequency - dust	days/week	7	7	7	7	standard exposure frequency
Efd1	Exposure Frequency - dust	weeks/yr	52	52	52	52	assumes 365/365 days of access to dust (or 0 days of cover); CTE assumes some time away from primary residence
ED	Exposure Duration	years	4.5	4.5	4.5	4.5	standard exposure frequency
BW	Body Weight for S1	kg	16.5	16.5	16.5	16.5	Toddler body weight as per MOECC
C	Unit Conversion	days/year	365	365	365	365	standard exposure frequency
AP	Averaging Period	years	4.5	4.5	4.5	4.5	standard exposure frequency

2.1.2 Development of a Tiered Remedial Strategy – Human Health

- Applying the MOECC suggested approach described above and adjusting specific input parameters (i.e., the oral TRV and SAF), a series of concentration bands of nickel in soil were developed in an effort to provide a tiered remediation approach that bridges the gap between the RBSCs developed in the CBRA and outstanding MOECC concerns with their derivation.

- Five (5) concentration bands (or tiers) for each soil type (clay, fill material, and organic soils) were developed. The concentration bands represent RBSCs developed using the same approach suggested by the MOECC (in Table 1) but adjusting the oral TRV and the soil allocation factor (SAF).

- As discussed in further detail below, each concentration band is associated with an action(s) in an effort to mitigate potential exposures. With each successive concentration band, the action(s) required to mitigate potential exposures increases.

2.1.2.1 Development of Concentration Bands

Prior to presenting the concentration bands and associated action items (Table 4), the following provides a brief description of how each band was derived.

- The CCME (2015) indicated that it seems '*…reasonable that a 10% increase in the EDI is within the variability of observed data from various media'*. The CCME (2015) reports a provisional range of nickel concentrations in background till (of < 2 to 215 mg/kg) to provide justification for this statement. However, the CCME (2015) does not acknowledge the combined variability associated with all of the input parameters required to approximate an EDI (e.g., food intake rates, body weights, nickel concentrations in various food products, etc.)

- As such, exceeding the nickel EDI by 20% (as opposed to 10%) is likely a more realistic indication of additional exposures in excess of typical background conditions. Twenty percent (20%) is also consistent with the MOECC default SAF of 0.2 (or 20%) used to develop soil standards under Ontario Regulation 153/04.

- Rather than taking the average of the four (4) RBSC estimates (as illustrated in Table 1), the median (or middle value) between the RME and CTE estimates (that utilize 20% of the EDI) was considered to result in a concentration of nickel in soil more likely to result in exposures (among toddlers) greater than typical background conditions (i.e., the EDI).

- Based on the rationale provided above and using the same approach and input parameters suggested by the MOECC (Table 1), RBSCs (for Band 1) of 2,500 ppm, 1,800 ppm, and 1,200 ppm were derived for clay, fill, and organic soil, respectively. Nickel concentrations in soil below these levels do not warrant any proposed action (refer to Table 2).

Table 2 – RBSCs for Nickel in Port Colborne using an Approach Suggested by the MOECC			
Soil Type	20% of the EDI		Median RBSC[1]
	RME	CTE	
Fill	1,274	*2,317*	***1,800***
Clay	1,784	*3,244*	***2,500***
Organic	836	*1,520*	***1,200***

[1]Median values rounded to two significant figures

- The background EDI of nickel for toddlers from dietary sources as suggested by the MOECC (2016a) is 11 µg/kg/day and represents 55% of the oral TRV (of 20 µg/kg/day). Allocating 40% of the oral TRV of 20 µg/kg/d (or 8 µg/kg/d) to soil/dust related exposures, reserves 60% of the oral TRV (or 12 µg/kg/d) for other sources, including diet.

