Executive Summary

Conclusions

The Ministry of the Environment's soil investigation and human health risk assessment report for the Rodney Street community has determined that elevated nickel and lead soil contamination on some properties warrants action. This report is the ministry's final report and supercedes the two earlier versions (March 2001, October 2001). The report provides a comprehensive soil investigation and human health risk assessment that examined almost 2,000 soil samples from about 200 properties to determine the level of human health risk posed by metal and arsenic levels in surface soil in the Rodney Street community. The health risk assessment reviewed concentrations of seven metals and arsenic and makes the following final recommendations:

- an intervention level of 8,000 parts per million[1] be set for soil nickel. The intervention level for nickel requires action through remediation of soil.

- an intervention level of 1,000 ppm for lead for play areas on residential properties or in public areas ***covered by sod or grass*** to which children have access. ***The bare soil*** intervention level for lead is 400 ppm for these areas. The intervention levels for lead require action through follow-up by individual residents to reduce personal exposure to lead.

The assessment also concludes that no action for the remaining five metals (antimony, beryllium, cadmium, copper, cobalt) and arsenic in soil is required.

In carrying out the investigation and assessment, the Ministry of the Environment identified soil nickel levels in excess of 8,000 ppm, in at least one composite soil sample, in the first 30 cm of soil at 25 properties. The soil nickel results from historical emissions from Inco Limited (Inco). The ministry also found soil lead levels in excess of 1,000 ppm at 11 properties, including two of the 25 properties with elevated soil nickel levels. These soil-lead levels are typical of older urban residential neighborhoods and result from the historical use of lead-based paints, leaded gasoline and discarded lead-acid batteries. The elevated lead levels found on some properties are not caused by either Inco or Algoma emissions.

The following summarizes the report's key findings for the Rodney Street community:

1. A soil nickel intervention level of 8,000 ppm has been established to protect toddler-aged children (7 months to less than 5 years);

2. Soil nickel levels in the community should not pose any immediate or long-term risks to other age groups;

[1]Also referred to as ppm, µg/g, micrograms per gram, or, millionths of a gram.

3. At least one composite soil sample from twenty-five properties had more than 8,000 ppm nickel;

4. Intervention levels for lead have been established to protect children;

5. Eleven properties have soil lead levels over 1,000 ppm; and

6. The soil levels of antimony, beryllium, cadmium, copper, cobalt and arsenic were below the level of concern and therefore no action is needed.

Human Health Risk Assessment

The Ministry of the Environment conducted a human health risk assessment for seven metals (antimony, beryllium, cadmium, cobalt, copper, lead, nickel) and arsenic because these elements were found in the surface soils of the Rodney Street community at concentrations that warranted further investigation. The health risk assessment was peer reviewed by an international panel of experts so the ministry could be assured that the best and most recent science was used in its Rodney Street study. The panel included recognized North American and European experts from the fields of: human health, nickel toxicology, risk assessment and metal bioaccessibility. The peer review experts were:

- Dr. Ambika Bathija (Washington, D.C.), affiliated with the United States Environmental Protection Agency

- Dr. Lynne Haber (Cincinnati, Ohio), affiliated with the Toxicology Excellence for Risk Assessment

- Dr. Robert Jin (Toronto, Ontario), affiliated with the Ontario Ministry of Health and Long-Term Care

- Dr. Tor Norseth (Oslo, Norway), affiliated with the Norwegian National Institute of Occupational Health

- Dr. Rosalind Schoof (Seattle, Washington), affiliated with Gradient Corporation

- Dr. John Wheeler (Atlanta, Georgia), affiliated with the Agency for Toxic Substances and Disease Registry

A human health risk assessment can be triggered when contaminants are found in a community at levels above the ministry's *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997). The ministry's health risk assessment examined total exposure to contaminants through a number of possible pathways, such as the air we breathe, the soil we may incidentally ingest, the water

we drink and the food we eat.

This human health risk assessment has assessed exposure to soil contaminants in the Rodney Street community. The ministry's report established soil concentration levels that maintain human exposure below health protection criteria. The assessment has also established levels to remediate soil and to reduce exposure to contaminated soil.