- Applying the same approach and input parameters suggested by the MOECC to derive RBSCs presented in Table 1 but assigning 40% of the oral TRV of 20 µg/kg/day (*i.e.,* 8.0 µg/kg/d) rather than 10% to 20% of the EDI, results in the following RBSCs (Table 3);

Table 3: RBSCs for Nickel in Port Colborne Using the 'Modified S1 Component Value' Approach and 40% of the oral TRV of 20 µg/kg/day			
Soil Type	40% of TRV		Median RBSC[1]
	RME	CTE	
Fill	4,634	*9,043*	***6,800***
Clay	6,487	*12,660*	***9,600***
Organic	*3,041*	5,934	***4,500***

[1] Median RBSCs have been rounded to 2 significant figures

- As illustrated above, the MOECC default soil allocation factor SAF (of 20%) is not a reasonable assumption as it applies to nickel. In other words, there is no need to reserve 80% of the oral TRV for nickel to account for other sources of exposure since it has been demonstrated that the EDI for nickel (of 11 µg/kg/day) represents approximately 55% of the oral TRV of 20 µg/kg/day. It is not unprecedented for default SAF to differ from 20% for some chemical parameters. For example, the default SAF for petroleum hydrocarbons (PHCs) in soil is 0.5 or 50% (MOECC, 2016b).

- Table 4 presents the five (5) concentration bands for each soil type of interest, an interpretation of nickel exposures (based on the methods used to derive the RBSCs), and corresponding intervention strategies (or actions) to eliminate or reduce potential exposures of toddlers to nickel in soil.

- It should be noted that as you progress from concentration band 2 to concentration band 5 (Table 4), the exposure assumptions used to derive the RBSCs (or concentration bands) become less of a 'reasonable worst-case' and, therefore, the likelihood of actual exposures (from soil and dust) approaching or exceeding the 40% of the oral TRV increases as you progress through the concentration bands.

- To be consistent with the previously issued MOECC Control Order, concentration band 5 for clay and fill material soils was set at greater than 8,000 ppm nickel in soil. Calculations representing exposures for toddlers to nickel that meet or potentially exceed 40% of the EDI result in much higher concentrations for the stated soil types.

- RBSCs or concentration bands presented below (Table 4) represent exposure point concentrations (EPC) within a given exposure unit (EU). A typical EU within a residential setting may be considered a single residential property.

- The US EPA Risk Assessment Guidance for Superfund (US EPA, 1989) recommends that the reasonable maximum exposure should be evaluated using the upper 95% confidence interval on the arithmetic mean of the data set (*i.e*., the 95% UCLM). This is considered to be the reasonable maximum exposure point concentration to which a receptor might be exposed over a significant amount of time within a given EU. When enough data are present, the 95% UCLM incorporates the central tendency (*i.e*., the arithmetic mean) and the variability associated with the data set.

Table 4: Tiered Remedial Action Plan for Residential Properties – Human Health

Concentration Band	Exposure Point Concentrations (ppm)			Description	Proposed Actions
	Clay	Fill Material	Organic Soil		
1	≤ 2,500	≤ 1,800	≤ 1,200	Toddlers who come into regular contact with soil over a prolonged period of time containing nickel within Concentration Band 1 (i.e., 1,200 ppm to 2,500 ppm) are likely to experience exposures (via incidental ingestion of soil and indoor dust) that are less than 20% of the Estimated Daily Intake (EDI) of nickel from all background sources, including food of 11 ug/kg/d (i.e., 2.2 ug/kg/d).	No Action Proposed - long-term exposures of toddlers from soil containing nickel within this Concentration Band are likely to be less than 20% of the background EDI of nickel from all sources, including diet.
2	> 2,500 ≤ 6,500	> 1,800 ≤ 4,600	> 1,200 ≤ 3,000	Toddlers who come into regular contact with soil over a prolonged period of time containing nickel above Concentration Band 1 may experience exposures that exceed 20% of the EDI from all background sources, including food of 11 ug/kg/d (i.e., 2.2 ug/kg/d). Nickel concentrations within Concentration Band 2 are likely to result in exposures among toddlers that are less than 40% of the oral Toxicity Reference Value (TRV) of 20 ug/kg/d (*i.e.*, 8 ug/kg/d).	**1.)** Communication Plan - Communicate (in consultation with the local Public Health Department and MOECC) that nickel concentrations found in Concentration Band 2 may result in exposures (among toddlers) that are greater than 20% of the EDI of nickel from all background sources but likely less than 40% of the oral toxicity reference value (TRV) of 20 ug/kg/d (i.e., 8 ug/kg/d).
3	> 6,500 < 8,000 (> 6,500 ≤ 9,600)	> 4,600 ≤ 6,900	> 3,000 ≤ 4,500	Toddlers who come into regular contact with soil over a prolonged period of time containing nickel within Concentration Band 3 may, under conditions approaching a reasonable worst-case, experience exposures that approach or are equal to 40% of the oral TRV for nickel of 20 ug/kg/day (i.e., 8 ug/kg/d). It is noted for clay soils, nickel concentrations were limited to < 8,000 ppm (under Band 3) to be consistent with a previous MOECC Order that soil (of an unspecified nature) containing nickel > 8,000 ppm be removed.	**1.)** Communication Plan and; **2.)** A re-greening effort whereby bare or exposed native soil material is covered in an effort to limit direct access to native soil materials and reduce re-suspended wind blown dust. Depending on the location and landuse, the re-greening effort may range from the addition of top soil and sod in low traffic areas to the application of engineered surfaces in high traffic areas used by children (e.g., around play structures, swings, etc.).
4	NA (> 9,600 ≤ 12,600)	>6,900 <8,000 (>6,900 <9,000)	>4,500 <5,900	Toddlers who come into regular contact with soil over a prolonged period of time containing nickel within Concentration Band 4 are more likely to experience exposures that approach or are equal to 40% of the oral TRV for nickel of 20 ug/kg/day (i.e. 8 ug/kg/d). It is noted that for clay and fill material, nickel concentrations were limited to 8,000 ppm (Band 4) to be consistent with an MOECC Order that soil (of an unspecified nature) containing nickel > 8,000 ppm be removed.	**1.)** Communication Plan.and; **2.)** A limited soil removal program for properties who have concentrations within Concentration Band (4); and **3.)** Possible removal and cleaning of in-house dust.
5	≥8,000	≥8,000	≥5,900	Consistent with previous MOECC Order, soil material (of an unspecified nature) that contains nickel greater than 8,000 ppm will be removed. Toddlers who come into regular contact with 'organic soils' over a prolonged period of time containing nickel greater than 5,900 ppm are likely to experience exposures to nickel that meet or potentially exceed 40% of the oral TRV for nickel of 20 ug/kg/day (i.e., 8 ug/kg/d).	**1.)** Communication Plan; and **2.)** Soil removal and replacement program consistent with the previous Order should be undertaken for those properties with an Exposure Point Concentration (EPC) > 8,000 ppm in fill material or clay. Consistent with the previous Order, the program should address impacts to a depth of 12 inches. For properties classified as having organic soils with an EPC > 5,900 ppm, soil removal and replacement (to 12 inches in depth) should be priorized in yards where children under 6 years old reside; and **3.)** Possible removal and cleaning of in-house dust.

NA - Not applicable. Calculated RBSC in clay exceed the 8,000 ppm limit. As such, this concnetration band is not applicable to clay material.

2.1.3 An Overview of Proposed Remedial Actions and their Associated Effectiveness

- Table 4 presents five (5) different possible intervention strategies (or actions) to be used in an effort eliminate or reduce potential exposures of toddlers to nickel present in soil and indoor dust. These actions include:
  - A Communications Plan and/or Public Outreach and Education;
  - A Regreening Plan;
  - An in-home dust cleaning program to remove or clean settled surface dust;
  - A limited soil excavation and replacement plan; and
  - A full depth (12 inches or 30 cm) soil removal and replacement program

- Different remedial actions are proposed depending on the concentration band that a particular property falls within. For example, a residential property that falls within concentration band 3 would be subject to the communications plan and a re-greening program. Whereas a property determined to fall within concentration band 5, would be subject to a communications plan, full depth soil removal/replacement and an in-home dust cleaning program.

The following provides further details on each of the proposed intervention strategies or actions mentioned above.

2.1.3.1 Communication Plans – Public Outreach and Education

- Any type of communications or public outreach/education plan should be designed in consultation with the local Public Health Unit and the MOECC.

- Public Outreach and Education programs may include activities such as:
  - *Publication and Distribution of Fact Sheets* – general public health facts pertaining to how people are exposed to nickel, what the possible health implications are, who are the most sensitive individuals within a community, and measures that can be taken to help reduce personal exposures (*e.g.,* hand washing and indoor dust control, etc.). These fact sheets may be available on-line, at community events, and/or for pick-up at various public buildings in the community.