Nickel

The report reviewed the toxicological basis for health protection criteria that have been developed by key agencies worldwide responsible for health and environmental protection. These health-based criteria are developed to provide protection against the most sensitive effects found in human or animal studies. For nickel, the most sensitive effects are reproductive effects and reduced organ weight in animals. The health risk reassessment establishes a soil nickel intervention level of 8,000 ppm, which is intended to protect toddler-aged children. The report finds this soil intervention level should not pose immediate or long-term risks to other age groups. However, it is noted in the report that there are insufficient scientific data to determine if the Rodney Street community nickel soil intervention level of 8,000 ppm will prevent nickel dermatitis in sensitized individuals, or prevent people from becoming sensitized to nickel. The Ventana Community Health Assessment Project being undertaken through the Community Based Risk Assessment will further investigate nickel dermatitis in Port Colborne.

In this human health risk assessment, the ministry considered contaminant exposures from a variety of sources including: indoor and outdoor air; soil and dust; food from the supermarket and home gardens; and the municipal drinking water supply. To protect residents, and especially toddlers, the soil nickel intervention level was developed to ensure that all of these nickel exposures did not exceed a value that is well below any potential health risk.

The ministry's *Guideline for Use at Contaminated Sites in Ontario* (MOE, 1997) references a human health value for nickel in soil of 310 ppm. However, the 310 ppm value is only used for a generic clean-up of soil or as a trigger value above which soil nickel levels require a detailed, scientific, human health risk assessment. Soil levels above 310 ppm do not necessarily constitute a health risk, rather they trigger the need for further study. The 310 ppm value should not be used for site specific health risk assessments, such as the study done by the ministry for the Rodney Street community, or the Community Based Risk Assessment that is being done for the broader community.

The form of nickel in the soil can have an important impact on its availability and its toxicity for both the natural ecosystem and human health.

The predominant form of nickel in the soil in the Rodney Street community is nickel oxide (80% of the total nickel, on average). This is consistent with known emissions from the metallurgical process employed by Inco, especially in its historic operations. This is also acknowledged by

Inco.

After the shutdown of the refinery in 1984, nickel injury on sensitive species of vegetation has rarely been observed in Port Colborne. This corroborates the low soil nickel plant bioavailability results (the ability of plants to absorb nickel from the soil) and suggests that most of the nickel injury observed on vegetation up to 1984 was likely from deposition and absorption of nickel from the ambient air and not from uptake of soluble nickel from nickel-contaminated soil by plants. There were no symptoms of nickel related injury to plants observed in the Rodney Street community during the most recent investigations.

Nickel levels in air fell continuously from 1992 to 1995, the most recent time period for which the ministry has complete air data. Limited ambient air data for the Rodney Street community obtained by the MOE in 2001 shows that the current nickel levels in air are about 1/3 of what they were from 1992 to 1995 and are in the concentration range found in other Ontario cities.

Using the 2001 air nickel data, and taking a cautious approach that assumes all of the nickel is in the form of nickel oxide (the predominant form of nickel found in the soil), the life-time cancer risk is estimated to be in the range of 3.1×10^{-6} to 1.6×10^{-5}, a range which is considered to be very low. This is an interim estimate since risks for carcinogens are usually based on an average annual air concentration. Data for the summer and fall months are available for the Rodney Street community in 2001. The ministry will continue to monitor ambient air in 2002 to confirm the declining trends in air nickel levels. In addition, the ministry will determine the form of nickel present in the air to better estimate the risk. Inco, at the ministry's request, is also assessing air emissions from their Port Colborne refinery.

Lead

Lead in soil has long been recognized as posing potential risks, particularly to children up to five years of age, who were considered the most sensitive to exposures for direct soil/dust ingestion.

The average soil lead level in surface soil in the Rodney Street community is about 200 ppm, which is similar to other older urban residential communities in Ontario. As a result, estimated exposures (and hence blood lead levels) are predicted to be similar to those for other urban Ontario populations. The Regional Niagara Public Health Department undertook blood lead screening clinics in Port Colborne between April and June 2001. A key conclusion from the clinics was that children under seven years and pregnant women in the Eastside community are not at increased risk of lead exposure compared to other communities in Ontario, even considering the localized elevated soil lead levels on some properties.

It is prudent, however, to conclude that the 11 properties with reported soil lead levels higher than 1,000 ppm may have some possibility of elevating blood lead levels in children who routinely play in these areas.