  - *Development of Website and Social Media* – could be launched and may represent an online hub for all program information, updates, and resources. Program information could also be shared through various social media channels: Facebook, Twitter, etc.

  - *Community Events and/or School Visits* – in consultation with Public Health Unit and the MOECC, efforts could be made to provide continued outreach to members of the community and the local schools to communicate public health information concerning the importance of hand washing efforts with a particular focus directed to towards young children (age 6 and under).

- *Door-Knocking Campaign*s – may be considered in the most affected areas. This provides an opportunity to distribute public health information and details concerning any remedial work being offered. It also provides an opportunity to discuss concerns or questions on a one-on-one basis. Residents that are not at home can be left information packages specific to their concentration band (or zone) in their mailboxes.

2.1.3.2 Regreening or Revegetation Program

A re-greening program could be established whereby bare/exposed native soil material is identified and covered in an effort to reduce:

- the opportunity for direct contact with isolated areas of bare native soil;
- the opportunity for outdoor soil to be tracked into indoor environments; and,
- the opportunity for bare soil to be re-suspended into windblown dust.

- Any re-greening program is not likely to be completed within a single season. On-going monitoring and re-greening efforts are recommended not only to ensure that previously treated areas are effectively established but that a continued effort to identify bare soil areas is recommended on a seasonal basis for an agreed upon time frame.

- The re-greening techniques may vary depending on the specific land use. For example, high foot-traffic areas used predominately by children (*e.g.,* playgrounds, play equipment areas, etc.) may require an engineered permanent barrier as a vegetative cover would likely not withstand the constant foot traffic. In lower foot traffic areas, establishing vegetation on existing bare soil areas may be more appropriate.

- Consideration should be given to the selection of appropriate plant species prior to application. Plant species that are quick to establish and that are drought tolerant are vital considerations.

- Re-greening efforts would require the proper incorporation of top soil and the application of a vegetative cover.

- If there are areas where grass is considered the most appropriate vegetative cover, it is recommended that top soil be properly incorporated into the affected area and that either sod or preferably hydroseeding methods be used. These methods (as opposed to seed) increase the likelihood of establishing a vegetative cover.

- Hydroseeding is the preferred overall option in that the watering requirements are less and, therefore, the likelihood of establishing grass is increased over sod and/or seed applications.

2.1.3.3 In-Home Surface Dust Cleaning/Removal

- The methods used to derive the action trigger levels (presented in Tables 1 through 3) and the foundation of the concentration bands (presented in Table 4) assume that a specific proportion (approximately 56%) of the nickel present in outdoor surface soil is present in indoor surface dust. The method also applies approximately half (or 50%) of the total soil/dust ingestion rates (of either 200 mg/d or 110 mg/d) to indoor surface dust.

- Mitigating direct exposures to nickel from soil alone may not (given the assumptions outlined above) necessarily mitigate all soil-related exposures (*i.e.,* nickel present in indoor dust originating from soil).

- It is important to note that there are no on-going atmospheric emissions of nickel in the area and, therefore, surfaces are not continuously impacted by atmospheric deposition.

- As such, an indoor dust mitigation program designed to provide a one-time extensive cleaning/removal of indoor settled dust after soil mitigation measures have been completed will be offered in an effort to mitigate exposures resulting from direct contact with indoor dust.

- For those residential properties that potentially require indoor dust mitigation (*i.e.,* residential properties that fall within concentration bands 4 and 5), it is recommended that indoor dust sampling and analysis will be completed prior to commencing indoor cleaning activities.

    - In 2011, a report was written by Wilson Scientific and Meridian under contract to Health Canada entitled: *Guidance on the Assessment of Human Health Risks Posed by Contaminants in Indoor Dust and Derivation of Human Health-Based Screening Concentrations for Contaminants in Residential and Commercial Environments.*

    - This document provides recommendations (including detailed protocols) for the sampling of indoor dust. In addition to these protocols, the report derives generic screening-level indoor dust concentrations for nickel (and other metals) that may exist inside residential homes and commercial buildings that are protective of human health.