As a result, the report proposes an intervention level of 1,000 ppm for lead for play areas on residential properties or in public areas ***covered by sod and grass*** to which children have access. ***The bare soil*** intervention level for lead is 400 ppm for these areas. Residents at properties exceeding 1,000 ppm lead in soil were advised in March and again in October 2001 of their soil lead levels and provided information on reducing environmental lead exposure. Additional ways to reduce exposure to the lead in soil are presented in the ministry's fact sheet, *"Frequently Asked Questions About Lead Contamination"*.

Arsenic

People everywhere in North America are exposed to low levels of arsenic in the environment. Exposures can occur by a number of different pathways including normal diet and drinking water. The measured soil-arsenic levels in the Rodney Street community were compared to the levels found in other Ontario communities with elevated levels of soil arsenic. In the case of these communities, no adverse health effects were predicted to be associated with the arsenic in the soil.

This report concludes that the measured levels of arsenic in Rodney Street community soil are unlikely to pose an undue health risk to residents of this community, based on consideration of: the measured availability of the arsenic in these soils; comparison to typical levels elsewhere; and knowledge of health study outcomes involving arsenic soil exposure in other Ontario communities.

Antimony, Beryllium, Cadmium, Cobalt and Copper

Taking the same approach as used for nickel, estimates were modeled using the maximum reported levels of each metal in the Rodney Street community surface soil and backyard produce, Port Colborne municipal drinking water, ambient air and supermarket food.

For the metals antimony, beryllium, cadmium, cobalt and copper, estimated total daily intakes for all age groups were well below stringent oral or breathing exposure limits from major recognized jurisdictions, such as the US Environmental Protection Agency, World Health Organization and Health Canada. No adverse health effects are anticipated to result from exposure to antimony, beryllium, cadmium, copper or cobalt, in soils in the Rodney Street community.

Therefore, soil intervention levels were not developed and no action is required for these metals for the Rodney Street community.

Background

From 1918 to 1984 Inco operated a nickel refinery in the city of Port Colborne. Between the years 1972 and 1991, the Ontario Ministry of the Environment conducted numerous investigations to document the impact of Inco's emissions on soil and vegetation in and around

Port Colborne. These investigations concluded that emissions from more than a half a century of of nickel refining had resulted in metal contamination of soil in various locations throughout the Port Colborne area. Nickel, copper and cobalt concentrations in surface soil (0 to 5 cm depth) were elevated in residential communities adjacent to Inco and for a considerable distance downwind (east-northeasterly) of the refinery to levels which could or did cause injury to vegetation (phytotoxicity). Generally, the vegetation impacts were on farm crops and to silver maple trees.

The ministry's effects-based guideline for nickel, copper, cobalt, arsenic and zinc are all based on phytotoxicity (injury to vegetation). The Guideline's criterion for selenium is based on the protection of grazing animals. Numerous ministry studies conducted on Port Colborne farms in the 1970s and 1980s documented toxicity to agricultural crops as a result of ambient air SO_2 fumigations and metal soil contamination. Up to 1991 the highest soil nickel concentration that could be proven to exist through repeat sampling in the Port Colborne area was 9,750 ppm. A human health risk assessment using this maximum soil-nickel level was published by the ministry and Regional Niagara Public Health Department in 1997. It was concluded at the time that based on a multi-media assessment of potential risks, no adverse health effects are anticipated to result from exposure to nickel, copper, or cobalt, in soils in the Port Colborne community.

Additional extensive soil sampling was conducted by the ministry in Port Colborne and the surrounding area in 1998 and 1999 and demonstrated that soil nickel concentrations exceeded background levels up to 28 km downwind of the refinery, covering a 345 km^2 area of the Niagara peninsula. Furthermore, soil nickel levels exceeded the ministry's effects-based guideline (the level of nickel in soil that ***may*** cause injury to plants) for a distance of up to 3 km downwind of Inco over an area of almost 29 km^2. In addition, copper and cobalt also exceed their corresponding effects-based soil guidelines in smaller areas of the community, mainly immediately east, north, and northeast of the refinery.