    - The proposed generic indoor dust screening concentrations for nickel designed to protect human health are as follows:
        - Residential – 1,000 µg/g or 570 µg/m^2 for wipe samples
        - Commercial with toddlers (e.g., daycare, schools) – 2,200 µg/g or 1,200 µg/m^2 for wipe samples

    - It should be recognized that the screening levels stated above are generic and hence highly protective or conservative. The input parameters used are generic but the ability (if necessary) to alter these input parameters exists. For example:
        - The Ni screening values assume 100% bioavailability – a conservative assumption.

- If the results of the indoor dust sampling and analysis indicate that nickel concentrations are less than health-based screening-levels, no indoor dust mitigation would be required. If indoor dust levels exceed the generic screening-levels, indoor dust mitigation could proceed.

- The one time in-home dust cleaning/removal should be conducted by qualified individuals who have the ability to follow many of the procedures used to remove lead dust.

- The Children's Environmental Health Branch of North Carolina Department of Environment and Natural Resources provides detailed procedures on cleaning techniques to remove lead dust. The most effective method for removing lead-impacted dust combines both vacuuming and wet wiping.

2.1.3.4 Limited Soil Removal Program

- A limited soil removal program may involve the following actions:
  - Through the use of a portable XRF, delineation efforts within a given exposure unit (i.e., a residential property) would be required to further characterize the lateral and vertical extent of soil impacts on a given residential property.
  - If isolated impacts above the applicable health-based RBSC (e.g., 6,900 µg/g) are identified, the top surface layer of native soil (*e.g.,* the first 5 to 10cm) is removed from this specific area.
  - If confirmatory soil testing reveals that the remaining native soil material within the excavated area still exceeds the applicable RBSC (*e.g.,* 6,900 µg/g for fill material), further soil removal may be required (to a depth of 30 cm) and replaced with clean fill to original grade.

2.1.3.5 Full Depth Soil Removal and Replacement

- Consistent with a previous MOECC Order concerning residential properties on Rodney Street, native soil material containing nickel greater than or equal to 8,000 µg/g will simply be removed to a depth of 30 cm (or 12 inches) and replaced with clean fill to the original grade.

2.2 Community-Based Action Plan – Natural Environment

- Substantive revisions to the Risk Assessment for the Natural Environment were made in response to comments received from the MOECC in May of 2011. Despite these revisions, the MOECC has indicated that significant concerns remain with the site-specific soil intervention values protective of the natural environment.

2.2.1 Recommended Actions for the Natural Environment

- It is proposed that further work be conducted on the aquatic environment. More specifically, a survey of the aquatic environment be conducted. The objective of the survey would be to better characterize aquatic risks in municipal drains east of the refinery. Such a survey would seek to identify the role of Ni in aquatic risk in these drains. Slightly elevated total Ni concentrations have been documented in the Wignell and Beaverdam Drains. These drains are used for quarry dewatering and also receive significant agricultural inputs.

- Further study is required in the woodlot areas to identify more sophisticated risk management options. Previous risk management plans (Vale Inco's "Integration Report") had taken the stance that woodlots should not be bulldozed in order to remediate the elevated soil metals present. However, it is possible that woodlot management could be undertaken in the form of selective silviculture and hot-spot clean-up within the woodlots. Alternatively, although the most contaminated woodlots are known to have some impairment, the woodlots appear to be more or less normal to those without specialized knowledge of ecological processes. It is proposed that a Reuter Road Woodlot scoping study be conducted to ascertain whether to leave the woodlots alone or take a more substantive approach to managing them. The study will also look at human interactions with the woodlot to determine future fencing needs and registration on title.

2.3 Community-Based Action Plan – Ecological (Crops)

- The MOECC indicated that although the 2014 Update Report considered additional information from other crop studies conducted in the Port Colborne environment, the latest analysis, does not 'adequately reflect' their previous concerns.

- Although the 2004 Crops Report includes several studies, the numerical Site Specific Threshold Level (SSTL) values were derived from the JW 2001 greenhouse studies. The MOECC indicated (in their May, 2011 comments) that, for various reasons, these studies were not considered definitive.

- The 2014 Update Report reaffirmed Vale's stance on the SSTLs, and the MOECC's latest comments indicate that it still considers Vale's proposed SSTLs to be unacceptable. In the absence of consensus between Vale and the Ministry, Vale has nevertheless been studying potential remediation options for the agricultural lands around the refinery. The potential remediation options currently favoured by Vale are presented below.