In September 2000, soil nickel levels from a single property on Rodney Street were found to exceed the soil nickel level used in the 1997 health risk assessment (9,750 ppm). This result caused the ministry to sample and analyze soil from all properties on Rodney Street. Preliminary results of the additional sampling indicated that surface soil nickel levels ranged up to 17,000 ppm, and that the soil metal levels were extremely variable between properties. As a result, in November 2000, the ministry sampled soil from residential properties south of Louis Street to Rodney Street and east of the Welland Canal to Davis Street, to determine the extent of this contamination. Between April 25 and May 5, 2001 the ministry sampled surface soil from additional residential properties as requested by the residents. In all, almost 2,000 soil samples were collected from about 200 properties.

The findings that some properties had high metal levels in soil triggered the ministry to undertake a human health risk assessment of metals and arsenic found at elevated concentrations in the soil.

Soil Investigation Results - Extent and Severity

Ministry investigations have shown elevated soil metals levels around Port Colborne and in residential communities adjacent to the Inco site. Because the community is in close proximity to the refinery, soil would have received stack emissions as well as extensive fugitive emissions, both of which would have been particularly significant early in Inco's operating history.

The ministry sampled the front, back or side yard on each property, depending on the size and nature of each yard. The strategy also included intensive quality control with the taking of duplicate and triplicate soil core samples from selected properties. The strategy was designed to allow the ministry to describe the specific soil levels for each property and to also define with precision, the soil-metal level variability that is present in the community. This information was used in combination with the human health risk assessment to establish a soil intervention level for nickel.

The soil nickel concentration in the Rodney Street community averaged about 2,500 ppm, while the single highest concentration was 17,000 ppm. Ninety per cent of the soil nickel concentrations for all samples collected in the Rodney Street community are below 5,600 ppm. Twenty-five of the properties sampled had at least one soil result that exceeded the soil nickel intervention level of 8,000 ppm developed to be protective of toddler-aged children.

Soil-metal concentrations on average increased slightly with depth to a maximum of between 10 cm to 20 cm, the limit of the majority of residential sampling performed. Based on trench digging, metal concentrations above the proposed soil nickel intervention level are not likely to be found much deeper than 30 cm on most residential properties within the community.

Sources and Mechanisms

Based on the extensive surface soil sampling investigation and laboratory testing, elevated soil levels for nickel, copper, and cobalt in the Rodney Street community are considered directly related to Inco emissions. The company acknowledged this in an open letter to the public in December 2000.

Both Inco and Algoma emitted arsenic, however it is not possible to confidently apportion which company contributed how much arsenic and where it was deposited in the Rodney Street community.

Elevated soil lead levels were found on some properties randomly scattered in the Rodney Street community. This is considered typical of domestic residential lead sources in older urban communities and is not attributed to either Inco or Algoma emissions. The erosion and flaking of old lead-based paint from exterior structures such as house and shed walls, porches, fences, poles and playground equipment is a common source of soil lead contamination in older urban communities. The soil lead levels found in the Rodney Street community are not unusual, either

in extent or concentration, relative to other similar urban communities in Ontario.

Levels of cadmium, chromium, copper, barium, and zinc in soil were often associated with higher lead levels. Along with lead, these elements were common pigment, anti-mildew, or anti-fungal additives in old exterior paint and are frequent co-contaminants in residential soil. Lead and antimony levels observed in the soil are an indication that batteries may have been stored or disposed of on the property, whereas lead, barium and zinc soil contamination is a signature of lead-based paint.

With the exception of one property where elevated beryllium levels were concurrent with high lead and other metals, the marginally elevated soil beryllium concentrations across the Rodney Street community are likely related to the presence of slag and local shale deposits. Emissions from Algoma may have contributed to the marginally elevated soil beryllium levels in the Rodney Street community.

Considerable variability in soil contaminant levels was evident between adjacent properties. This "patchwork" pattern of high-and-low soil contamination on neighbouring lots is likely related to property maintenance and landscaping. Adding topsoil or mulch, re-sodding, building, and cultivating gardens are landscaping practices that, over time, tend to cover or dilute contaminants that are predominantly present in the surface soil. It also indicates that the source of the soil contamination is likely atmospheric and that with recent deposition substantially decreased, newly landscaped properties have not become re-contaminated to the levels of undisturbed properties.

Information from six trenches in the community indicated that the higher levels of metals in soil were to be found in the upper layers, supporting the likelihood that metals in soil in the wider community resulted from atmospheric deposition. However, visual and test findings from three other trench samples indicated that fill materials may have contributed to higher metal levels in soils on some properties, particularly on the south of Rodney Street.