2.3.1 Recommended Actions for the Ecological Assessment (Crops)

- The previously proposed agricultural risk management proposal was to add lime at a very high rate (88 T/ha) to minimize Ni bioavailability and toxicity to plants. A trial was conducted by Vale in 2015 and 2016. Vale's current view is that this approach is less suitable than deep tilling. The lime additions are not permanent and application itself represents an issue for crop husbandry.

- Phytoremediation using the plant *Alyssum murale* had been previously proposed as a potential remedial approach. However, experiences with phytoremediation with *Alyssum* have shown the plant has the potential to become an invasive weed. Finally, although *Alyssum* does indeed hyperaccumulate Ni to very high levels in its tissues, Vale's current models of the success of phytoremediation suggest that phytoremediation would not be effective within a reasonable time period.

- Vale's current recommended approach for remediation of agricultural lands is deep tilling of agricultural soils (to a depth of 30 cm) to mitigate potential agricultural impacts. Since the contamination is largely present in the upper 15 cm of soil, the effect of this deep tilling is to reduce the soil CoC concentrations by half.

- A preliminary deep-tilling trial was conducted in the field in October, 2016, and a laboratory pot study has evaluated the potential fertility issues associated with bringing deeper (15-30 cm depth) soils to the surface and distributing the metal-rich surface soil (0-15 cm) deeper into the soil profiles. These preliminary studies indicate that the deep tilling approach may be the most suitable option for managing the metal-contaminated agricultural lands.

2.4 Effectiveness of Proposed Remedial Actions

- Under Ontario Regulation 153/04, there is a requirement that any Risk Management Plan (RMP) include a discussion of the performance objectives of the risk management measure (or actions) being proposed. As part this discussion, there is a requirement (under the Regulation) to provide an estimate of the anticipated reduction in exposure that will result from the risk management measure being implemented.

- It is understood that the PCCAP does not fall under Ontario Regulation 153/04; however, a request was made by the MOECC to include this type of information in any action plan moving forward.

- The objectives of risk management measures or actions are to mitigate or completely block exposure to the contaminants of concern (COCs). It is anticipated that the opportunity to come into direct contact with surface soil and indoor dust (originating from surface soil) containing nickel will be reduced through the combined implementation of a communication/outreach program, re-greening efforts, and an indoor dust removal/cleaning program.

- Direct contact with impacted soil will be blocked through the implementation of a limited soil removal program in residential surface soils containing nickel within concentration band 4. Full depth soil removal and replacement of residential soil greater than or equal to 8,000 µg/g will result in a complete removal of the potential exposures from native materials. A summary of the performance objectives of the risk management measures (RMMs) is provided below (Table 5).

Table 5 Performance Objectives of the Proposed Risk Management Actions/Measures

Proposed Risk Management Measures or Actions	***Estimated Reduction in Exposure***
Communications Plan – Public Outreach and Education	Certain aspects of an outreach program (*e.g.,* handwashing programs, etc.) may result in an overall reduction in exposures among toddlers. A quantitative estimate of the % reduction in exposure cannot be effectively stated. Refer to the discussion below.
Revegetation program to minimize areas of bare native soil material.	This proposed action should reduce the probability of direct contact with bare native soil materials, reduce the amount of soil tracked into indoor environments, and reduce the generation of wind swept dusts. A quantitative estimate of the % reduction in exposure cannot be effectively stated.
In-home surface dust removal/cleaning program	A reduction in exposure to nickel from indoor surface dust is anticipated to occur as a result of this remedial action; however, a quantitative estimate of the % reduction cannot be confidently determined. Refer to the discussion below.
Limited soil removal program	It is anticipated that a 100% reduction in exposure to impacted soils would be experienced by residents.
Full depth (up to 30 cm) soil removal and soil replacement program	100% reduction in exposure to impacted soil would be anticipated
Aquatic Survey and Wood Lot Scoping Study – Natural Environment	Exposure reduction estimates are not applicable with respect to these two proposed actions.
Deep Tilling – Agricultural Soils (Crops)	A quantitative estimate of the exact % reduction cannot be confidently determined. It is anticipated that deep tilling will effectively mitigate impacts on agricultural crops by a factor of 2.

2.4.1 Discussion Concerning Effectiveness of Individual Risk Management Actions

- Attempting to provide meaningful quantitative estimates concerning the effectiveness of certain remedial measures or actions (expressed as a percentage of a reduction in exposure) is often simply not possible within the context of an overall remedial action plan. The following highlights the challenges with attempting to quantify reductions in exposures as a result of a specific risk management measure by providing examples of lead exposure reduction strategies at existing and former mining and smelting sites.

- There are many examples in the scientific literature of intervention or remedial action programs that have been used at existing and former mining and smelting sites in an effort to reduce exposures of nearby populations to metals of concerns. Many of these intervention programs and individual techniques have focused on reducing exposures of young children to lead at sites where active point-source emission(s) exist.

- Many of the intervention programs used measurements of blood lead levels (BLLs) among young children to determine the effectiveness of the intervention programs. There are several examples of programs (*e.g.,* Broken Hill, Torreón, Port Pirie, Herculaneum, etc.) that employed a variety of exposure reduction strategies simultaneously (*e.g.,* emission reduction, soil replacement, in-home dust cleaning, handling modifications, re-location of at-risk families, education, *etc.*); however, it was not possible to determine which specific intervention was responsible for the observed decrease in BLLs (Boreland et al., 2008, 2009; CDC, 2001; Rubio-Andrade et al., 2011; Soto-Jimenez and Flegal, 2011; Maynard et al., 2003; Talyor, 2012; Simon et al., 2006; ATSDR, 2002; CDC, 2005a).

- Examples from other smelter sites (e.g., La Oroya and Flin Flon) and the scientific literature would suggest that primary prevention approaches that result in a reduction or elimination of ongoing lead source(s) (e.g., reduction in smelter and fugitive emissions and/or modifications to handling methods, etc.) were likely most effective at reducing BLLs (CDC, 2005b; US Committee on Foreign Affairs, 2012).

2.4.2 Examples of the Effectiveness of Education and Household Interventions Concerning Lead

- Educational programs providing information concerning lead hazards and in-home dust mitigation techniques (*e.g.,* wet mopping, reducing soil track in, vacuuming, *etc.*) have been shown when used alone to have limited effectiveness in lower blood lead levels (BLLs) among children at sites where active point source air emissions are ongoing (Taylor et al., 2011). It is noted that there are no active point source air emission impacting the Port Colborne community and, therefore, residential properties are not subjected to ongoing atmospheric deposition.

- Kegler and Malcoe (2004) tested the efficacy of community education (delivered by way of a lay health advisor) as the primary intervention in reducing mean BLLs among Native American children living in a former mining area and were unable to exclusively attribute the educational intervention efforts to declines in BLLs.

- Lanphear et al. (2000) found no significant change in BLLs among children whose families received information on lead poisoning prevention, cleaning techniques, equipment and supplies to reduce lead-impacted house dust. Dust mitigation efforts did not appear to be effective in reducing BLLs, unless conducted by professional dust mitigation teams.

- Campbell et al. (2003) concluded that a one-time professional cleaning of homes occupied by children with elevated BLLs was effective in significantly reducing dust lead levels; however, dust lead levels returned to pre-cleaning levels within 3 to 6 months. It should be recognized that in the case of lead, a variety of indoor sources of lead have potential to contribute to indoor dust lead levels.

- Ettinger et al. (2003) found significant reductions in most dust samples after a single professional cleaning.

- Rhoads et al. (1999) observed that continued in-home cleaning interventions conducted once every two weeks by trained workers for one year resulted, on average, in a 17% decrease in BLLs among children (average age 20 months) over pre-intervention measurements (average BLL of 20 µg/dL). It was noted that children in homes that were cleaned 20 or more times throughout the one year (i.e., those household that missed few cleaning appointments) had an approximately 34% decline in BLL.

- Despite the lack of evidence supporting the efficacy of educational-based interventions directed towards parents concerning the importance of personal hygiene, child mouthing behavior, and household dust, these programs are often employed in response to evidence indicating elevated BLLs among children. Although these types of interventions have, in some instances, been reported to lower BLLs among children, Taylor et al. (2011) indicated it is difficult to attribute reductions in BLLs to any one individual intervention (*e.g.,* hand washing versus wet mopping, *etc.*).

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